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2017

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UNIVERSITY OF CALIFORNIA,
IRVINE

Compact Development and Gender Inequality:
Do More Accessible and Walkable Built Environments Promote Gender Equality in Travel and
Activity Space Behaviors?

DISSERTATION

submitted in partial satisfaction of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

in Transportation Science

by

Ashley (Wan-Tzu) Lo

Dissertation Committee:
Associate Professor Douglas Houston, Chair
Professor Jean-Daniel Saphores
Professor Michael McNally

2017

DEDICATION

To my family,
Mom, Dad, Hideo, and Kevin

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ABSTRACT OF THE DISSERTATION

Do More Accessible and Walkable Built Environments Promote Gender Equality in Travel and Activity Space Behaviors?

By

Ashley (Wan-Tzu) Lo

Doctor of Philosophy in Transportation Science

University of California, Irvine, 2017

Associate Professor Douglas Houston, Chair

Researchers have been concerned that suburban sprawl could reinforce gendered mobility patterns and lead to gendered differences in mobility. Previous studies also argued that the effectiveness of land use policy could be influenced by men and women's different mobility patterns in response to built environments. To address these concerns, this dissertation uses the 2010-2012 California Household Travel Survey data and directly compares the within-household gendered travel and spatial behaviors for households with paired heads living in Southern California. The study examines whether built environments, including destination accessibility, design and walkability have different impacts on male and female heads' daily travel and activity space behaviors and whether potential urban design can help improve gendered inequality in daily mobility.

Based on negative binomial, Tobit, and feasible generalized least squares regressions, the results show that that male and female heads respond to built environments with different travel and spatial behaviors. Living in walkable and accessible areas is likely to encourage male heads

to walk, reduce their dependence on driving, locate activity center close to home, and have spatially concentrated activities. Female heads tend to respond to walkable and accessible living environments with reducing automobile travel and with centering and confining their activities near residential neighborhoods.

The negative binomial, Tobit, and binary logit regression analyses that investigate the influences of built environments on gendered inequality indicate that high walkability and regional accessibility are likely to reduce the gendered inequality in motorized travel distance and relax female heads' spatial (and temporal) constraints relative to their husbands.

This dissertation contributes to the policy debates by informing planners and feminist geographers that the effects of built environments can be heterogeneous even for men and women from similar backgrounds and compact design can be the key to gendered equity. Given that compact developments are being rapidly implemented in Southern California, this dissertation study is expected to help shape effective and efficient land use policies in the future.

PREFACE

Feminist planners have been long concerned that suburban sprawl could lead to gendered mobility patterns. To my knowledge, however, the empirical studies on whether men and women respond to urban form with different travel and spatial behaviors and how urban design influences gendered differences in mobility remain limited. In particular, given that the region of Southern California is seeking to implement compact developments, this study can help understand the effectiveness of the proposed plans from a gender perspective.

This dissertation research directly compares the within-household gendered travel and activity space behaviors for households residing in the region of Southern California Association of Governments. This dissertation consists of four chapters. Chapter 1 introduces the background, objectives, policy relevance, and datasets of this dissertation research. Chapter 2 investigates how accessibility at local and regional levels differs for male and female heads' daily travel behaviors and whether elements of compact design can help promote gendered equality in daily travel patterns. Chapter 3 moves beyond the one-dimensional measure through examining the influences of built environments on the within-household gendered differences of activity space behaviors, including the size of activity space, the degree of residential deconcentrating, the compactness degree, and the degree of bounding non-home activities. Chapter 4 provides the overall conclusions, contributions and policy implications of this dissertation research.

These studies were processed from 2013 to 2017 at the Transportation Science Program, Institute of Transportation Studies, University of California, Irvine.

CHAPTER 1: General Introduction

1.1 Motivation

Scholars have raised concerns that suburban sprawl could strengthen gender stereotypes and gender differences in the participation of social activities (Hayden, 1980, 2002; Johnson & Johnson, 2008; Little, Peake, & Richardson, 1988). Sprawling development patterns, in turn, could result in and reinforce gendered differences in travel behavior (Handy, 2006). Given one recent study suggests that elements of compact design may help reduce gender difference in the division of household tasks (Fagan & Trudeau, 2014), planners should consider whether urban design can help improve gender equity in travel and activity spatial behaviors. Unfortunately, previous research has failed to directly connect characteristics of the urban form and built environment of residential neighborhoods with gendered differences in travel and spatial activity patterns. As a result, further empirical work is needed to better understand the influence of built environments on gendered differences in travel and activity space in order to identify potential urban design and sustainability policies which could help improve gender equality in access to urban environments and associated opportunities.

This dissertation argues that three important areas of research should be developed to better understand the implications of urban design on gender equality: (1) Studies should provide a more comprehensive analysis of the influence of built environments on daily travel and activity space patterns rather than focusing primarily on particular trip purpose such as work or chauffeur trips; (2) Studies should examine the influence of a more comprehensive set of built

environments variables on gendered travel and activity spatial behaviors after controlling for socio-demographic factors in order to analyze the effectiveness of each land use policy; (3) Studies should more directly measure the absolute differences in travel and activity spatial behaviors between men and women within households rather than aggregately emphasizing differences for particular subpopulations. As far as is known, this dissertation is the first study that incorporates all the three elements.

1.2 Objectives and Organization of the Dissertation

This dissertation contributes to these areas by analyzing the 2010-2012 California Household Travel Survey (CHTS) to examine the within-household gendered equalities in daily travel and spatial patterns for heterosexual paired heads. The analysis examines the daily travel patterns for 3,588 married couples in Los Angeles and daily spatial behaviors for 1,316 married couples in Southern California based on travel diary.

The primary research questions are whether elements of compact design can help improve gendered equality in mobility and whether men and women respond to built environments differently, and is it investigated two stages: Part 1 examines gendered inequalities in daily trip frequencies and daily travel distances, and Part 2 examines gendered differences in the sizes of activity spaces, the degree of centering activity spaces on residences, the degree of localizing activity spaces, and the degree of bounding non-home activities.

Results will contribute to the literature by extending analysis by Hanson (2010) and Hayden (1980, 2002); they will in particular contribute to policy debates by informing feminist

planners whether compact design is a key leverage to suggest gendered equity in men and women's mobility patterns (Little et al., 1988).

1.3 Background: How Gender Inequality Relates to Mobility and Built Environments

Mobility is the process of moving people between places in their daily lives (Hanson, 2010) and is one important dimension of understanding social equity (Bailey & Surface Transportation Policy Project, 2004; Hjorthol, 2008; Kim, 2011; Ong & Houston, 2002; Rosenbloom & Altshuler, 1977). Mobility is influenced by endogenous and exogenous factors. For example, employed female heads in two-partner households tend to be primarily responsible for household-supporting errands (Demo & Acock, 1993; Golob & McNally, 1997; Hanson & Hanson, 1981; Presser, 1994; Sarmiento, 1996), and she needs to complete these primary tasks within certain amount of time; therefore, the geographic extent of her daily activity space is likely to be more limited than her male counterpart (Hjorthol, 2008). The endogenous factor within household (the division of household tasks) leads to different commute patterns between men and women (Johnston-Anumonwo, 1992).

Previous literature also argues that suburban settlement patterns isolate women's public participation and burden employed women with second shift duty (Hayden, 1980; Little et al., 1988). Second shift indicates that employed women undertake in the responsibility of the unpaid household-related tasks after they come back home from their professional jobs (Hochschild & Machung, 2012). Hayden (1980) and Pickup (1988) suggested a strategy that could advantage women who play dual roles in work and at home: enhancing land use mixing and surrounding

opportunities (Hayden, 1980; Pickup, 1988). A recent case study in Minneapolis-St. Paul metropolitan region suggests that elements of new urbanism, including compact mixed-use design and the proximity between home and commercial establishments, results in more even distribution of domestic labors within a household (Fagan & Trudeau, 2014). Given this finding, it could be valuable to investigate whether urban design, as an exogenous factor, accounts for gender equality in mobility patterns.

Existing research provides some insights into gendered travel patterns and the effects of development patterns on mobility patterns. Men and women are likely to have dissimilar travel patterns because of their social roles (Greenwald & McNally, 2008; McGuckin & Murakami, 1999; McGuckin & Nakamoto, 2005; Noland & Thomas, 2007; Rosenbloom, 1995, 2006; Strathmen & Dueker, 1995; Wachs, 1996). Urban design is associated with individual travel behavior (Burnett & Hanson, 1982; Cervero, 1996; Cervero & Gorham, 1995; Crane & Crepeau, 1998; de Abreu e Silva, Golob, & Goulias, 2006; Dieleman, Dijst, & Burghouwt, 2002; Maat & Timmermans, 2006; McNally & Ryan, 1993; Strathmen & Dueker, 1995; Wallace, Barnes, & Rutherford, 2000). However, to our knowledge, understanding how the influence of the built environment differs for men and women remains an understudied area (Crane, 2007; Hanson, 2010), and more research is needed to more directly measure how the built environment affects gendered inequality in mobility patterns.

1.4 Policy Relevance

A more comprehensive understanding of the connection between gender and mobility is needed to understand the implications of sustainable development and transportation and policies (Hanson, 2010). In particular, the regional transportation plan and sustainable community strategy (RTP/SCS) of the Southern California Association of Governments (SCAG) aims at promoting sustainable mobility through integrating land use and transportation planning.

For example, SCAG projects to direct nearly 50% of new housing and employment growth in high-quality transit areas (HQTAs) between 2012 and 2040 (SCAG, 2016). SCAG defines that an HQTA is a walkable and compact transit neighborhood with one-half mile of distance to a well-serviced transit stop. People living in HQTAs can enjoy integrated residential and commercial opportunities as well as convenient access to transportation alternatives to drive alone (SCAG, 2016). This dissertation can help shed light on how policy contexts, such as characteristics of compact developments, interact with gender and mobility, and is expected to draw implications for tailoring effective policies.

SCAG's RTP/SCS also anticipates achieving the economy, environment, and social equity by equitably distributing the benefits of the plan for all demographic groups over the region and not disproportionately impacting any particular group (Southern California Association of Governments, 2016). The regional plan specifically emphasizes the goal to protect minority and low-income communities from being unevenly exposed to negative environmental impacts of transportation projects. It is equally important for planners to consider whether these policies for the region of Southern California build an equitable travel environment for men and women. This dissertation focus on gendered issues can help ensure that the proposed plans are attuned to providing more equality in different areas.

1.5 Dataset Background

Travel and activity location data used in this dissertation are based on the 2010-2012 California Household Travel Survey (CHTS) and built environment and land use information from various sources. Below describes the common data sources that are analyzed in the dissertation in detail.

1.5.1 2010-2012 California Household Travel Survey

This dissertation analyzes paired household heads' travel and activity behaviors based on 2010-2012 California Household Travel Survey (CHTS) (National Renewable Energy Laboratory, 2013). The survey is a two-year statewide household travel survey project conducted by California Department of Transportation (Caltrans). It collected travel diaries from 42,431 households in California and portions of three nearby counties in Nevada over a 24-hour period on the assigned travel day from February 1, 2012 through January 31, 2013 (NuStats, 2013a). Analyses in this dissertation are based on the CHTS one-day travel logs of the survey participants.

The original survey data provide information of survey participants at household, person, place, and activity levels. Each household is assigned a sample number, and each survey respondent in the household is given a person number that is unique to the household. Data at household and person levels contain comprehensive demographic and socio-economic information. For each place visited by a survey participant, a unique identifier is assigned to the person; in particular, each visited place corresponds with up to three activities with unique identifiers as well.

The place data file includes records of unlinked trips for survey participants, including travel time, travel distance, travel mode, longitudinal and latitudinal data of visited place, and other relevant information; note that the longitudinal and latitudinal data are stored in WGS 84 geographic coordinate system and are not released to the public to protect participants' privacies. Travel behavior and activity space variables that are used in the dissertation study are calculated based on the place data file. Records of vehicle information and long-distance trips of the survey respondents are also included in the original data but are not used in this dissertation.

The main purpose of this dissertation is to understand the influence of built environments on gendered travel patterns and spatial behaviors for households in Southern California, so the analyses focus on 15,235 households from the counties of Los Angeles, Orange, Riverside, San Bernardino and Ventura that encompasses the SCAG region. Overall, there were 8,219, 2,401, 1,701, 1,703, and 1,211 households from Los Angeles, Orange, Riverside, San Bernardino and Ventura Counties, respectively. Analyses in this dissertation directly compare the travel and spatial behaviors for each of the paired households. The number of individuals included in the analyses is twice the number of household heads: Chapter 2 analyzes the gendered travel patterns for 3,588 married couples (7,176 paired heads) and Chapter 3 analyzes the gendered spatial behaviors for 1,316 married couples (2,632 paired heads).

1.5.2 Built Environment Variables

To understand the influences of urban design on travel and activity patterns, the dissertation considers the D factors as the built environment measures: destination accessibility and design (Ewing & Cervero, 2001, 2010). Destination accessibility is defined as the ease of access to trip attractions. Design measures the characteristics of nearby street network. In addition, the

dissertation also obtains walk score from Walk Score[®] as an integrated built environment measure of design and destination accessibility (Carr, Dunsiger, & Marcus, 2011). Definitions and sources of the built environment factors are described below.

Regional Accessibility (Destination Accessibility) is a gravity measure calculated by the number of employment opportunities on a 10-meter grid and the Euclidean distance between the household's grid cell and other grid cells. The gravity measure implies that the influences of destinations on a household would decrease as the distances between the destinations and household locations increase. The data were obtained from 2008 firm-level InfoUSA employment data (Houston, Boarnet, Ferguson, & Spears, 2014). Below describes the gravity measure.

$$RA_i = \frac{Emp_i}{5} + \sum_{j \neq i} \frac{Emp_j}{d_{ij}}$$

where

RA_i is the regional accessibility for household i

Emp_i is the number of employment in the grid cell in which household i is located

Emp_j is the number of employment in grid cell j

d_{ij} is the Euclidean distance between the centroids of cells i and j

Note that the distance of five meters is used to weight the employment opportunities in the household's grid cell. This dissertation uses the standardized regional accessibility across the SCAG region calculated by Houston et al. (2014) for the analyses.

Local Accessibility (Destination Accessibility) measures near-residency neighborhood business firms as the number of local population-serving retail and service establishments within 0.25 miles of a household's residency based on 2008 firm-level InfoUSA employment data. Firms classified as local retail and service establishments had an industry code which was identified in previous research as being associated with greater walking and increased local accessibility (Boarnet, Joh, Siembab, Fulton, & Mai Thi Nguyen, 2011). Note that employment accessibility and near-residency neighborhood business firms respectively represent regional and local destination accessibilities, because these two variables indicate the ease of access to trip attractions in different spatial scales (Ewing & Cervero, 2010; Handy, 1993)

Street Connectivity (Design) was calculated based on 2010 Topologically Integrated Geographic Encoding and Referencing (TIGER) roadway data from US Census Bureau. It estimates nearby street connectivity based on the number of multi-intersections within a quarter mile of household's residence.

Walk Score (Destination Accessibility and Design) represents walkability of a given geo-location obtained from Walk Score[®]. Several studies have validated the reliability of walk score (Carr et al., 2011; Duncan, Aldstadt, Whalen, Melly, & Gortmaker, 2011; Manaugh & El-Geneidy, 2011). Walk Score[®] analyzes possible walking routes between the given geo-location and nearby amenities. This measure accounts for the accessibility to the destinations and the street connectivity of the vicinity of a given location (Carr et al., 2011).

The web service employs gravity-based model that awards points to amenities based on the distance to the amenities (“Walk Score Methodology,” 2016). The model designates maximum points to the amenities within 5 minutes of walking but no points to amenities with more than 30 minutes of walking. The range of the walk score values for a given location falls between 0 to 100. According to Walk Score[®], the surrounding area of a given location is regarded walkable when the walk score is greater than 70, otherwise the location is not very walkable or car-dependent.

The Walk Score[®] for each household in the analysis was obtained from the Walk Score[®] service. In order to increase efficiency and avoid typos, I requested the Application Programming Interface (API) key from Walk Score[®]. The API service provides users a free service to obtain walk scores of 5000 locations per 24 hours. The API key service also allows users to use longitude and latitude as inputs so that users are able to acquire walk score directly instead of converting longitudinal and latitudinal data into address via Google Map (“Walk Score API,” 2016). Therefore, I acquired the walk scores for the 15,235 study households in the SCAG region.

CHAPTER 2: Do More Accessible and Walkable Built Environments Promote Gender Equality in Travel?

2.1 Introduction

This chapter examines whether near-residence built environments influence gender differences in different travel behaviors between paired heterosexual couples in Los Angeles County, California in terms of daily trip frequency and travel distance by all modes of ground transportation, walking, driving, and automobile travel. Results indicate that walk score and regional accessibility of the residential location consistently play key roles in the estimations of people's daily trips and travel distances and gendered inequalities in daily trip frequencies and travel distances whereas street connectivity and local accessibility do not play key roles. Male heads consistently have greater daily travel distances than their female counterparts. Estimation results suggest that living in areas with a higher walk score and higher regional accessibility overall decrease the inequality, in particular the inequality of travel distance. This study is expected to provide planners and policy makers new perspectives of understanding gendered travel equality, especially given compact development policies are being rapidly adopted to create more sustainable regions and communities. These communities could be associated with more sustainable travel outcomes, but no previous study has directly addressed the impact of compact development on gender inequality and whether men or women are more likely to shift towards more sustainable travel behavior.

The remainder of this chapter consists of four parts. The next section reviews previous research regarding gendered travel behaviors and the association between built environments and travel behaviors. The first analysis section analyzes the daily trip frequencies and travel distances by mode for paired heterosexual couples in Los Angeles controlling for demographics, socio-economics, and built environments. The second analysis section more directly examines gendered inequalities in these travel outcomes within households and the influence of built environmental factors on such inequalities. Each analysis section describes the relevant data, variables of interests and methodologies that were employed in the section. The final section discusses the policy implications based on the findings and limitations. Subsequently, tables, appendices, and references are provided.

2.2 Background

2.2.1 Gender Inequality in Travel Behavior

Several previous studies have identified significant differences in travel behaviors between men and women (Crane, 2007; Law, 1999; Rosenbloom, 2006). In terms of trip frequency, women tend to make more trips overall than men (Lu & Pas, 1999; Nobis & Lenz, 2005; Rosenbloom, 2006). In particular, women are more involved in non-work trips than men (Boarnet & Crane, 2001; Boarnet & Sarmiento, 1998; Crane & Crepeau, 1998; Nobis & Lenz, 2005). For example, a logistic regression study showed that women had higher propensity of conducting grocery-shopping trips (Mauch & Taylor, 1997). Rosenbloom (2006) analyzed the 2001 NHTS data by selected life cycle and sex, and found that married women undertook more shopping and passenger-serving trips than married men; however, these results did not directly compare the

within-household differences for paired household heads. The study of the 1999 Adelaide travel survey made similar conclusions, and found that women tended to make stops for shopping and passenger-serving in their simple trip chains, whereas men undertook more work-related trips (Primerano, Taylor, Pitaksringkarn, & Tisato, 2007).

On the other hand, women tend to have shorter trips than men. Based on 1990 NPTS data, Rosenbloom (1995) indicated that not only did female trip makers have lower daily vehicle-mile-traveled (VMT) but their daily aggregate travel distance was less than male trip makers. The similar trend was found outside of the U.S.: analysis of the 2002 travel survey data in Germany showed women on average had shorter trip distance (Nobis & Lenz, 2005). Studies focusing on commute patterns yielded comparable results. According to the analysis of the 1990 and 2000 travel survey data in the San Francisco Bay Area, women's commute time was less than that of men (Gossen & Purvis, 2005). Turner and Niemeier (1997) also suggested that women traveled less than men in terms of commute time and distance based on 1990 NPTS data. Other studies consistently showed that women had lower commute distance than men (Cervero & Duncan, 2006; Clark, Huang, & Withers, 2003; Crane, 2007; de Abreu e Silva et al., 2006; Johnston-Anumonwo, 1992; Nobis & Lenz, 2005).

Regarding mode choice, women have a higher reliance on walking, transit and auto-passenger modes, while men have a higher reliance on driving modes (Crane, 2007; Hanson & Johnston, 1985; Nobis & Lenz, 2005). Furthermore, men are less likely to travel by a non-personal vehicle mode for home-based personal business trips (Cervero & Kockelman, 1997). de Abreu e Silva et al. (2006) utilized structural equation modeling (SEM) to identify that gender had indirect effects on individuals' travel behavior. Their results revealed that women made more transit and non-motorized trips but less car trips compared to men. Demographic factors,

such as life-cycle events, also explain gendered differences in travel patterns (Scheiner, 2014). Women's responsibilities for household tasks and child-care leads them to have dissimilar travel pattern and greater need for travel flexibility (Spain, 1996). Although Gossen and Purvis (2005) concluded that the gendered difference in travel time converged, other studies suggest found that the divergence of gendered travel behavior persists (Crane, 2007; Rosenbloom, 2006).

2.2.2 Built Environment and Travel Behavior

Built environmental factors has a significant influence with travel behavior (Boarnet & Crane, 2001; Cervero, 1996; Crane & Crepeau, 1998; de Abreu e Silva et al., 2006; Dieleman et al., 2002; McNally & Ryan, 1993). Ewing and Cervero (2010) identified five “D” variables, which represent different measures built environments, including density, diversity, design, destination accessibility and distance to transit.

A substantial body of literature provided insights of how these “D”s explain travel behavior in terms of trip frequency, travel length and mode choice. For example, transit and non-motorized trip frequencies have positive correlations with residential and employment densities, mixed land-use, mixed street design, accessibility to employment and retails, and density of nearby transit stops (Boarnet & Crane, 2001; Ewing, 1995; Frank & Pivo, 1994; Handy, 1992; Houston, Boarnet, et al., 2014; Ross & Dunning, 1997; Sun, Wilmot, & Kasturi, 1998). In contrast, automobile trip frequency decreases with increasing residential and employment densities, diversity and street connectivity (Boarnet & Crane, 2001; Boarnet & Sarmiento, 1998; Crane & Crepeau, 1998; Frank & Pivo, 1994).

Some studies identified that trip length is negatively associated with density, land use mixing, retail and employment accessibility, and proximity to public transit (Boarnet, Houston, Ferguson, & Spears, 2011; Cervero, 1996; Cervero & Duncan, 2006; Cervero & Kockelman, 1997; Ewing & Cervero, 2001; Handy, 1993; Houston, Boarnet, et al., 2014). In particular, improved destination accessibility can better account for decreasing VMT than do other built environment variables. Based on a quantitative statistical analysis of previous research, Ewing and Cervero (2010) calculated the weighted average elasticity of VMT with respect to built environment variables. The authors suggested that VMT is negatively associated with two measures of destination accessibility: employment accessibility by automobiles and distance to downtown, and that other built environment variables had relatively weak and inelastic relationships with VMT.

Regarding mode choice, previous research indicated that the propensity of using public transit and non-motorized modes increased with higher density, land use diversity, proportion of four-way intersections, and shorter distance to transit, and that the likelihood of using automobiles drops along with increases in these built environment factors (Cervero, 1989, 1996; Cervero & Kockelman, 1997; Ewing & Cervero, 2010; Ross & Dunning, 1997). Even though individual preference and perception of the surrounding environments may attenuate the influence of built environmental factors (Handy, Cao, & Mokhtarian, 2005, 2006; Spears, Houston, & Boarnet, 2013), the significance of built environment still remained after controlling for residential self-selection (Cao, Mokhtarian, & Handy, 2009).

2.2.3 Gender, Built Environment, and Travel Behavior

Few studies have examined the influences of built environments on gendered differences of travel behavior. Hanson and Johnston (1985) suggested that the spatial distributions of male and female-dominated occupations account for the gendered difference in commute trip length. Rosenbloom (1995) showed that women had higher trip frequency than men in urban areas, but found no significant gendered difference between men and women in rural settlements. The study also indicated that gendered differences in daily travel distance were greater in urban areas than in rural areas.

Clifton and Livi (2005) analyzed the impacts of the perceptions of the urban environments on gendered walking behaviors based on a travel survey of three Maryland communities. They found that women were more sensitive to walking environments than men because of safety concerns, which implied that the characteristics of urban form affected women's willingness to walk. Clifton & Dill (2005) further suggested that men were more adaptable to walking environments and took more walks than women and these differences could be due to different shares of household responsibilities and different perceptions of safety and built environmental factors. Nevertheless, Mokhtarian, Ye, & Yun (2010) found that women were more likely to adapt their commute behaviors by avoiding rush hour and changing routes and modes to the changing built environments than men.

Results of previous research on community design, travel behaviors, and perception identified that community design might account for gendered difference in vehicle miles driven per week but not in walking trips (Handy, 2006); on the weekly basis, the results showed that women living in traditional design neighborhoods on average drove 35 miles less than the male

counterparts while women living in suburban areas on average drove 50 miles less than the male counterparts.

A recent study by Boarnet and Hsu (2015) used the 2001 Southern California Household Travel Survey to analyze the influences of built environments on the gendered gap of non-work travel (Boarnet & Hsu, 2015). The study directly compared the within-household differences in chauffeuring trips for paired household heads. It found that the households with the presence of children had remarkably gendered differences in chauffeuring behaviors and female heads primarily bore the chauffeuring responsibilities. In terms of the land use effects, the paper suggested that compact development can minimize the gender gap in chauffeuring travel.

Baronet and Hsu (2015) also compared the within-household differences in chauffeuring before and after the sample was adjusted for residential selection bias by implementing propensity score matching. The matching technique considered two cases: (1) households living within 0.5-mile of a bus stop or beyond 0.5-mile of a bus stop, and (2) households living in 0.5-mile radius neighborhoods with more than 50% of low density residential use and less than 50% of low density residential use. The authors concluded that residential selection was not associated with land use effects on within-household differences in chauffeuring trips.

2.2.4 Limitation of Previous Studies

Yet, these previous studies on gendered travel patterns only used a limited set of built environment measures for analyses, considered only one type of travel mode, or were limited to a particular trip purpose. Hanson & Johnston (1985) focus on gendered differences in commute trips and only considered whether the residence and workplace were located in city to

approximate to built environmental characteristics. The study was based on the 1990 NPTS data and analyzed gendered differences in daily travel patterns for people living in urban and rural areas (Rosenbloom, 1995).

Handy (2006) suggested that men and women had significantly different vehicle miles driven per week, and the results showed that the gendered differences became greater for those living in suburban areas than for those living in traditional neighborhoods. These studies only used simplified built environment variables to conduct bivariate analyses and they failed to account for how specific near-residence built environment characteristics could affect gendered travel behaviors.

Although Clifton & Livi (2005) and Clifton and Dill (2005) used a set of comprehensive built environment factors and attitudinal data to analyze gendered travel behaviors, these studies only examined walking behaviors. Boarnet & Hsu (2015) conducted analyses to understand the effects of land uses on gendered gap in chauffeuring trips for paired household heads with children under 16 years old; however, this study focused only on child-serving tasks rather than accounting for the overall gendered travel patterns.

This dissertation study provides a more comprehensive understanding of difference and inequality in travel patterns by using specific near-residence built environment variables and examining trips for all purposes. Since men and women have dissimilar travel behavior, and elements of new urbanism may help reduce trip lengths, we hypothesize that: (1) men and women have different mobility patterns in response to urban design; (2) there exists less gendered inequality in travel behavior as urban design incorporates any element of compact development.

2.3 Data and Methods

2.3.1 Part I Data

The first part of the analysis examines gender differences in trip frequency and mean travel distance by mode for paired heterosexual couples in Los Angeles controlling for demographics, socio-economics, and built environmental factors. Through the separate estimations on men and women's daily travel patterns, the analysis provides an understanding of whether built environments differently account for male and female heads' travel patterns.

The analysis examines households with heterosexual paired heads living in Los Angeles County based on the 2010-2012 CHTS. The 2010-2012 CHTS provided detailed information to help identify the head of a surveyed household and the relationships of other surveyed respondents to the head from the same household. In this context, a household with paired heads represents that the head of the household had exactly one spouse or partner who was identified by the travel survey. For demographic and socio-economic records, households without complete information for number of children under 15-year-old, household income, number of household vehicles, paired head's age, ethnicity, possession of driver license, and employment status were removed from the dataset during data cleaning.

Only travel records for the male and female heads of household were retained and used for analysis, and households in which either the female or male head traveled outside of California, or had non-ground travel or incomplete travel data were eliminated from the dataset. Among the 8,219 households over the Los Angeles County, there were 4,549 households with paired male and female heads. After the data cleaning process was performed to remove households with incomplete information, there were 3,588 households remaining in the dataset

for the analysis. For analysis of driving trips, only records for the female or male head with a valid driver license were included in the analysis, which resulted in a subsample of 3,431 male heads and 3,194 female heads.

The analyses focused on individual's daily trip frequency and travel distance by all modes of ground transportation, walking, driving, and automobile travel. Driving trips include trips for which the individual was the driver of private vehicle on the trip, and automobile trips include trips travelled by private automobile, motorcycle, carpool, and rental vehicle. Separate analysis of automobile trips allows analysis of the effect of built environmental factors on the daily VMT per capita from the perspective of sustainability. For each private automobile trip, VMT per capita per trip is the total vehicle mile travelled of the trip divided by the total number of people traveling on the trip. The daily VMT per capita is to aggregate the VMT per capita per trip over all the automobile trips taken by a person on the surveyed day (Frank et al., 2006; U.S. Department of Transportation, 2010).

Analysis of daily travel time was not conducted for two reasons. First, traffic congestion would be one factor that could bias daily travel time analysis. Second, since the dataset was based on self-reported travel diary, there could exist discrepancies between the self-reported travel time and the actual travel time (Houston, Luong, & Boarnet, 2014). The 2010-2012 CHTS used TripBuilder to calculate distance of each trip so it could possibly provide a more systematic estimation of travel distance and avoid using potentially faulty estimates of travel time (NuStats, 2013a).

Given that previous meta-analysis suggested that destination accessibility showed strong associations with motorized and non-motorized travel (Ewing & Cervero, 2010), the analysis aimed at the influence of destination accessibility on gendered travel behaviors. Built

environment factors included street connectivity (design), regional accessibility (destination accessibility), local accessibility (destination accessibility), and walk score (design and destination accessibility). Note that since walk score represents an integrated measurement of street design and local destination accessibility (Carr et al., 2011; “Walk Score Methodology,” 2016), the analysis further controlled for street connectivity.

Street connectivity, regional accessibility, and local accessibility were stratified into quartiles based on the total of 8,219 CHTS households in Los Angeles County. The stratified data allowed us to directly compare built environment factors at different levels. The lower level indicates the built environment of a household’s residence was below the first quartile. Built environment variables that were in-between the first and second quartiles and the second and third quartiles were at low-medium and medium-high levels, respectively. Lastly, the high level indicates that the built environment of a household’s residence was greater than the third quartile. The stratified thresholds are shown in Table 2-1. The analysis did not stratify Walk Score[®] because it provides the criteria that identify the walkability of a given location, and this score was only obtained for the analysis sample. The location with a Walk Score[®] greater than 70 is considered as a very walkable area, locations with walk score between 50 and 69 and less than 49 are regarded as moderately walkable and car-dependent areas, respectively (“Walk Score Methodology,” 2016).

Table 2-1 Stratified thresholds of street connectivity, regional accessibility, and local accessibility over the 8,219 surveyed households in Los Angeles

Quartile	1st	2nd	3rd
Street connectivity	5	9	15
Regional accessibility	245.16	299.05	339.20
Local accessibility	4	14	39

2.3.2 Part I Methodology

The methodologies employed in this section include descriptive statistics, hypothesis testing and regression analysis. The descriptive statistics provide the summaries of the variables of interest. The mean travel behaviors were calculated based on the weights at household, person, and trip levels. The formula below demonstrates the calculation methods of the weighted means for individuals suggested by Appendix P of 2010-2012 CHTS report (NuStats, 2013b):

$$\overline{wTB} = \frac{\sum_{i=1}^I \sum_{k=1}^K tcfpwgt_{i,k} \cdot TB_{i,k}}{\sum_{i=1}^I perwgt_i}$$

$\overline{wTB}$ is the weighted mean travel behavior

$TB_{i,k}$ and $tcfpwgt_{i,k}$ represent the travel behavior and weight of trip k for individual i ; $perwgt_i$ is the person weight.

The hypothesis testing is conducted to identify potential differences in individual travel behaviors among subgroups. I processed the hypothesis testing based on unweighted data. For the purpose of testing the means of paired heads' daily trip frequency and travel distance, I used χ^2 and paired t-test; for testing the differences of the means of individual daily trip frequency and travel distance by stratified built environments, I employed χ^2 and ANOVA (Washington, Karlaftis, & Mannering, 2003).

Following the hypothesis testing, I separately estimated the influence of socio-demographics and built environment variables on male and female heads' daily travel behaviors for the 3,588 households in order to understand whether built environmental factors accounted for differences in male and female heads' travel behaviors. I conducted the analysis based on two regression methods: the negative binomial models for daily trip frequency and Tobit models for daily travel distance. The negative binomial model is expressed as follows:

$$y_i = \exp \left(\sum_{k=0}^K \beta_k x_{i,k} + \varepsilon_i \right), \varepsilon_i \sim \text{iid } \Gamma(1, \alpha)$$

y_i represents daily trip frequency for the head of household i ,

β_k is the coefficient for covariate x_k .

The expression of Tobit model is as follows:

$$y_i = \begin{cases} y_i^* & \text{if } y_i^* > 0 \\ 0 & \text{if } y_i^* \leq 0 \end{cases}$$

$$y_i^* = \sum_{k=0}^K \beta_k x_{i,k} + u_i, u_i \sim N(1, \sigma^2)$$

y_i^* is a latent variable that represents daily travel distance for the head of household i ,

β_k is the coefficient for covariate x_k .

The regressions were programmed in R by employing MASS and AER packages (Kleiber & Zeileis, 2008a, 2008b; Venables & Ripley, 2002). For each regression method, I developed two models that contain different measures of local destination accessibilities: the first model considered street connectivity, regional accessibility, and local accessibility; the second model incorporated regional accessibility and walk score.

Previous research, however, stressed the importance of accounting for potential endogeneity between residential selection and built environments (Boarnet & Crane, 2001; Cao & Fan, 2012; Handy et al., 2006). Not accounting for residential selection may lead to the fallacious interpretation of the influences of built environments (Mokhtarian & Cao, 2008). The problem of selection bias arises when people choose their residential locations based on their travel preferences (Boarnet & Crane, 2001); this could generate systematic differences that could

result in biased effects (Cao et al., 2009). I implemented propensity score matching (PSM) to mimic quasi-randomized experiment in order to remedy the biases and approximately and equally compare the outcomes (d'Agostino, 1998; Rosenbaum & Rubin, 1983).

The purpose of PSM is to pair a treatment unit with a control unit that has the closest propensity score to the treatment unit. I developed three models that estimated a set of demographic and socioeconomic covariates on the probability of household's residence choice. I used the MatchIt package in R (Ho, Kosuke, King, & Stuart, 2011, 2013) and the 0.01 caliper that matches the treated and control units suggested by a 2012 study on investigating the effect of population density on travel behaviors by using propensity score matching (Cao & Fan, 2012).

The designations of PSM "treated" groups were based on the following dichotomous variables: the household residence was located (1) within 0.25 miles of any transit stop, (2) in a block group with 50% or more of the land use was designated as single-family residential, and (3) in a walkable neighborhood (walk score greater than 70). Results of PSM are described in Appendix A.

For the three treatment cases, the summary statistics after matching in general show that the mean differences between treated and control groups were improved (Appendix A). The regression analyses in this chapter utilize the matched data based on the third treatment group, "the household residence was located in a walkable community", for the following reason. Near-residence transit stops and the percentage of single-family land uses may only be able to reflect the neighborhood characteristics of household's residence in one dimension, whereas walk score is a composite index that represents the near-residence walkability in terms of street connectivity and local destination accessibility (Carr et al., 2011; "Walk Score Methodology," 2016).

Relatively speaking, a household's walkability could provide more composite and complete information related to household's residential choice than the other two binaries.

The matching technique that assigned households living in walkable neighborhoods to treated group generated 1,728 households: 983 treatment households matched with 745 control households. Given that I only analyzed the driving behaviors for household heads with valid driver license, the driving pattern analysis was performed using 1,581 male heads (886 treatment and 695 control units) and 1,361 female heads (749 treatment and 612 control units). In the main results section below, descriptive results are based on the full sample of 3,588 households; negative binomial and Tobit analyses that used the PSM subsample based on the walkable neighborhood estimation were used to discern the influences of built environmental factors.

Appendix D documents the estimations of people's daily trip frequencies and travel distances based on the other two PSM subsamples for households living within 0.25 mile of any transit stop and for households living in block groups with more than 50% of single-family use. The comparisons of the results of the three PSM subsamples suggest that the signs and magnitudes of the estimated coefficients in general remain consistent but the significances of the built environment factors become less significant for the walkability PSM sample than for the other two PSM samples.

2.3.3 Part II Data

The second part of the analysis more directly examines gendered differences and inequalities in travel outcomes within paired households and the influence of built environmental factors on such differences and inequalities. It uses the same dataset of the 3,588 households from 2010-

2012 CHTS that were analyzed in the first part of the analysis. The focal point of this part is to assess the influence of built environments on gendered gap in daily trip frequency and travel distance by examining directly the difference in these travel outcomes between partners in the same household to investigate whether households residing in areas with more compact development have greater equality in their travel behaviors. Since it could introduce the appearance of artificial equality to include households without any trips on the observed day (Boarnet & Hsu, 2015), such "artificial zero gap" were eliminated from the dataset, which resulted in 3,174 households, 711 households, 2,966 households, and 3,019 households that were valid for the analyses of all modes, walking, driving, and automobile trips, respectively.

I considered the following demographics and socio-economics for regression analysis: the number of children under 15 years old, household income levels, the number of household vehicle, age, ethnicity, the possession of valid driver license, and being employed. Built environmental factors included the street connectivity, regional accessibility, local accessibility, and walk score previously described.

2.3.4 Part II Methodology

In part II of the analysis, I used two approaches to define gendered gap. The first one estimates the difference in travel behaviors between paired heads; it is defined as the subtraction of female head's travel behavior from the paired male head's travel behavior, as follows:

Difference in travel behavior

$$= \text{Male head's travel behavior} - \text{Female head's travel behavior}$$

The second definition estimates the inequality in travel behaviors in terms of the absolute value of the difference in travel behaviors between paired heads, as follows:

Inequality in travel behavior

$$= |\text{Male head's travel behavior} - \text{Female head's travel behavior}|$$

The analysis of the difference in travel behaviors helps understand whether the female head has relatively limited mobility compared to male counterpart. These measures of inequality in gendered travel provide a more direct measure of whether built environmental factors seem to be associated with greater equality in travel behaviors between paired heads. The weighted mean differences and inequalities are summarized based on the following equations:

$$\overline{wMD} = \frac{\sum_{i=1}^I (\sum_{k=1}^K \text{tcfpwgt}_{i,MHH,k} \cdot \text{TB}_{i,MHH,k} - \sum_{l=1}^L \text{tcfpwgt}_{i,FHH,l} \cdot \text{TB}_{i,FHH,l})}{\sum_{i=1}^I \text{hhwgt}_i}$$

$$\overline{wMI} = \frac{\sum_{i=1}^I (|\sum_{k=1}^K \text{tcfpwgt}_{i,MHH,k} \cdot \text{TB}_{i,MHH,k} - \sum_{l=1}^L \text{tcfpwgt}_{i,FHH,l} \cdot \text{TB}_{i,FHH,l}|)}{\sum_{i=1}^I \text{hhwgt}_i}$$

$\overline{wMD}$ and $\overline{wMI}$ are the weighted mean difference and inequality, respectively

$\text{tcfpwgt}_{i,MHH,k}$ and $\text{TB}_{i,MHH,k}$ respectively represent the weight and travel behavior of trip k for male head from household i.

$\text{tcfpwgt}_{i,FHH,k}$ and $\text{TB}_{i,FHH,k}$ respectively describe the weight and travel behavior of trip l for female head from household i hhwgt_i is the weight of household i.

Hypothesis testing was employed to test the mean differences and the mean inequalities of the unweighted data across built environments. I used χ^2 for testing the mean difference and inequality in trip frequency and ANOVA for examining the mean difference and inequality in travel distance. Regression estimations adopted negative binomial and Tobit models for

investigating the influence of built environments on gendered inequality in terms of daily trip frequency and travel distance, respectively.

The negative binomial model was programmed by using MASS package in R (Venables & Ripley, 2002), using the following equation:

$$y_i = \exp\left(\sum_{k=0}^K \beta_k x_{i,k} + \varepsilon_i\right), \varepsilon_i \sim \text{iid } \Gamma(1, \alpha)$$

y_i represents the inequality in daily trip frequency between paired heads for household i
 β_k is the coefficient for covariate x_k .

The Tobit model employed AER package in R (Kleiber & Zeileis, 2008b) for obtaining the estimated coefficients on covariates, using the following equation:

$$y_i = \begin{cases} y_i^* & \text{if } y_i^* > 0 \\ 0 & \text{if } y_i^* \leq 0 \end{cases}$$

$$y_i^* = \sum_{k=0}^K \beta_k x_{i,k} + u_i, u_i \sim N(0, \sigma^2)$$

y_i^* is a latent variable that represents the inequality of daily travel distance between paired heads for household i
 β_k is the coefficient for covariate x_k .

Each regression method was conducted based on two sets of covariates that controlled for the same demographic and socio-economic covariates but different built environmental variables. The first set considers street connectivity, regional accessibility, and local accessibility; the second set includes regional accessibility and walk score. Subsequent to the estimations on gendered inequality, the section employed the same negative binomial and Tobit models from

the analysis part I section for the part II analysis subsamples in order to examine the individual travel patterns for heads from households with no artificial zero gap (Appendix C).

Nevertheless, the problem of residential selection could remain, and neglecting selection bias could make interpretation of the influence of built environmental factors problematic (Boarnet & Crane, 2001; Cao & Fan, 2012; Cao et al., 2009; Handy et al., 2006; Mokhtarian & Cao, 2008). Consistent with part I analysis, the PSM and MatchIt package in R was applied again for pairing treatment and control units based on the households with no artificial zeros (d'Agostino, 1998; Ho et al., 2011, 2013; Rosenbaum & Rubin, 1983), and I used the 0.01 caliper to match the treatment and control groups (Cao & Fan, 2012). I considered the same dichotomous variables to designate treatment groups, including (1) household's residence was located within 0.25 miles of any transit stop, (2) single-family residential use was more 50% in household's block group, and (3) household lived in a walkable neighborhood (walk score greater than 70).

Similar to the PSM results in part I, the results for matching non-artificial zero households show that the mean differences of propensity scores after matching were improved by more than 99% (Appendix A). The mean differences of the covariates between treated and control groups were overall improved as well.

The analysis regression results presented in part II include households in the PSM dataset that was matched based on household's surrounding walkability. Similar to what has been described in part I, walkability is an integrated measure that describes both street connectivity and local destination accessibility (Carr et al., 2011; "Walk Score Methodology," 2016). The walkability measure may better reflect household's residential choice because it reveals the composite attributes of the nearby built environments, unlike the other two treatments only

describe the neighborhood characteristics near households' residences from a one-dimensional perspective.

The matching technique obtained 1,537 households (860 treated and 677 control units), 388 households (244 treated and 144 control units), 1,379 households (780 treated and 599 control units), and 1,413 households (799 treated and 614 control units) for analyzing the gendered inequalities of all modes of ground transportation, walking, driving, and automobile travel, respectively. Appendix A presents the estimation methods and results of PSM. In the main analyses below, descriptive statistics are based on the full sample of the non-artificial-zero households by mode. The negative binomial and Tobit regressions were conducted again based on the matched units, and are presented as the core analyses. Appendix B provides the results of the full datasets for comparative purposes to see whether significances of built environment were diluted when selection bias was accounted for.

Appendix D provides the estimation results of within-household gendered inequalities in daily travel patterns based on the PSM subsamples for households living within 0.25 mile of a transit stop and for households living within the block group with more than 50% of single-family use. The results based on the three PSM subsamples show that the signs and magnitudes of the estimated coefficients are consistent.

However, for the estimations on gendered inequality in all mode trip frequency, the built environment factors remain moderately significant in the PSM subsample for walk score whereas the significances of built environmental factors disappear for the estimations based on the other two PSM samples. For the estimations on gendered inequalities in travel distance, built environmental factors became moderate in the PSM subsample for walk score but the results

based on the other two PSM samples show that regional accessibility remain significances at 1% level.

2.4 Results

2.4.1 Results Part I: Travel Behaviors for Paired Household Heads

This section analyzes gender differences in trip frequency and mean travel distance by mode for married heterosexual couples in Los Angeles controlling for demographics, socio-economics, and built environmental factors. The separate estimations for men and women's travel behaviors are expected to provide an understanding of whether built environments differently account for male and female heads' travel patterns.

Descriptive Results

Table 2-2 summarizes the socio-demographic variables and built environment measures that are considered in Analysis I. The mean numbers of children and vehicles are 0.65 and 2.11 per household, respectively. More than 50% of the households had an annual income between \$50,000 and \$99,999. Male and female heads on average are about 54 years old. Hispanic heads represent 30% of the sample whereas African-American heads are only 5% of the sample. The summary also indicates that male heads are more likely to possess a valid driver license and to be employed compared to female heads. The distribution of built environmental factors suggests that more than half of the households in the sample live in areas with low and low-medium street connectivity and destination accessibility. The mean of walk score suggests that most of the households live in car-dependent neighborhoods.

Table 2-3 provides the summary of household head's weighted daily mean frequency by mode and by gender. Overall, female heads on average has more daily trips than male heads; male and female heads have 3.68 and 4.11 trips per day, respectively. When trip frequency is compared by mode, female heads have more walking trips, but fewer driving trips than male heads. Results of the hypothesis testing indicate that these differences in mean trip frequencies were statistically significant. Although female heads have slightly higher overall automobile trips than male heads, this difference is not significant. Recall that for a person who has a driving trip, this person is the driver of private vehicle on the trip. For a person who takes an automobile trip, this person travels by privately operating automobile, carpool, motorcycle or rental car.

Table 2-3 also shows the mean trip frequencies by stratified built environment categories. Male and female heads living in areas with low street connectivity, low regional and local accessibility, and a low walk score are more likely to take driving and automobile trips than household heads living in areas with greater accessibility and walkability. Male and female heads living in areas with high street connectivity, high regional and local accessibility, and a high walk score consistently take more trips by all modes and walking than heads living in areas with less walkability and accessibility.

The greatest differences in trip frequencies across built environmental contexts occur for driving trips. Male and female heads have significantly different means of driving trip frequencies at different levels of built environments. The findings reveal that head living in the area with higher level of built environment tends to have more trips. According to the results of the hypothesis testing, daily trip numbers for male head, walking trips for male and female heads, and automobile trips for female heads show significantly differences across the stratified built environments.

Tables 2-4a and 2-4b summarize the weighted mean travel distance by mode and by gender. Male and female household heads travel 26.12 miles and 22.50 miles per day, respectively, and male heads had greater miles traveled than female heads across all built environmental categories. Note that VMT per capita per trip is defined as the total vehicle mile travelled of an automobile trip divided by the total number of people traveling on the trip. A person's daily VMT per capita is to aggregate the VMT per capita per trip over all the automobile trips taken by the person on the surveyed day (Frank et al., 2006; U.S. Department of Transportation, 2010).

Both male and female heads who reside in areas with low street connectivity, low regional and local accessibility, and a low walk score consistently traveled more miles by all modes and driving and automobile modes than household heads residing in areas with greater walkability and accessibility. Male and female heads in areas with high walkability and accessibility consistently traveled fewer miles by all modes and by driving and automobile modes. The overall daily walking distance for households was greater in areas with higher accessibility and walkability, and female heads consistently had higher walking distance across all levels of built environmental categories compared to male heads.

Table 2-2 Descriptive statistics of independent variables in Part I analysis

Means of independent variables	Male heads	Female heads
Household characteristics		
The number of children		0.65
HH income: \$0-\$49,999 (1/0)		0.27
HH income: \$50,000-\$99,999 (1/0)		0.53
HH income: Greater than \$100,000 (1/0)		0.20
Number of vehicles		2.11
Head's characteristics		
Age	54.18	51.52
Hispanic (1/0)	0.27	0.28
African-American (1/0)	0.05	0.04
Valid driver license (1/0)	0.96	0.89
Employed (1/0)	0.73	0.57
Street connectivity¹		
Low (1/0)		0.34
Low-medium (1/0)		0.24
Medium-high (1/0)		0.21
High (1/0)		0.20
Regional accessibility²		
Low (1/0)		0.30
Low-medium (1/0)		0.26
Medium-high (1/0)		0.25
High (1/0)		0.19
Local accessibility³		
Low (1/0)		0.34
Low-medium (1/0)		0.23
Medium-high (1/0)		0.24
High (1/0)		0.19
Walkable neighborhood⁴		
Walk Score		52.97
Sample size	3,588	3,588

¹ Street connectivity is defined as the number of multi-intersections within a quarter mile of household's residence. Low street connectivity represents that value is less than the 1st quartile of street connectivity; low-medium and medium-high levels of street connectivity represent that the values are in-between 1st and 2nd quartiles and 2nd and 3rd quartiles, respectively. High street connectivity represents that the value is greater than the 3rd quartile of street connectivity.

² Regional Accessibility is calculated by the number of employment opportunities on a 10-meter grid and the Euclidean distance between the household's grid cell and other grid cells. Definitions of the stratifications can be referred Footnote 1.

³ Local accessibility measures the near-residency neighborhood business firms as the number of local population-serving retail and service establishments within 0.25 miles of a household's residency. Definitions of the stratifications can be referred to Footnote 1.

⁴ Walkable neighborhood uses the data from Walk Score[®] to represents walkability of a given geo-location. The higher the Walk Score is, the more walkable the residential neighborhood is. According to Walk Score[®], Walk Score below 49 is regarded as car-dependent; Walk Score between 50 and 69 means somewhat walkable; Walk Score ranging from 70 to 89 represents very walkable; Walk Score greater than 90 suggests walker's paradise.

Table 2-3 Male and female household heads' daily mean trip frequency by mode

Mean trip frequency		Trips by All Modes			Walking Trips			Driving Trips ¹			All Automobile Trips ²		
		MHH	FHH	Sig. ³	MHH	FHH	Sig. ³	MHH	FHH	Sig. ³	MHH	FHH	Sig. ³
All		3.68	4.11	***	0.43	0.77	***	2.66	2.32	***	3.03	3.12	
Street connectivity	Low	3.54	3.92		0.21	0.33		2.83	2.68	***	3.26	3.52	
	Low-medium	3.49	4.14	*	0.41	0.78		2.52	2.35	**	2.88	3.08	**
	Medium-high	3.81	4.34		0.60	1.06		2.58	2.12	**	2.87	2.94	
	High	3.96	4.12		0.62	1.12		2.64	1.95	***	3.04	2.75	
Sig. ⁴		*			***	***				***		*	
Regional accessibility	Low	3.43	3.87	*	0.21	0.34		2.76	2.61	**	3.12	3.45	
	Low-medium	3.71	3.93		0.36	0.53		2.81	2.52	***	3.19	3.26	
	Medium-high	3.59	4.05		0.37	0.66		2.66	2.43		3.02	3.22	
	High	4.03	4.65		0.85	1.64	*	2.38	1.65	***	2.78	2.49	
Sig. ⁴		**	*		***	***			***			***	
Local accessibility	Low	3.45	4.00		0.18	0.30		2.85	2.78	***	3.18	3.63	
	Low-medium	3.46	3.96		0.37	0.52		2.58	2.55	*	2.91	3.25	
	Medium-high	3.86	4.18		0.54	1.03		2.69	2.01	***	3.08	2.86	
	High	4.00	4.33		0.74	1.38		2.43	1.82	***	2.88	2.59	
Sig. ⁴		***			***	***		**	*		***	**	
Walk Score	Car dependent	3.34	3.87		0.17	0.30		2.73	2.67	***	3.11	3.50	
	Somewhat	3.74	4.04	*	0.40	0.59		2.78	2.50	***	3.14	3.24	
	Walkable	3.97	4.43		0.75	1.43	*	2.47	1.77	***	2.85	2.60	
Sig. ⁴		**	*		***	***			***			**	

Significance: * p < .1, ** p < .05, *** p < .01.

¹ For a person who has a driving trip, this person is the driver of private vehicle on the trip.² For a person who takes an automobile trip, this person travels by privately operating automobile, carpool, motorcycle or rental car.³ χ^2 test was used to examine whether there existed significant differences in mean trip frequencies between male and female heads in each subgroup (e.g. low street connectivity). Significance indicates that the mean trip frequency of male heads is different from the mean trip frequency of female heads in the subgroup.⁴ χ^2 test was used to examine whether there existed significant differences in mean trip frequencies for people living in different BEs (e.g. low, low-medium, medium-high, and high street connectivity). Significance indicates that the mean trip frequencies are different for people living in different BEs.

Table 2-4a Male and female household heads' daily mean travel distance by all modes and walking

Mean travel distance (mile)		Miles by All modes			Walking Miles		
All		MHH	FHH	Sig. ¹	MHH	FHH	Sig. ¹
		26.12	22.50	***	0.18	0.36	***
Street connectivity	Low	31.87	26.72	***	0.12	0.18	
	Low-medium	24.54	22.38	***	0.15	0.46	***
	Medium-high	22.65	19.60	***	0.20	0.44	***
	High	22.95	19.31	**	0.26	0.43	***
Sig. ²		***	***		***	***	
Regional accessibility	Low	34.31	29.03	***	0.12	0.18	
	Low-medium	26.41	23.15	***	0.13	0.31	***
	Medium-high	22.59	20.90	**	0.18	0.32	***
	High	20.56	16.30	***	0.28	0.68	***
Sig. ²		***	***		***	***	
Local accessibility	Low	32.01	27.39	***	0.11	0.17	*
	Low-medium	23.12	22.28		0.15	0.30	**
	Medium-high	24.98	20.69	***	0.21	0.45	***
	High	22.24	18.15	***	0.26	0.59	***
Sig. ²		***	***		***	***	
Walk Score	Car dependent	31.16	27.30	***	0.09	0.16	***
	Somewhat	25.28	22.39	***	0.16	0.31	*
	Walkable	21.60	17.61	***	0.28	0.62	***
Sig. ²		***	***		***	***	

Significance: * $p < .1$, ** $p < .05$, *** $p < .01$.

¹ Paired t-test was used to examine whether there existed significant differences in mean travel distances between male and female heads in each subgroup (e.g. low street connectivity). Significance indicates that the mean travel distance of male heads is different from the mean travel distance of female heads in the subgroup.

² ANOVA test was used to examine whether there existed significant differences in mean travel distances for people living in different BEs (e.g. low, low-medium, medium-high, and high street connectivity). Significance indicates that the mean travel distances are different for people living in different BEs.

Table 2-4b Male and female household heads' daily mean travel distance by driving, automobile mode, and VMT per capita

Mean travel distance (mile)		Driving Miles			All Automobile Miles			VMT Per Capita ¹		
All		MHH	FHH	Sig. ²	MHH	FHH	Sig. ²	MHH	FHH	Sig. ²
		20.90	13.30	***	24.48	20.87	***	18.99	13.40	***
Street connectivity	Low	26.37	16.69	***	30.96	25.93	***	23.73	16.69	***
	Low-medium	20.32	12.50	***	23.05	19.94	***	18.75	12.65	***
	Medium-high	17.68	10.92	***	20.51	17.45	***	15.34	11.01	***
	High	16.77	11.57	***	20.54	17.84	*	15.95	11.75	***
Sig. ³		***	***		***	***		***	***	
Regional accessibility	Low	29.04	17.77	***	33.46	28.31	***	26.28	18.42	***
	Low-medium	22.26	13.53	***	25.42	22.09	***	19.77	14.13	***
	Medium-high	17.26	13.42	***	20.91	19.37	*	16.42	12.62	***
	High	14.35	7.91	***	17.33	12.89	***	12.80	7.85	***
Sig. ³		***	***		***	***		***	***	
Local accessibility	Low	27.24	17.17	***	31.27	26.73	***	24.59	17.34	***
	Low-medium	19.07	14.16	***	21.87	20.75		17.48	14.06	**
	Medium-high	19.21	10.66	***	22.93	18.56	***	17.33	10.94	***
	High	15.84	10.32	***	19.37	15.66	**	14.58	10.27	***
Sig. ³		***	***		***	***		***	***	
Walk Score	Car dependent	26.21	17.27	***	30.50	26.65	***	23.53	17.34	***
	Somewhat	20.64	13.22	***	23.89	20.78	***	18.97	13.32	***
	Walkable	15.53	9.26	***	18.65	14.93	***	14.20	9.36	***
Sig. ³		***	***		***	***		***	***	

Significance: * p < .1, ** p < .05, *** p < .01.

¹ A person's daily VMT per capita is to aggregate the VMT per capita per trip over all the automobile trips taken by the person on the surveyed day. VMT per capita per trip is defined as the total vehicle mile travelled of an automobile trip divided by the total number of people traveling on the trip.

² Paired t-test was used to examine whether there existed significant differences in mean travel distances between male and female heads in each subgroup (e.g. low street connectivity). Significance indicates that the mean travel distance of male heads is different from the mean travel distance of female heads in the subgroup.

³ ANOVA test was used to examine whether there existed significant differences in mean travel distances for people living in different BEs (e.g. low, low-medium, medium-high, and high street connectivity). Significance indicates that the mean travel distances are different for people living in different BEs.

Regression Results

Part I regression analyses separately investigate factors associated with male and female head's travel behaviors. Results are presented in separate tables, and each table represents two models for each of the following travel outcomes: total trips, walking trips, driving trips, all automobile trips, total travel distance, walking distance, driving distance, all automobile distance, and VMT per capita. Each table contains two models that estimate the influence of a different set built environmental explanatory factors: The first includes street connectivity, regional accessibility, and local accessibility; the second includes regional accessibility and walk score. Note that walk score represents an integrated measurement of design and local destination accessibility.

The core analyses presented in the main text are the estimations based on PSM sample for walkable neighborhoods and the estimations based on the PSM subsamples for near-residency transit stop and single-family land use are provided in Appendix D. P-values of χ^2 tests claim whether the regression models are favorable. For comparative purpose, Appendix B (Tables B-1 to B-9) demonstrates the estimation results for the full dataset before PSM was implemented in order to understand the effects of residential selection.

The comparisons between the estimations on the PSM samples for walk score and the full sample suggests the presence of selection bias. For the estimations on the full sample for daily trip frequency and daily travel distance, street connectivity, local and regional accessibility, and walkability overall show significant impacts to various extents; however, for the estimations on the PSM sample, the significances of street connectivity and local accessibility disappear and the significances regional accessibility and walk score dilute.

This section first discusses factors associated with individual daily trip frequencies by all modes of ground transportation, walking, driving, and automobile based on the results of

negative binomial regressions, then it discusses factors associated with individual daily travel distance by all modes of ground transportation, walking, driving, automobile, and VMT based on the results of Tobit models.

In terms of the total daily trips estimated by negative binomial regressions, the number of children was consistently associated with a higher number of daily trips for both male and female heads after controlling for other factors (Table 2-5). The number of children is associated with a 14% of increase in female head's daily trip frequency, compared to 8% of increase in male head's daily trip frequency. Being in a lower income household was associated with fewer daily trips for male heads, but this variable was not significant in models for female heads. Age has parabolic relationship with daily trip frequency for both male and female heads. Regarding built environments, walk score has moderately associated with more daily trips for male and female heads.

In terms of daily walking trip frequency, the number of household vehicles and the possession of a valid driver license are consistently and negatively associated with the number of walking trips (Table 2-6). Living in an area with a higher Walk Score was associated with more walking trips. An increasing walking score is associated with a 1.8% and 1.6% increase in male and female heads' walking trip frequency, respectively. The number of children, being employed, and the possession of valid driver license were associated with more daily driving and automobile trips, but built environmental factors were not significantly associated with these travel outcomes (Tables 2-7 and 2-8).

Table 2-5 Negative binomial models for estimating individual daily trip frequency of all modes based on the PSM data

Dependent variable: Trip frequency of all modes of ground transportation	Model I-1				Model I-2			
	Male heads		Female heads		Male heads		Female heads	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	0.5227		-0.3355		0.4372		-0.3323	
Household characteristics								
The number of children	0.0822	***	0.1402	***	0.0838	***	0.1395	***
HH income: \$0-\$49,999 (1/0)	-0.1481	**	-0.0301		-0.1515	**	-0.0257	
HH income: \$50,000-\$99,999 (1/0)	-0.0019		0.0202		-0.0041		0.0225	
Number of vehicles	-0.0486	*	-0.0459		-0.0465	*	-0.0461	
Head's characteristics								
Age	0.0291	**	0.0579	***	0.0291	**	0.0561	***
Square age	-0.0003	***	-0.0006	***	-0.0003	***	-0.0006	***
Hispanic (1/0)	-0.0849		-0.0530		-0.0767		-0.0541	
African-American (1/0)	-0.1007		-0.0561		-0.0870		-0.0535	
Valid driver license (1/0)	0.0423		0.2996	***	0.0500		0.2997	***
Employed (1/0)	0.0449		0.0467		0.0402		0.0534	
Street connectivity								
Low-medium (1/0)	0.0199		0.0488					
Medium-high (1/0)	-0.0134		-0.0239					
High (1/0)	0.0485		-0.0344					
Regional accessibility								
Low-medium (1/0)	0.0773		-0.0733		0.0448		-0.0946	
Medium-high (1/0)	0.0596		-0.0462		0.0152		-0.0807	
High (1/0)	0.1042		-0.0048		0.0395		-0.0491	
Local accessibility								
Low-medium (1/0)	-0.0119		0.0610					
Medium-high (1/0)	0.0705		0.0752					
High (1/0)	0.0381		0.1328	*				
Walkable neighborhood								
Walk Score					0.0025	**	0.0021	*
Sample size	1,728		1,728		1,728		1,728	
Treated units	983		983		983		983	
Control units	745		745		745		745	
P-value of χ^2 (goodness of fit)	7.10E-07		1.60E-14		1.35E-08		3.33E-16	
Street connectivity	0.7390		0.5952					
Regional accessibility	0.5555		0.6361		0.9043		0.5733	
Local accessibility	0.5942		0.3855					
Walk Score					0.0340**		0.1036	
Log-likelihood	-4,006.85		-4,073.06		-4,006.50		-4,074.08	
McFadden adjusted R²	0.0033		0.0085		0.0046		0.0095	

Significance: * p < .1, ** p < .05, *** p < .01.

Table 2-6 Negative binomial models for estimating individual daily walking trip frequency based on the PSM data

Dependent variable: Walking trip frequency	Model I-3				Model I-4			
	Male heads		Female heads		Male heads		Female heads	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	-0.9191		-0.6501		-1.8723		-1.1008	
Household characteristics								
The number of children	-0.0071		0.0572		0.0098		0.0454	
HH income: \$0-\$49,999 (1/0)	-0.3808		-0.2609		-0.4113		-0.2485	
HH income: \$50,000-\$99,999 (1/0)	-0.1778		-0.2746		-0.2006		-0.2652	
Number of vehicles	-0.6212	***	-0.5256	***	-0.5818	***	-0.5131	***
Head's characteristics								
Age	0.1010	**	0.0547		0.1037	**	0.0550	
Square age	-0.0010	**	-0.0007		-0.0010	**	-0.0007	
Hispanic (1/0)	-0.5364	**	0.0439		-0.4524	**	0.0748	
African-American (1/0)	-0.9286	**	0.0911		-0.7952	*	0.2169	
Valid driver license (1/0)	-1.1569	***	-0.5268	**	-1.1408	***	-0.5321	**
Employed (1/0)	-0.3221		-0.1868		-0.3182		-0.1943	
Street connectivity								
Low-medium (1/0)	-0.0464		0.2009					
Medium-high (1/0)	-0.1695		0.0845					
High (1/0)	0.1996		0.1594					
Regional accessibility								
Low-medium (1/0)	0.3243		0.0999		0.0896		-0.0115	
Medium-high (1/0)	0.0028		0.1739		-0.3012		-0.0488	
High (1/0)	0.5182	*	0.4547	*	0.0896		0.1773	
Local accessibility								
Low-medium (1/0)	-0.0718		0.0873					
Medium-high (1/0)	0.3853		0.4306					
High (1/0)	0.3472		0.5363	**				
Walkable neighborhood								
Walk Score					0.0180	***	0.0157	***
Sample size	1,728		1,728		1,728		1,728	
Treated units	983		983		983		983	
Control units	745		745		745		745	
P-value of χ^2 (goodness of fit)	2.30E-10		2.05E-13		2.37E-13		2.22E-16	
Street connectivity	0.4248		0.8522					
Regional accessibility	0.0991*		0.2537		0.2678		0.7032	
Local accessibility	0.2528		0.1174					
Walk Score					0.0002***		0.0003***	
Log-likelihood	-1,141.98		-1,396.41		-1,139.05		-1,393.93	
McFadden adjusted R²	0.0199		0.0222		0.0266		0.0274	

Significance: * p < .1, ** p < .05, *** p < .01.

Table 2-7 Negative binomial models for estimating individual daily driving trip frequency based on the PSM data

Dependent variable: Driving trip frequency	Model I-5				Model I-6			
	Male heads		Female heads		Male heads		Female heads	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	0.2128		-1.1979	**	0.1978		-1.1070	**
Household characteristics								
The number of children	0.1104	***	0.2468	***	0.1122	***	0.2427	***
HH income: \$0-\$49,999 (1/0)	-0.2060	**	0.0151		-0.2181	**	0.0138	
HH income: \$50,000-\$99,999 (1/0)	-0.0238		0.0903		-0.0338		0.0926	
Number of vehicles	0.0713	**	0.0728	*	0.0687	**	0.0693	
Head's characteristics								
Age	0.0209		0.0676	***	0.0222		0.0663	***
Square age	-0.0002		-0.0007	***	-0.0002	*	-0.0007	***
Hispanic (1/0)	0.0434		-0.0949		0.0442		-0.0972	
African-American (1/0)	-0.0607		-0.1181		-0.0625		-0.1316	
Valid driver license (1/0)								
Employed (1/0)	0.1784	**	0.1451	*	0.1706	**	0.1431	*
Street connectivity	-0.0591		0.1075					
Low-medium (1/0)	-0.0571		0.0939					
Medium-high (1/0)	0.0524		0.0274					
High (1/0)								
Regional accessibility	0.0619		-0.0394					
Low-medium (1/0)	0.0276		-0.0420		0.0718		-0.0159	
Medium-high (1/0)	0.0237		-0.1020		0.0496		-0.0166	
High (1/0)					0.0352		-0.0721	
Local accessibility								
Low-medium (1/0)	-0.0124		0.0591					
Medium-high (1/0)	0.0118		-0.0271					
High (1/0)	-0.0654		0.0462					
Walkable neighborhood								
Walk Score					-0.0007		0.0001	
Sample size	1,581		1,361		1,581		1,361	
Treated units	886		749		886		749	
Control units	695		612		695		612	
P-value of χ^2 (goodness of fit)	5.22E-08		1.52E-09		5.02E-09		6.85E-11	
Street connectivity	0.3767		0.6607					
Regional accessibility	0.8978		0.8464		0.8603		0.9266	
Local accessibility	0.7251		0.7902					
Walk Score					0.6450		0.9591	
Log-likelihood	-3,345.93		-2,807.25		-3,347.92		-2,808.66	
McFadden adjusted R²	0.0050		0.0075		0.0059		0.0087	

Significance: * p < .1, ** p < .05, *** p < .01.

Table 2-8 Negative binomial models for estimating individual daily automobile trip frequency based on the PSM data

Dependent variable: Automobile trip frequency	Model I-7				Model I-8			
	Male heads		Female heads		Male heads		Female heads	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	-0.6669	*	-1.3326	***	-0.6921	*	-1.2993	***
Household characteristics								
The number of children	0.0930	***	0.1668	***	0.0946	***	0.1660	***
HH income: \$0-\$49,999 (1/0)	-0.1598	**	-0.0461		-0.1648	**	-0.0424	
HH income: \$50,000-\$99,999 (1/0)	-0.0054		0.0578		-0.0081		0.0604	
Number of vehicles	0.0743	**	0.0773	**	0.0739	**	0.0756	**
Head's characteristics								
Age	0.0146		0.0528	***	0.0147		0.0521	***
Square age	-0.0002		-0.0005	***	-0.0002		-0.0005	***
Hispanic (1/0)	0.0110		-0.0993		0.0146		-0.0996	
African-American (1/0)	-0.0896		-0.1407		-0.0862		-0.1417	
Valid driver license (1/0)	1.2111	***	0.9822	***	1.2170	***	0.9845	***
Employed (1/0)	0.1075		0.0915	*	0.1016		0.0946	*
Street connectivity								
Low-medium (1/0)	-0.0311		-0.0090					
Medium-high (1/0)	-0.0480		-0.0378					
High (1/0)	0.0178		-0.0574					
Regional accessibility								
Low-medium (1/0)	0.0514		-0.0933		0.0490		-0.0819	
Medium-high (1/0)	0.0274		0.0011		0.0273		0.0123	
High (1/0)	-0.0115		-0.1091		-0.0183		-0.0951	
Local accessibility								
Low-medium (1/0)	-0.0168		0.0340					
Medium-high (1/0)	0.0602		0.0489					
High (1/0)	0.0131		0.0591					
Walkable neighborhood								
Walk Score					0.0005		-0.0003	
Sample size	1,728		1,728		1,728		1,728	
Treated units	983		983		983		983	
Control units	745		745		745		745	
P-value of χ^2 (goodness of fit)	0.00E+00		0.00E+00		0.00E+00		0.00E+00	
Street connectivity	0.7256		0.8848					
Regional accessibility	0.7737		0.2631		0.7342		0.3218	
Local accessibility	0.6944		0.9178					
Walk Score					0.6963		0.8533	
Log-likelihood	-3,714.42		-3,696.43		-3,715.76		-3,696.86	
McFadden adjusted R²	0.0168		0.0293		0.0178		0.0305	

Significance: * p < .1, ** p < .05, *** p < .01.

Table 2-9 presents the Tobit regression results of daily travel distance for all travel modes for male and female heads. In terms of demographics and socio-economics, individuals with household income less than \$49,999 have 8-10 miles fewer daily travel miles than individual with household income greater than \$100,000 (the excluded category); the possession of a driver license and being employed were associated with greater overall daily travel distance. Regional accessibility is significant and negatively associated with individual daily travel distance. The estimated coefficients indicate that the regional accessibility may have stronger impacts on female heads than on male heads. For example, female heads living in areas with low-medium, medium-high, or high regional accessibility travelled 10-16 fewer miles than female heads living in low regional accessibility area (the excluded category). However, the differences between male heads living in low and higher regional accessibility categories are 7-12 miles.

In terms of daily walking distance, the number of household vehicles and the possession of driver license were negatively associated with daily walking distance (Table 2-10). Household income less than \$49,999 and being African-American could decrease male heads' walk distances. A household's walk score encourage walking behavior: a one unit increase in walk score was associated with 0.02 miles of increase in individual's daily walking distance.

Being employed was associated with 14-16 miles more miles of driving compared to being unemployed (Table 2-11). Regional accessibility consistently and significantly shows negative associations with male and female heads' driving distance. Male and female heads living in higher regional accessibility area drove 10-12 and 9-13 miles less than male and female heads living in low regional accessibility area, respectively. Interestingly, high regional accessibility does not guarantee the greatest decrease in daily travel distance. Walk Score has moderately

negative impact on male head's driving distance: one unit increase in walk score goes along with 0.13 miles of decrease in driving distance.

Households with annual income less than \$49,999 were associated with lower overall automobile travel distance and VMT compared to households with an income greater than \$100,000 (Tables 2-12 and 2-13). The number of household's vehicles is only significantly associated with greater automobile travel distance and VMT for male heads. Not surprisingly, household heads with a driver license and who were employed travelled greater distances than heads without driver license and who were not employed. The possession of a driver license is more influential on the travel distance of male heads compared to female heads. Households in areas with low-medium, medium-high, or high regional accessibility travelled fewer miles households living in a low regional accessibility area (the excluded category), and this effect was strongest for households in areas with the highest level of regional accessibility.

Table 2-9 Tobit models for estimating individual daily travel distance of all modes based on the PSM data

Dependent variable: Travel distance of all modes of ground transportation (mile)	Model I-9				Model I-10			
	Male heads		Female heads		Male heads		Female heads	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	-7.5580		8.0818		-9.5403		8.2373	
Household characteristics								
The number of children	2.7894	**	1.6573		2.8917	**	1.7139	
HH income: \$0-\$49,999 (1/0)	-8.4128	**	-9.2853	**	-8.9577	**	-9.6446	**
HH income: \$50,000-\$99,999 (1/0)	-2.2737		-4.4438		-2.4001		-4.7778	
Number of vehicles	1.9231		-0.6131		1.8771		-0.6934	
Head's characteristics								
Age	0.8398		0.4580		0.8475		0.4903	
Square age	-0.0087		-0.0068		-0.0088		-0.0071	
Hispanic (1/0)	1.3779		1.0556		1.3373		0.7039	
African-American (1/0)	-6.7199		-4.8370		-6.9326		-5.3626	
Valid driver license (1/0)	13.9623	**	13.5680	***	14.7800	**	13.8292	***
Employed (1/0)	10.8424	***	10.5684	***	10.6140	***	10.6414	***
Street connectivity								
Low-medium (1/0)	-6.0322		-3.3366					
Medium-high (1/0)	-6.1276		-2.8479					
High (1/0)	-4.0127		0.2071					
Regional accessibility								
Low-medium (1/0)	-6.7738	*	-12.3727	***	-7.8130	**	-11.2842	***
Medium-high (1/0)	-10.3878	***	-11.3722	***	-11.4612	***	-9.5888	**
High (1/0)	-11.0039	***	-16.3228	***	-11.7630	***	-13.7622	***
Local accessibility								
Low-medium (1/0)	-4.7230		1.2352					
Medium-high (1/0)	-0.8281		1.0531					
High (1/0)	-1.8985		3.6404					
Walkable neighborhood								
Walk Score					-0.0556		-0.0286	
Sample size	1,728		1,728		1,728		1,728	
Treated units	983		983		983		983	
Control units	745		745		745		745	
P-value of χ^2(goodness of fit)	1.65E-14		1.94E-17		1.20E-15		4.39E-19	
Street connectivity	0.3316		0.5605					
Regional accessibility	0.0359**		0.0005***		0.0293**		0.0082***	
Local accessibility	0.6127		0.7483					
Walk Score					0.3835		0.6455	
Log-likelihood	-7,574.24		-7,249.44		-7,576.83		-7,251.06	
McFadden adjusted R²	0.0046		0.0059		0.0049		0.0063	

Significance: * p < .1, ** p < .05, *** p < .01.

Table 2-10 Tobit models for estimating individual daily walking distance based on the PSM data

Dependent variable: Walking distance (mile)	Model I-11				Model I-12			
	Male heads		Female heads		Male heads		Female heads	
Intercept	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
	-0.9344		-2.8432		-1.9186		-3.3630	*
Household characteristics								
The number of children	-0.1012		0.1852		-0.0959		0.1758	
HH income: \$0-\$49,999 (1/0)	-0.5921	*	-0.3734		-0.6436	**	-0.3777	
HH income: \$50,000-\$99,999 (1/0)	-0.2139		-0.3550		-0.2442		-0.3617	
Number of vehicles	-0.8241	***	-0.8446	***	-0.7930	***	-0.8235	***
Head's characteristics								
Age	0.0829		0.0833		0.0860		0.0785	
Square age	-0.0009	*	-0.0010		-0.0010	*	-0.0010	
Hispanic (1/0)	-0.4010		0.0696		-0.3483		0.1080	
African-American (1/0)	-1.2024	**	0.3813		-1.0983	**	0.5118	
Valid driver license (1/0)	-1.4967	***	-1.1907	***	-1.4499	***	-1.1929	***
Employed (1/0)	-0.3058		-0.1465		-0.3378		-0.1367	
Street connectivity								
Low-medium (1/0)	-0.2192		0.4166					
Medium-high (1/0)	-0.4657		-0.2110					
High (1/0)	0.0191		0.1273					
Regional accessibility								
Low-medium (1/0)	0.1431		0.3924		-0.2672		0.1037	
Medium-high (1/0)	-0.0410		0.3663		-0.5217		-0.0537	
High (1/0)	0.5199		0.8926	**	-0.1400		0.2980	
Local accessibility								
Low-medium (1/0)	0.0280		0.1993					
Medium-high (1/0)	0.4921		0.4326					
High (1/0)	0.4414		0.5084					
Walkable neighborhood								
Walk Score					0.0211	***	0.0207	***
Sample size	1,728		1,728		1,728		1,728	
Treated units	983		983		983		983	
Control units	745		745		745		745	
P-value of χ^2(goodness of fit)	6.21E-16		5.55E-17		2.33E-19		7.78E-20	
Street connectivity	0.2138		0.2848					
Regional accessibility	0.1296		0.1414		0.2953		0.7170	
Local accessibility	0.2727		0.6311					
Walk Score					0.0001***		0.0029***	
Log-likelihood	-938.77		-1,205.36		-935.66		-1,203.85	
McFadden adjusted R²	0.0391		0.0330		0.0473		0.0382	

Significance: * p < .1, ** p < .05, *** p < .01.

Table 2-11 Tobit models for estimating individual daily driving distance based on the PSM data

Dependent variable: Driving distance (mile)	Model I-13				Model I-14			
	Male heads		Female heads		Male heads		Female heads	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	-23.8755		-20.0586		-23.3449		-16.1376	
Household characteristics								
The number of children	3.7383	***	3.0155	**	3.8414	***	2.9569	**
HH income: \$0-\$49,999 (1/0)	-8.7598	**	-3.0988		-9.2856	**	-3.2009	
HH income: \$50,000-\$99,999 (1/0)	-2.5533		-1.5634		-2.7201		-1.8237	
Number of vehicles	4.8138	***	1.3910		4.7664	***	1.2933	
Head's characteristics								
Age	1.1430	*	1.0023		1.1833	*	0.9957	
Square age	-0.0114	*	-0.0126		-0.0117	*	-0.0125	
Hispanic (1/0)	6.8331	**	-2.1298		6.6692	**	-2.5484	
African-American (1/0)	-1.5382		-6.5757		-1.9648		-7.1929	
Valid driver license (1/0)								
Employed (1/0)	16.7055	***	14.4473	***	16.3672	***	14.5100	***
Street connectivity								
Low-medium (1/0)	-5.9696		0.3232					
Medium-high (1/0)	-5.9795		0.4174					
High (1/0)	-2.4165		1.8911					
Regional accessibility								
Low-medium (1/0)	-3.9901		-11.6155	***	-3.5681		-9.0904	**
Medium-high (1/0)	-12.3039	***	-6.4122		-11.4451	***	-2.9144	
High (1/0)	-10.9415	**	-13.1951	***	-9.6172	*	-8.5826	*
Local accessibility								
Low-medium (1/0)	-3.3658		3.9878					
Medium-high (1/0)	-2.3850		0.1480					
High (1/0)	-4.8945		3.7327					
Walkable neighborhood								
Walk Score					-0.1267	*	-0.0529	
Sample size	1,581		1,361		1,581		1,361	
Treated units	886		749		886		749	
Control units	695		612		695		612	
P-value of χ^2(goodness of fit)	8.18E-19		3.86E-10		1.15E-20		1.10E-11	
Street connectivity	0.2917		0.9598					
Regional accessibility	0.0073***		0.0062***		0.0226**		0.0586*	
Local accessibility	0.6555		0.5521					
Walk Score					0.0538*		0.4334	
Log-likelihood	-6,075.54		-4,685.21		-6,076.91		-4,686.20	
McFadden adjusted R²	0.0076		0.0049		0.0082		0.0057	

Significance: * p < .1, ** p < .05, *** p < .01.

Table 2-12 Tobit models for estimating individual daily travel distance of automobile trip based on the PSM data

Dependent variable: Automobile travel distance (mile)	Model I-15				Model I-16			
	Male heads		Female heads		Male heads		Female heads	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	-44.9135	**	-8.7764		-45.2099	**	-8.9619	
Household characteristics								
The number of children	3.3538	**	2.2171	*	3.4543	***	2.2937	*
HH income: \$0-\$49,999 (1/0)	-9.4575	**	-9.3867	**	-10.0420	**	-9.8775	**
HH income: \$50,000-\$99,999 (1/0)	-2.2314		-4.0166		-2.4030		-4.4684	
Number of vehicles	5.1596	***	2.1362		5.0615	***	2.0247	
Head's characteristics								
Age	0.8263		0.1813		0.8357		0.2597	
Square age	-0.0092		-0.0038		-0.0093		-0.0047	
Hispanic (1/0)	4.2114		0.3788		4.0366		-0.0112	
African-American (1/0)	-5.8450		-6.4301		-6.3331		-6.9333	
Valid driver license (1/0)	42.3582	***	28.7432	***	43.2178	***	29.0756	***
Employed (1/0)	12.4450	***	12.0555	***	12.1578	***	11.9582	***
Street connectivity								
Low-medium (1/0)	-6.4163	*	-6.1107					
Medium-high (1/0)	-6.5106		-3.2668					
High (1/0)	-3.6820		0.6421					
Regional accessibility								
Low-medium (1/0)	-7.4530	*	-13.5949	***	-7.4371	*	-11.8829	***
Medium-high (1/0)	-11.7081	***	-11.1902	***	-11.3723	***	-8.3136	**
High (1/0)	-14.1838	***	-19.4131	***	-13.1251	***	-15.3888	***
Local accessibility								
Low-medium (1/0)	-4.0978		0.8228					
Medium-high (1/0)	-1.2250		1.0539					
High (1/0)	-1.8624		2.8901					
Walkable neighborhood								
Walk Score					-0.0983		-0.0635	
Sample size	1,728		1,728		1,728		1,728	
Treated units	983		983		983		983	
Control units	745		745		745		745	
P-value of χ^2 (goodness of fit)	1.28E-31		2.21E-35		1.08E-33		3.07E-37	
Street connectivity	0.2876		0.1657					
Regional accessibility	0.0073***		0.0001***		0.0255**		0.0037***	
Local accessibility	0.7752		0.8883					
Walk Score					0.1383		0.3365	
Log-likelihood	-7,027.09		-6,644.06		-7,028.82		-6,646.54	
McFadden adjusted R²	0.0112		0.0132		0.0116		0.0136	

Significance: * p < .1, ** p < .05, *** p < .01.

Table 2-13 Tobit models for estimating individual daily VMT per capita based on the PSM data

Dependent variable: VMT per capita (mile)	Model I-17				Model I-18			
	Male heads		Female heads		Male heads		Female heads	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	-35.9687	***	-2.6229		-35.1845	***	-3.2730	
Household characteristics								
The number of children	0.5997		-0.8820		0.6421		-0.8329	
HH income: \$0-\$49,999 (1/0)	-5.7301	**	-4.3582	**	-5.8900	**	-4.7298	**
HH income: \$50,000-\$99,999 (1/0)	-0.5803		-1.5183		-0.5422		-1.8423	
Number of vehicles	4.1101	***	1.3023		4.0254	***	1.2572	
Head's characteristics								
Age	0.6018		0.0260		0.6016		0.0805	
Square age	-0.0070	*	-0.0020		-0.0070	*	-0.0025	
Hispanic (1/0)	3.9238	*	-0.0952		3.9152	*	-0.3139	
African-American (1/0)	-1.7708		-2.9815		-1.8634		-3.3115	
Valid driver license (1/0)	31.3324	***	17.5477	***	31.7308	***	17.8102	***
Employed (1/0)	10.8360	***	10.2826	***	10.7326	***	10.1802	***
Street connectivity								
Low-medium (1/0)	-3.5625		-4.5708	**				
Medium-high (1/0)	-4.2518		-1.4143					
High (1/0)	-3.1505		0.1255					
Regional accessibility								
Low-medium (1/0)	-3.4476		-6.8502	***	-3.1196		-6.1926	***
Medium-high (1/0)	-7.6586	***	-5.4105	**	-7.1885	**	-4.0565	*
High (1/0)	-9.2451	***	-10.7873	***	-8.4770	***	-8.7040	***
Local accessibility								
Low-medium (1/0)	-1.2712		0.6758					
Medium-high (1/0)	0.2351		-0.4643					
High (1/0)	-1.5870		1.2461					
Walkable neighborhood								
Walk Score					-0.0748		-0.0381	
Sample size	1,728		1,728		1,728		1,728	
Treated units	983		983		983		983	
Control units	745		745		745		745	
P-value of χ^2 (goodness of fit)	5.45E-35		6.39E-52		1.49E-37		1.84E-53	
Street connectivity	0.4473		0.0478**					
Regional accessibility	0.0066***		4.38E-05***		0.0235**		0.0025***	
Local accessibility	0.8154		0.7737					
Walk Score					0.1014		0.2959	
Log-likelihood	-6,556.65		-5,936.42		-6,557.39		-5,940.45	
McFadden adjusted R²	0.0132		0.0213		0.0138		0.0215	

Significance: * p < .1, ** p < .05, *** p < .01.

2.4.2 Results Part II: Gender Inequality in Travel Behaviors for Paired Household Heads

The section analyzes the influence of built environmental factors on gendered gap in daily trip frequency and travel distance by examining directly the difference in these travel outcomes between partners in the same household. The goal is to investigate whether residing in areas with more compact development is associated with greater equality in travel behaviors of married heterosexual couples.

Descriptive Statistics

Descriptive statistics for variables used in the regression analysis were generated using the Walk Score matched PSM subsamples with 3,174, 711, 2,966, and 3,019 households with no artificial zero gaps by all modes of transportation, walking, driving, and automobile, respectively (Table 2-14). For the full subsample, the average number of children per household was 0.68, and the average number of household vehicles was greater than 2. About 73% of the households in this sample had annual income greater than \$50,000. Male and female heads averaged 54 and 51 years old, respectively. About 30% of the heads were Hispanic and African-American heads only represent 4% of the sample. About 96% of the male heads in the sample possessed a driver license, and the possession rate of driver license was slightly lower for female heads (90%). The employment rate of male heads (75%) was substantially higher than the rate for female heads (59%).

Regarding built environment measures, more than half of the households in the samples resided in the areas with low and low-medium street connectivity and destination accessibilities; Walk Score averaged around 53, indicating that the households on average lived somewhat

walkable areas. Noticeably, the descriptive statistics identify that the features of the samples for all modes of transportation, driving, and automobile are similar.

The subsample used to analyze gender inequality in walking behaviors was smaller (711 households) and differs from the larger sample of 3,174 households. Compared to the other three samples, the number of children in the walking sample (0.85) and the percentage of households with income less than \$49,999 (39%) were higher. The average age of the heads of households in the walking sample were about two years younger. The percentage of Hispanic heads was about 10% greater than the other three samples. Households in the walking sample had lower vehicle accessibility (1.75 vehicles per household) and were less likely to possess driver license compared to the other samples. The employment rate of female heads in the walking sample is about 6-8% lower than that of female heads in the other samples. A greater percentage of the walking sample resided in areas with higher walkability and accessibility.

The mean difference in the number of daily trips for all modes between paired households was -0.58 indicating that male heads had on average fewer daily trips than female heads (Table 2-15). When broken down by mode, male heads had on average had fewer walking trips and automobile trips than their female counter part but had more driving trips than female heads. The difference in driving trips was more pronounced for households living in areas with the highest regional accessibility and Walk Score, but there were no significant differences in walking trips across these two built environmental categories.

Recall the definitions of driving and automobile trips. A driving trip for a person is defined as a trip for which the person was the driver of the vehicle on the trip. An automobile trip for a person represents that this person travels by privately operating vehicle, carpool, motorcycle or rental car. Given these definitions, the results suggest that male heads likely dominate the driver

role compared to female heads; female heads not only play driver role but also are more likely to ride with other people than the male counterpart.

The average household gender inequality measure was generated by averaging the absolute value of the differences in each trip category between male and female heads in each household and provides a more relative and standardized measure of absolute inequality between household heads. The mean inequalities of the total trips, walking, driving, and automobile are 2.97, 3.26, 3.27, and 2.62, respectively. The smallest within-household inequalities in total trip and walking trip frequencies occur for households residing in areas with low street connectivity, low regional and local accessibility, and low walkability. It appears that higher walk score and accessibility are likely associated with greater inequalities in total daily trips, walking trips, and driving trips.

Male heads on average travelled 2.65, 7.47, 2.88, and 5.23 miles more than his female counterpart for all modes, driving, automobile and VMT per capita, respectively; on the contrary, male heads walked 0.8 miles less per day than female heads (Table 2-16). The gendered differences in travel distances do not follow any particular pattern varying with built environments. It is only found that households living in areas with low accessibility and walkability tended to have greater within-household differences in daily driving distances, and these mean differences in driving distances were significantly different across street connectivity and regional and local accessibility.

The mean inequalities in travel distances are 18.99, 1.54, 24.94, 19.34, and 17.48 miles for travel distance for all modes, walking, driving, automobile travel, and VMT per capita, respectively. Mean inequalities varied across built environment categories for travel distance for all modes, driving, automobile, and VMT per capita: the mean inequalities in travel distances decrease as destination accessibility and walkability increase. Furthermore, the results of the

hypothesis testing suggest that mean inequalities are significantly different across these built environment categories. Mean inequalities in walking distance were not significantly different across built environment categories.

Table 2-14 Descriptive statistics of independent variables in Analysis II

	All modes	Walking	Driving	Automobile
Household characteristics				
The number of children	0.68	0.85	0.68	0.68
HH income: \$0-\$49,999 (1/0)	0.26	0.39	0.24	0.24
HH income: \$50,000-\$99,999 (1/0)	0.53	0.41	0.55	0.55
HH income: Greater than \$100,000 (1/0)	0.20	0.19	0.21	0.21
Number of vehicles	2.11	1.75	2.17	2.16
Male head's characteristics				
Age	53.64	51.18	53.70	53.71
Hispanic (1/0)	0.27	0.37	0.25	0.26
African-American (1/0)	0.04	0.05	0.04	0.04
Valid driver license (1/0)	0.96	0.89	0.98	0.98
Employed (1/0)	0.75	0.77	0.76	0.76
Female head's characteristics				
Age	50.97	48.41	51.04	51.03
Hispanic (1/0)	0.29	0.38	0.27	0.27
African-American (1/0)	0.04	0.04	0.04	0.04
Valid driver license (1/0)	0.90	0.75	0.92	0.92
Employed (1/0)	0.59	0.53	0.61	0.61
Street connectivity				
Low (1/0)	0.34	0.25	0.36	0.35
Low-medium (1/0)	0.24	0.23	0.25	0.24
Medium-high (1/0)	0.21	0.25	0.21	0.21
High (1/0)	0.20	0.27	0.19	0.20
Regional accessibility				
Low(1/0)	0.30	0.19	0.31	0.31
Low-medium (1/0)	0.26	0.23	0.27	0.27
Medium-high (1/0)	0.24	0.25	0.25	0.25
High (1/0)	0.19	0.33	0.17	0.18
Local accessibility				
Low(1/0)	0.34	0.21	0.35	0.35
Low-medium (1/0)	0.23	0.20	0.23	0.23
Medium-high (1/0)	0.25	0.30	0.24	0.24
High (1/0)	0.19	0.29	0.18	0.18
Walkable neighborhood				
Walk Score	53.26	62.91	52.27	52.51
Sample Size	3,174	711	2,966	3,019

Table 2-15 Mean difference and mean inequality in trip frequency by mode

Mean difference/ Mean inequality in trip frequency		All modes (N=3,174)		Walking (N=711)		Driving ¹ (N=2,966)		Automobile ² (N=3,019)	
		Difference	Inequality	Difference	Inequality	Difference	Inequality	Difference	Inequality
All		-0.58	2.97	-1.47	3.26	0.26	3.27	-0.22	2.62
Street connectivity	Low	-0.54	2.79	-0.82	2.22	0.01	3.35	-0.43	2.72
	Low-medium	-0.69	2.87	-1.55	3.28	0.14	3.08	-0.26	2.49
	Medium-high	-0.75	3.17	-1.76	3.97	0.38	3.23	-0.25	2.59
	High	-0.30	3.18	-1.64	3.42	0.73	3.40	0.23	2.65
Sig. ³				*	***				
Regional accessibility	Low	-0.51	2.48	-0.85	2.17	0.05	2.94	-0.41	2.41
	Low-medium	-0.33	2.93	-0.87	2.86	0.21	3.23	-0.18	2.69
	Medium-high	-0.63	2.97	-1.32	3.04	0.15	3.42	-0.35	2.65
	High	-0.91	3.71	-2.24	4.19	0.84	3.67	0.20	2.82
Sig. ³					*	***		***	
Local accessibility	Low	-0.56	2.53	-0.81	2.16	0.02	3.03	-0.49	2.42
	Low-medium	-0.70	2.83	-0.83	2.52	-0.12	3.08	-0.53	2.60
	Medium-high	-0.52	3.48	-1.88	4.04	0.68	3.82	0.11	3.02
	High	-0.53	3.22	-1.89	3.67	0.65	3.18	0.21	2.47
Sig. ³		*	*			**	**		
Walk Score	Car dependent	-0.57	2.63	-0.91	2.24	0.00	3.16	-0.45	2.52
	Somewhat	-0.51	3.14	-1.02	3.31	0.13	3.35	-0.30	2.79
	Walkable	-0.65	3.21	-1.96	3.67	0.77	3.33	0.17	2.57
Sig. ³		***				***	**	***	**

Significance: * p < .1, ** p < .05, *** p < .01.

¹ For a person who has a driving trip, this person is the driver of private vehicle on the trip.² For a person who takes an automobile trip, this person travels by privately operating automobile, carpool, motorcycle or rental car.³ χ^2 test was used to examine whether there existed significant differences in mean gendered differences/inequalities in trip frequencies for households living in different BEs (e.g. low, low-medium, medium-high, and high street connectivity). Significance indicates that the mean gendered differences/inequalities of trip frequencies are different for households living in different BEs.

Table 2-16 Mean difference and mean inequality in travel distance by mode

Mean difference/mean inequality in travel distance (mile)		All modes (N=3,174)		Walking (N=711)		Driving (N=2,966)		Automobile (N=3,019)		VMT Per Capita ¹ (N=3,019)	
		Diff.	Ineq.	Diff.	Ineq.	Diff.	Ineq.	Diff.	Ineq.	Diff.	Ineq.
All		2.65	18.99	-0.80	1.54	7.47	24.94	2.88	19.34	5.23	17.48
Street connectivity	Low	3.52	20.50	-0.41	1.35	8.63	28.20	3.56	20.83	5.96	19.06
	Low-medium	1.72	19.43	-1.32	1.96	7.97	23.40	2.87	19.91	6.09	17.95
	Medium-high	1.91	16.85	-0.92	1.59	6.76	22.50	2.24	17.16	3.98	15.42
	High	3.15	18.30	-0.57	1.28	5.61	23.75	2.41	18.40	4.28	16.42
Sig. ²			***	**		*	***		***		***
Regional accessibility	Low	3.67	21.30	-0.36	1.22	9.61	28.51	3.66	21.53	6.41	19.86
	Low-medium	2.36	19.17	-0.85	1.47	8.35	24.30	2.58	19.45	5.13	17.62
	Medium-high	0.96	17.83	-0.64	1.55	3.69	23.77	0.90	18.17	3.62	16.65
	High	3.63	16.95	-1.10	1.72	7.86	21.59	4.67	17.27	5.64	14.63
Sig. ²			***			***	***		***	*	***
Local accessibility	Low	3.72	19.99	-0.41	1.17	9.17	27.19	3.77	20.15	6.45	18.75
	Low-medium	-0.47	18.58	-0.78	1.56	4.08	22.72	-0.12	18.79	2.57	16.70
	Medium-high	3.49	18.89	-0.91	1.78	9.26	25.62	3.96	19.46	6.57	17.38
	High	3.43	17.92	-0.97	1.51	6.15	22.62	3.53	18.38	4.50	16.28
Sig. ²		**	***			***	***	**	***	***	***
Walk Score	Car dependent	3.01	20.61	-0.52	1.17	8.22	27.78	3.10	20.65	5.52	18.76
	Somewhat	1.53	19.06	-0.75	1.70	6.83	24.24	1.93	19.37	4.92	17.72
	Walkable	3.40	17.02	-0.95	1.60	7.20	21.91	3.66	17.61	5.21	15.56
Sig. ²			***				***		***		***

Significance: * p < .1, ** p < .05, *** p < .01.

¹ A person's daily VMT per capita is to aggregate the VMT per capita per trip over all the automobile trips taken by the person on the surveyed day. VMT per capita per trip is defined as the total vehicle mile travelled of an automobile trip divided by the total number of people traveling on the trip.

² ANOVA test was used to examine whether there existed significant differences in mean gendered differences/inequalities in travel distances for households living in different BEs (e.g. low, low-medium, medium-high, and high street connectivity). Significance indicates that the mean gendered differences/inequalities of travel distances are different for households living in different BEs.

Regression Analyses

The goal of the regression analysis is to shed light on whether more accessible and walkable built environments are associated with increased within-household gendered equality in travel behavior. The models in this subsection examine factors associated with gendered inequalities in daily trip frequency and travel distance using negative binomial and Tobit regressions based on the Walk Score matched PSM subsamples. The goodness-of-fit tests overall show that the models had good fitting to the data. Results of the negative binomial and Tobit models for the full dataset are documented in Appendix B for investigating the effect of self-selection bias.

The comparisons between the estimations on the full samples (Appendix B, Tables B-10 to B-13b) and the walk score matched PSM subsamples (Tables 2-17 to 2-21) identify that the effect of household's residential selection remains unclear. For the estimations on gendered inequality in trip frequencies by all modes, driving, and automobile modes, regional accessibility and walk score become moderately significant in the PSM subsamples. However, for the estimations on the gendered inequalities in travel distances by all modes, driving, automobile modes, and VMT per capita, regional accessibility and walk score are attenuated suggesting the presence of residential selection.

Table 2-17 documents the estimations based on negative binomial model for gendered inequalities in daily trip frequency for all modes and for walking. For the gendered inequalities in total daily trip frequencies, p-values of χ^2 tests suggest that the estimations are good. The number of household children accounts 7% of increases in gendered inequality. Female head's age show parabolic relationship with the inequality. For household with employed female head, the inequality would be decreased by nearly 25% compared to the household with unemployed female head. Households in areas with low-medium, medium-high, or high regional accessibility

were associated with greater inequality in trips by all modes combined compared to household in the lowest category of regional accessibility. In particular, being in the low-medium regional accessibility category was associated with the greatest inequality in daily trip frequency by 26%.

In terms of gendered inequality in daily walking frequency, households with income less than \$49,999 are more likely to have the greatest inequality in the number of walking trips. Street connectivity at low-medium and medium-high levels approximately account for 30% increase in inequality compared to street connectivity at low level; however, the overall influence of street connectivity tested by goodness of fit shows that the variable is not significant.

Table 2-18 provides models for the gendered inequality in driving trip frequency and automobile trip frequency. In terms of driving frequency, the negative value of McFadden adjusted R^2 indicates that Model II-5 may not be adequately fitted for the PSM data. Inequality decreases by 8% as the number of household vehicles increases one unit. Households with an employed male head are associated with a 13% decrease in inequality, and households with an employed female head are associated with a 14% decrease in inequality. A one unit increase in walk score leads to 0.2% decrease in inequality, but this built environment measure only remains moderately significance.

The gendered inequality in automobile trip frequency increases along with the number of children; female head's age shows a parabolic association with inequality. Households with an employed female head have a 15% decrease in inequality compared to households with unemployed female head. Households in an area with a low-medium level of regional accessibility are associated with greater inequality compared to other levels of regional accessibility.

Table 2-19 provides results of the Tobit models for gendered inequalities in all modes of travel distance and in walking distance. Households with a Hispanic or employed male head were associated with greater inequality between paired heads in the travel distance for all modes. Female head's age has significant and parabolic association with the inequality for travel distance for all modes. Households in areas with the highest regional accessibility level were associated with a 7 miles decrease in gendered inequality when comparing to households in the lowest accessibility level (the excluded category). However, the goodness-of-fit tests and McFadden adjusted R^2 suggest that the models are not favorable for estimating the gendered inequality in terms of walking distance.

Models for gendered inequalities in daily driving distance, automobile travel distance, and daily VMT per capita are provided in Tables 2-20 and 2-21. Results of Model II-14 indicate that a one unit increase in the number of household children and households with an employed female head were associated with a 3-6 miles of decreases in the inequality in daily driving distance. Households in areas with the highest regional accessibility level and households with a higher Walk Scores were associated with lower levels of gendered inequality in driving distance. The estimated coefficients indicate that the inequality of driving distances for households residing in areas with high regional accessibility would be 7.8 miles less than for households residing in areas with low regional accessibility. One unit increase in household's walk score would decrease the within-household inequality by 0.13 mile.

For the gendered inequality in automobile travel distance, households with an employed male head were associated with greater inequality, and a one-unit increase in Walk Score was associated with a 0.09 miles reduction in gendered inequality; however, the significance level of walk score was moderate. Regarding the gendered inequality in daily VMT per capita, the

number of children and employed male head respectively explain negative and positive impacts. Model II-17 shows that living in areas with high regional accessibility is associated with 6.24 miles of decrease in the inequality of VMT per capita. Appendix C provides separate estimations on male and female heads' daily travel behaviors based on the PSM data for households with no artificial zero gaps.

Table 2-17 Negative binomial models for estimating gendered inequality in daily trip frequency for all modes and walking based on PSM data

Dependent variable: Gendered inequality in trip frequency	All modes				Walking			
	Model II-1		Model II-2		Model II-3		Model II-4	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	-0.1949		-0.2646		1.1420	*	1.2899	*
Household characteristics								
The number of children	0.0707	**	0.0699	**	-0.0111		-0.0199	
HH income: \$0-\$49,999 (1/0)	-0.0295		-0.0322		0.3649	**	0.3937	**
HH income: \$50,000-\$99,999 (1/0)	0.0123		0.0112		0.0599		0.1074	
Number of vehicles	-0.0416		-0.0425		0.0706		0.0672	
Male head's characteristics								
Age	0.0020		0.0042		-0.0317		-0.0329	
Square age	-7.58E-06		-2.58E-05		0.0003		0.0003	
Hispanic (1/0)	0.1243		0.1285		0.3741	**	0.4122	***
African-American (1/0)	0.2398		0.2286		0.3709		0.3413	
Valid driver license (1/0)	-0.1746		-0.1686		0.2089		0.1881	
Employed (1/0)	-0.0284		-0.0267		0.0171		0.0325	
Female head's characteristics								
Age	0.0579	**	0.0575	**	0.0040		0.0045	
Square age	-0.0006	**	-0.0006	**	-0.0001		-0.0001	
Hispanic (1/0)	-0.1208		-0.1218		-0.2609	*	-0.3002	**
African-American (1/0)	0.0662		0.0818		-0.1486		-0.2093	
Valid driver license (1/0)	0.0693		0.0666		-0.1043		-0.1245	
Employed (1/0)	-0.2463	***	-0.2489	***	-0.0030		-0.0199	
Street connectivity								
Low-medium (1/0)	-0.0767				0.3194	**		
Medium-high (1/0)	0.0261				0.2809	**		
High (1/0)	0.0062				0.1997			
Regional accessibility								
Low-medium (1/0)	0.2608	***	0.2558	***	-0.2011		-0.1232	
Medium-high (1/0)	0.1617	*	0.1692	*	-0.1023		-0.0369	
High (1/0)	0.1660	*	0.1943	*	-0.1524		-0.0468	
Local accessibility								
Low-medium (1/0)	-0.1392				-0.1147			
Medium-high (1/0)	-0.0552				0.1091			
High (1/0)	-0.0534				0.1746			
Walkable neighborhood								
Walk Score			-0.0009				0.0019	
Sample size	1,537		1,537		388		388	
Treated units	860		860		244		244	
Control units	677		677		144		144	
P-value of χ^2 (goodness of fit)	2.52E-06		5.33E-07		1.85E-04		5.30E-04	
Street connectivity	0.5868				0.1120			
Regional accessibility	0.0337**		0.0518*		0.5741		0.8295	
Local accessibility	0.4734				0.1418			
Walk Score			0.5762				0.4907	
Log-likelihood	-3,149.03		-3,151.09		-739.84		-745.27	
McFadden adjusted R²	0.0033		0.0043		0.0053		0.0048	

Significance: * p < .1, ** p < .05, *** p < .01.

Table 2-18 Negative binomial models for estimating gendered inequality in daily driving trip frequency and automobile trip frequency based on PSM data

Dependent variable: Gendered inequality in trip frequency	Driving trip				Automobile trip			
	Model II-5		Model II-6		Model II-7		Model II-8	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	1.0646	***	1.1174	***	0.0900		0.0341	
Household characteristics								
The number of children	0.0282		0.0293		0.0834	***	0.0872	***
HH income: \$0-\$49,999 (1/0)	-0.0028		-0.0061		0.1286		0.1133	
HH income: \$50,000-\$99,999 (1/0)	-0.0788		-0.0793		0.0951		0.0864	
Number of vehicles	-0.0820	***	-0.0835	***	-0.0156		-0.0176	
Male head's characteristics								
Age	0.0108		0.0104		-0.0073		-0.0057	
Square age	-0.0001		-0.0001		0.0001		0.0001	
Hispanic (1/0)	-0.0392		-0.0384		0.0622		0.0663	
African-American (1/0)	-0.0706		-0.0757		-0.1576		-0.1416	
Valid driver license (1/0)	-0.1118		-0.1088		-0.3568	**	-0.3531	**
Employed (1/0)	-0.1304	**	-0.1303	**	0.0168		0.0175	
Female head's characteristics								
Age	0.0194		0.0186		0.0509	*	0.0491	*
Square age	-0.0002		-0.0002		-0.0005	**	-0.0005	**
Hispanic (1/0)	-0.0291		-0.0304		-0.1623	*	-0.1646	*
African-American (1/0)	-0.0985		-0.1018		0.3308		0.3242	
Valid driver license (1/0)	-0.0016		-0.0028		0.1149		0.1151	
Employed (1/0)	-0.1430	***	-0.1413	***	-0.1562	***	-0.1568	***
Street connectivity								
Low-medium (1/0)	-0.0714				-0.1563	*		
Medium-high (1/0)	-0.0829				-0.0484			
High (1/0)	-0.0828				-0.0768			
Regional accessibility								
Low-medium (1/0)	0.0543		0.0724		0.2680	***	0.2372	***
Medium-high (1/0)	-0.0187		0.0022		0.0432		0.0113	
High (1/0)	0.0172		0.0513		0.1018		0.0767	
Local accessibility								
Low-medium (1/0)	-0.0499				-0.0873			
Medium-high (1/0)	-0.0010				-0.0708			
High (1/0)	-0.0214				-0.0658			
Walkable neighborhood								
Walk Score			-0.0020	*			-0.0008	
Sample size	1,379		1,379		1413		1413	
Treated units	780		780		799		799	
Control units	599		599		614		614	
P-value of χ^2 (goodness of fit)	0.0036		0.004		0.0008		0.0004	
Street connectivity	0.5683				0.2924			
Regional accessibility	0.6063		0.5320		0.0038***		0.0074***	
Local accessibility	0.8390				0.8029			
Walk Score			0.0783*				0.6141	
Log-likelihood	-2,981.72		-2,981.78		-2798.39		-2800.99	
McFadden adjusted R²	-0.0003		0.0013		0.0006		0.0015	

Significance: * p < .1, ** p < .05, *** p < .01.

Table 2-19 Tobit models for estimating gendered inequality in daily travel distance for all modes and walking based on PSM data

Dependent variable: Gendered inequality in travel distance (mile)	All modes				Walking			
	Model II-9		Model II-10		Model II-11		Model II-12	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	1.5668		1.2110		2.7980	*	3.0650	*
Household characteristics								
The number of children	-0.8164		-0.8270		0.0889		0.0828	
HH income: \$0-\$49,999 (1/0)	-4.7610	*	-4.7753	*	0.0660		0.0964	
HH income: \$50,000-\$99,999 (1/0)	-3.1917		-3.1634		0.1155		0.1305	
Number of vehicles	0.6874		0.6626		0.0844		0.0803	
Male head's characteristics								
Age	-1.1030	*	-1.0628		-0.1111		-0.1136	
Square age	0.0126	**	0.0121	**	0.0012	*	0.0012	*
Hispanic (1/0)	5.6954	**	5.6564	**	-0.1092		-0.0735	
African-American (1/0)	1.5333		1.4684		0.6089		0.6981	
Valid driver license (1/0)	1.1643		1.1809		0.0103		-0.0029	
Employed (1/0)	5.3674	**	5.4247	**	0.5340	**	0.5215	*
Female head's characteristics								
Age	1.8316	**	1.7717	**	-0.0030		-0.0018	
Square age	-0.0218	***	-0.0211	***	0.0001		0.0000	
Hispanic (1/0)	0.1705		0.1375		0.3006		0.3092	
African-American (1/0)	4.0475		3.9307		0.8100		0.7164	
Valid driver license (1/0)	3.0623		3.1334		-0.3039		-0.2596	
Employed (1/0)	1.0846		1.1480		-0.1240		-0.1302	
Street connectivity								
Low-medium (1/0)	0.1321				0.4652			
Medium-high (1/0)	0.2849				0.3681			
High (1/0)	-1.0740				0.3795			
Regional accessibility								
Low-medium (1/0)	-3.0141		-3.4156		-0.4619		-0.3735	
Medium-high (1/0)	-3.4398		-4.0038		-0.1884		-0.0948	
High (1/0)	-6.9147	***	-7.1831	**	-0.3349		-0.2546	
Local accessibility								
Low-medium (1/0)	-1.9051				0.1566			
Medium-high (1/0)	-1.4981				0.1212			
High (1/0)	0.1834				-0.0130			
Walkable neighborhood								
Walk Score			-0.0008				0.0013	
Sample size	1,537		1,537		388		388	
Treated units	860		860		244		244	
Control units	677		677		144		144	
P-value of χ^2 (goodness of fit)	5.55E-05		6.73E-06		0.4044		0.2945	
Street connectivity	0.9103				0.5029			
Regional accessibility	0.0645*		0.0916*		0.5351		0.6390	
Local accessibility	0.7039				0.9016			
Walk Score			0.9855				0.8400	
Log-likelihood	-6,777.47		-6,778.38		-712.31		-713.90	
McFadden adjusted R²	0.0009		0.0015		-0.0165		-0.0118	

Significance: * p < .1, ** p < .05, *** p < .01

Table 2-20 Tobit models for estimating gendered inequality in daily driving distance and automobile travel distance on PSM data

Dependent variable: Gendered inequality in travel distance (mile)	Driving				Automobile			
	Model II-13		Model II-14		Model II-15		Model II-15	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	9.7864		11.4378		-4.3254		-0.1517	
Household characteristics								
The number of children	-2.6168	**	-2.5153	**	-1.2904		-1.4124	
HH income: \$0-\$49,999 (1/0)	-3.2924		-3.7660		-2.7682		-2.2498	
HH income: \$50,000-\$99,999 (1/0)	-0.1064		-0.2661		-0.5621		-0.2399	
Number of vehicles	1.1084		1.0298		1.0899		1.0160	
Male head's characteristics								
Age	1.0901		1.1184		0.0444		0.0533	
Square age	-0.0120		-0.0123		0.0005		0.0002	
Hispanic (1/0)	0.9850		0.6440		4.6455		4.6000	
African-American (1/0)	-2.9906		-3.5281		-2.4984		-3.2796	
Valid driver license (1/0)	0.6583		0.6719		-3.4932		-3.7616	
Employed (1/0)	-0.0638		0.0290		8.1225	***	8.2994	***
Female head's characteristics								
Age	0.4986		0.4262		0.9108		0.9136	
Square age	-0.0053		-0.0045		-0.0114		-0.0113	
Hispanic (1/0)	1.0853		0.9437		-1.0775		-1.3088	
African-American (1/0)	0.5017		0.0653		4.4179		4.3093	
Valid driver license (1/0)	1.4711		1.6782		4.4970		4.7421	
Employed (1/0)	-5.9917	**	-5.7683	**	-2.0036		-1.7777	
Street connectivity								
Low-medium (1/0)	-5.4800				5.6050	**		
Medium-high (1/0)	-5.8833	*			1.7950			
High (1/0)	-5.0585				1.4436			
Regional accessibility								
Low-medium (1/0)	-4.5669		-4.0776		-2.1566		0.6817	
Medium-high (1/0)	-3.3891		-2.7374		-6.2016	**	-3.0403	
High (1/0)	-9.6202	**	-7.7699	*	-8.2196	***	-4.2858	
Local accessibility								
Low-medium (1/0)	-3.9704				0.6429			
Medium-high (1/0)	-3.7833				-1.7377			
High (1/0)	-1.3390				0.0764			
Walkable neighborhood								
Walk Score			-0.1276	**			-0.0846	*
Sample size	1,379		1,379		1,413		1,413	
Treated units	780		780		799		799	
Control units	599		599		614		614	
P-value of χ^2(goodness of fit)	0.0062		0.0015		0.0003		0.0001	
Street connectivity	0.3462				0.1813			
Regional accessibility	0.0586*		0.2254		0.0287**		0.2463	
Local accessibility	0.5935				0.7809			
Walk Score			0.0364**				0.0906*	
Log-likelihood	-6997.76		-6998.86		-6,379.60		-6,381.14	
McFadden adjusted R²	-0.0003		0.0003		0.0005		0.0011	

Significance: * p < .1, ** p < .05, *** p < .01

Table 2-21 Tobit models for estimating gendered inequality in daily VMT per capita on PSM data

Dependent variable: Gendered inequality in travel distance (mile)	VMT per Capita			
	Model II-13		Model II-14	
	Coefficient	Sig.	Coefficient	Sig.
Intercept	-0.0783		1.8297	
Household characteristics				
The number of children	-1.7117	**	-1.7786	**
HH income: \$0-\$49,999 (1/0)	-2.1121		-1.8259	
HH income: \$50,000-\$99,999 (1/0)	-0.7241		-0.4738	
Number of vehicles	1.0727		1.0273	
Male head's characteristics				
Age	-0.1064		-0.0996	
Square age	0.0014		0.0013	
Hispanic (1/0)	2.8267		2.7774	
African-American (1/0)	-1.2362		-1.7341	
Valid driver license (1/0)	-0.4618		-0.4643	
Employed (1/0)	7.4272	***	7.5604	***
Female head's characteristics				
Age	0.7613		0.7630	
Square age	-0.0095		-0.0094	
Hispanic (1/0)	0.4534		0.3270	
African-American (1/0)	3.2927		3.2620	
Valid driver license (1/0)	2.9756		3.0506	
Employed (1/0)	-1.6333		-1.4811	
Street connectivity				
Low-medium (1/0)	3.7036	*		
Medium-high (1/0)	0.8777			
High (1/0)	0.3613			
Regional accessibility				
Low-medium (1/0)	-0.0794		1.2475	
Medium-high (1/0)	-3.7432		-2.3727	
High (1/0)	-6.2425	**	-4.4432	
Local accessibility				
Low-medium (1/0)	-1.0454			
Medium-high (1/0)	-2.1488			
High (1/0)	-1.1966			
Walkable neighborhood				
Walk Score			-0.0568	
Sample size	1,413		1,413	
Treated units	799		799	
Control units	614		614	
P-value of χ^2(goodness of fit)	1.23E-05		1.76E-06	
Street connectivity	0.2627			
Regional accessibility	0.0134**		0.0487*	
Local accessibility	0.8260			
Walk Score			0.1508	
Log-likelihood	-6,087.38		-6,088.72	
McFadden adjusted R²	0.0014		0.0020	

Significance: * p < .1, ** p < .05, *** p < .01

2.5 Discussion and Future Research

This chapter explores whether urban design elements influence gendered travel patterns to different degrees. First, I analyzed the travel behaviors of the male and female heads from the 3,588 households in Los Angeles County based on the 2010-2012 CHTS. In the subsequent analysis, I examined the gendered difference and inequality in travel behaviors for households with no artificial zero gaps. In order to reduce the residential selection bias, the regression analyses employed PSM that matched treated and control units for mimicking quasi-experiments.

Based on the findings, I draw the following conclusions. First, male and female have significantly different travel patterns. Male household heads on average have lower trip frequencies but greater travel distance than female household heads by all modes, driving, and automobile, and this pattern is the opposite for walking behaviors. These findings are consistent with Rosenbloom (1995, 2006) and Handy (2006).

Second, income inequality and the presence of children consistently play an important role in travel behavior. Households with income less than \$49,999 tend to have shorter daily automobile travel distance than households with income greater than \$100,000. The limited access to vehicle use or ownership is one possibility that leads to unequal travel behaviors among subgroups with different income. In addition, the number of children in household can be the key factor that leads to gendered difference and inequality. The estimated coefficient of the number of children on female head's daily trip frequency is two times of the coefficient on male head. Gendered inequality in daily trip frequency also increases along with the number of children. The results together imply that female household head is primarily responsible for child-related tasks, such as chauffeuring trips (Boarnet & Hsu, 2015).

Third, built environments remain effectiveness after self-selection is accounted for. In particular, regional accessibility and walk score remarkably show significances to individual travel behaviors, whereas street connectivity and local accessibility do not present any notable influences in the analyses. Apart from the previous study on built environments and travel behaviors (Ewing & Cervero, 2010), the results in this chapter only suggest that regional accessibility is strongly related to motorized travel distance but has no relationship with walk patterns.

Walk Score exhibits significant impacts on individual's trip frequencies by all modes and walking and walking and driving distance. The establishment of a walkable community could encourage people to walk more because the number of surrounding trip attractions within walking distance is increased (Handy, 1992). The nearby amenities can also enable people to accomplish their tasks with short driving distances. Handy (1992) has pointed out that the trade-off mechanism between walking and motorized trips remains ambiguity. Findings in this chapter found that the increasing walk score encourages the overall trip frequency and walking trips but does not associate with motorized trip frequencies. The result could imply that walking trips are in addition to rather than substituting for motorized trips.

Fourth, walk score and regional accessibility are able to account for gendered inequality in terms of travel behaviors. Although regional accessibility shows moderately positive association with gendered inequality in trip frequency, the increasing walk score and regional accessibility reduce gendered inequality in daily travel distance and motorized travel distance. The results may imply that men and women are likely to enjoy more equal activity space as destination accessibility increases.

Fifth, men and women are likely to have different responses toward built environments. Similar to Clifton and Dill (2005), walk score shows slightly greater impacts on male head's walking pattern than on female head. Clifton and Livi (2005) have indicated that man and woman have different perceptions of safety, and this phenomenon could explain the different influences of walk score on male and female heads' walking trips. Furthermore, the increasing walk score suggest reducing men's reliance on driving trips. Regional accessibility is negatively associated with gendered travel distance to various extents. The results show that low-medium and high regional accessibilities have greater impacts on female head's travel distance and VMT per capita than on male head; on the other hand, medium-high regional accessibility performs greater influences on male than on female heads. The overall findings might be able to answer Crane's question (Crane, 2007): Men and women do respond to urban design features differently.

Lastly, future research may consider using walking score to analyze people's travel patterns. Results in the chapter show that walk score can better explain for individual's travel behaviors and gendered inequality than the traditional approaches (street connectivity and local accessibility) that measure urban designs at local level. Since several studies have shown the validity of walk score (Carr et al., 2011; Duncan et al., 2011; Manaugh & El-Geneidy, 2011), it is believed that walk score can work as a reliable data source for research on urban design and transportation.

Several policy implications are drawn based on the conclusions. As SCAG's 2016-2040 RTP/SCS projects to direct more than 50% of the employment growth in walkable transit village between 2012 and 2040 (SCAG, 2016), the increasing nearby opportunities will help people create a compact and efficient active space for their daily lives. Furthermore, locating employment growth in walkable transit village will help reach the goals of SB 375 and active

transportation: reducing VMT and greenhouse emissions and encouraging people to walk for physical activity and greater health (SCAG, 2016).

Transportation and land use planning that aims at decreasing travel burdens should focus on promoting regional accessibility. In particular the travel burden for women living in areas with high regional accessibility seems to be lightened compared for their male counterparts, suggesting that high regional accessibility is a possible approach for helping to relieve women of the burden of “second shift” and other household obligations (Fagan & Trudeau, 2014; Hayden, 1980).

Improving neighborhood walkability could encourage people to take more walking trips and could help improve physical activity and public health. However, as safety concerns could lead male and female to have different walking patterns, improving the public facilities to ensure a secure walking environment, such as lighting (Clifton & Livi, 2005), is key to enable women to feel more secure so they can enjoy walking in their neighborhoods. These findings together indicate that men and women would have different responses to urban design elements, planners and researchers should consider whether it is appropriate to adopt policies which primarily impact travel patterns for a particular subgroup by land use and transportation planning; after all, studies in the field of the influence of built environments on gendered travel remain limited (Crane, 2000).

High destination accessibilities at local and regional scales are expected to improve the within-household gendered equality in daily mobility patterns. In this context, household heads might be guaranteed with greater equal in activity and living spaces. It may be possible for men and women to evenly share tasks and further lighten women’s burden of “second shift” (Fagan & Trudeau, 2014).

The chapter remains some limitations. Although the result has identified that men and women likely respond to built environments with different travel behaviors based on the 2010-2012 CHTS data, different travel survey data, built environment measures and study designs are required in order to explore whether urban design can lead to systematic differences in men and women's travel patterns.

The walk scores at households' locations were obtained in 2016. The scores might have different attributes compared to the surrounding built environments of the survey respondents' residences in 2012. Such disparities could possibly generate some biases in the estimations. Although results in this chapter suggest that more accessible and walkable built environments promote gender equality in travel, further study is needed to understand whether more accessible and walkable built environments are also associated with greater gendered equality in activity spaces. The next chapter examines this question by analyzing activity patterns for the same paired CHTS sample.

CHAPTER 3: Do More Accessible and Walkable Built Environments Promote Gender Equality in Activity Space Behaviors?

3.1 Introduction

A main concern of feminist planners is that men and women are exposed to unequal levels of access to different opportunities due to societal constraints and expectations (Bowlby, 1988; Laws, 1997; Little et al., 1988). For example, the household responsibility hypothesis (HRH) states that women take primary responsibility for childcare and household maintenance tasks. Compared to their employed husbands, employed women are more likely to experience temporal constraints and have shorter commutes because they have more household responsibilities and tasks (Johnston-Anumonwo, 1992; Turner & Niemeier, 1997). Land use segregation within cities and regions could further constrain female travel and access to opportunities (Bowlby, 1988; Laws, 1997; Little et al., 1988). As urban sprawl creates greater spatial separation between private realms and public spaces, women are more likely to have limited social networks and to undertake work and leisure activities within their immediate neighborhoods because they tend to be more restricted to the private sphere of suburbs; on the contrary, men on average enjoy greater freedom of being unbounded (Hayden, 2002; Johnson & Johnson, 2008; Laws, 1997; Little et al., 1988; Tivers, 1988).

Chapter 2 of this dissertation indicates that husbands and wives respond to built environments differently in terms of travel patterns and that areas with increased destination

accessibility can help improve gendered inequality in daily travel patterns. This suggests that remedies for alleviating urban sprawl (Frumkin, 2002), such as high-density development, increasing destination accessibility, providing transportation alternatives, and improving walkability could potentially release women from the “sprawl trap”, namely being socially and spatially isolated and being homebound for household tasks. Further analysis is needed, however, to investigate how and in what ways the gendered inequalities in aggregate travel identified in Chapter 2 impact the geographic extent of spatial behaviors of men and women in married household. That is, is the fact that wives on average make fewer trips, have lower VMT, and walk more than their husbands associated with greater geographic concentration in their activities? Furthermore, do married couples living in areas with greater destination accessibility experience greater equality in the geographic extent and constraint of their activity space? Understanding these differences are particularly important given that a person with a larger daily activity space may have greater access to opportunity (Geurs & van Wee, 2004). The chapter expands the research in Chapter 2 to examine the interrelations between built environment, individual spatiotemporal behavior, and gendered difference in space-time patterns.

3.2 Background

3.2.1 The Importance of Understanding Spatial Behavior

Spatial behavior has been extensively studied in numerous fields over the past decades, and spatial behavior studies greatly increased as capabilities for processing spatial patterns using geographic information systems (GIS) has become more readily accessible. In geographical research, individual accessibility to urban opportunities have been simulated through spatiotemporal patterns in order to readdress gendered equity (Kwan, 1998, 1999b, 1999a, 2000).

Public health studies have investigated how people are exposed to food environments and healthcare facilities in terms of spatial activity patterns (Crawford, Jilcott Pitts, McGuirt, Keyserling, & Ammerman, 2014; Perchoux et al., 2014; Sherman, Spencer, Preisser, Gesler, & Arcury, 2005; Zenk et al., 2011). Furthermore, several studies have validated that measuring people's spatial behavior is one important research approach for the analyzing social network and segregation (Järv, Muurisepp, Ahas, Derudder, & Witlox, 2014; Jones & Pebley, 2014; Mason, 2010; Schönfelder & Axhausen, 2003; Shareck, Kestens, & Frohlich, 2014; Wang, Kang, Bettencourt, Liu, & Andris, 2015).

As mobility partially represents people's spatiotemporal experiences in daily life (Kwan, 2013), a body of transportation-related literature has examined the relationships between built environment characteristics and travel behavior (Boarnet & Crane, 2001; Cervero & Duncan, 2006; Cervero & Kockelman, 1997; Crane & Crepeau, 1998; Ewing & Cervero, 2001, 2010), and has expanded the research focus beyond the one-dimensional measure of travel behavior to consider spatial behavior patterns (Buliung & Kanaroglou, 2006; Fan & Khattak, 2008; Harding, Patterson, Miranda-Moreno, & Zahabi, 2014; Kwan, 1998, 1999b, 1999a, 2000; Manaugh & El-Geneidy, 2012; Newsome, Walcott, & Smith, 1998). Yet, knowledge of how urban form shapes individual spatial behavior remains limited (Fan & Khattak, 2008; Harding et al., 2014; Tana, Kwan, & Chai, 2016).

3.2.2 Spatial Behavior Measures: Action Space, Potential Path Area, and Activity Space

There are three main concepts that are commonly used to describe spatial behavior: action space, potential path area (PPA), and activity space (Golledge & Stimson, 1997; Horton & Reynolds, 1970; Patterson & Farber, 2015). Horton and Reynolds (1970) state that the first

measure, action space, is the spatial extent of a set of locations of which an individual is aware and each location is associated with individual preferences. Action space can be used to characterize the environment perceived by or known to an individual (Axhausen, 2007). Action space is also recognized as an individual's "mental map" that identifies his or her understanding of activity opportunities and the distribution of the opportunities across space (Schönfelder & Axhausen, 2003).

Some recent studies employ the concept of action space in order to delineate people's perceived areas (Chaix et al., 2012; Crawford et al., 2014; Perchoux et al., 2014). The interactive mapping tool developed by Chaix et al. (2012) allows survey participants to geolocate their perceived neighborhood boundaries (Chaix et al., 2012). This approach has been used and extended to assess people's spatial behaviors in the paper of Perchoux et al. (2014). The authors found that the degree to which activity spaces were centered on people's residential neighborhoods was largely explained by people's perceived neighborhoods; in addition socio-demographics and residential location were found as the strong predictors of people's spatial behaviors. Similarly, Crawford et al. (2014) compared survey participants' self-defined neighborhoods and their activity spaces to analyze the food environments for low-income women in Pitt County, North Carolina. Their findings indicate that the size of perceived neighborhoods on average is much smaller than the size of road network (a PPA measure) and the size of standard deviation ellipse (an activity space measure); however, the findings suggest that the perceived neighborhoods may not be able to correspond with food accessibility.

The second measure, potential path area (PPA) is based on a space-time prism that describes the spatial extent of where people seek and access feasible opportunities when they are spatially and temporally bounded (Hägerstrand, 1970; Lenntorp, 1976). PPA defines the two-

dimensional space to which an individual can travel for participating activities given the individual's time budget and other constraints (Golledge & Stimson, 1997; Patterson & Farber, 2015). One easy and intuitive way to estimate PPA is to determine the area to which an individual could reach using given time budget, travel distance, and transportation network (Crawford et al., 2014; Sherman et al., 2005).

Other PPA studies set home and workplace as an individual's pegs and determine the accessible locations and areas for the individual given the individual's time budget and road network. Kwan (1998) compares PPA with other conventional measures of place accessibility to evaluate individual accessibility and concludes that PPA is helpful for exploring the gendered difference in accessibility. Furthermore, she utilized PPA measures to compare the gendered difference in accessibility to urban opportunities (Kwan, 1999a, 1999b, 2000). PPA has also been applied to simulate people's space-time accessibility in research seeking to solve transportation network design problems (Tong, Zhou, & Miller, 2015). Since past research on PPA only considers home and workplace as individual's anchors, one recent study developed a new approach that incorporates home-based and work-based sub-activity space measures in order to better characterize people's complex spatial behaviors (Li & Tong, 2016).

The third approach to measure spatial behavior is activity space. An individual's activity space comprises the locations and the spatial extents with which the individual has direct contact over his daily life (Golledge & Stimson, 1997; Horton & Reynolds, 1970; Patterson & Farber, 2015). Standard deviation circle (SDC), standard deviation ellipse (SDE), minimum convex polygon (MCP), and network-based (NB) measures are commonly applied to delineate activity space based on travel diary and/or GPS trajectory data (These approaches are reviewed in the subsequent subsection). Previous studies usually analyzed people's activity spaces and the

associated spatial indices to explore mobility, social interactions, and exposures to food environments (Buliung & Kanaroglou, 2006; Buliung, Roorda, & Remmel, 2008; Crawford et al., 2014; Fan & Khattak, 2008; Järv, Ahas, & Witlox, 2014; Järv, Muurisepp, et al., 2014; Jones & Pebley, 2014; Manaugh & El-Geneidy, 2012; Mason, 2010; Newsome et al., 1998; Perchoux et al., 2014; Schönfelder & Axhausen, 2003; Shareck et al., 2014; Tana et al., 2016; Wang et al., 2015; Zenk et al., 2011).

The three measures of spatial behavior can be characterized in the following ways:

- *Action area represents the spatial extent of potential activity an individual perceives*
- *PPA represents the spatial extent that an individual is capable of reaching*
- *Activity space represents the spatial extent that an individual has actually reached*

Each measure provided a different perspective and has pros and cons. Action space measures can reflect people's spatial awareness, but it relies heavily on survey participants' involvements in drawing their perceived boundaries; the process of data collection could be time-consuming and only generate small samples. PPA measures can accurately describe people's accessibilities to opportunities based on the simulated results (Kwan, 1998; Patterson & Farber, 2015), but this person-based measure is computationally-demanding and has limited variation in its operationalization (Patterson & Farber, 2015). Activity space measures provide various methods of operationalization with less computation (Patterson & Farber, 2015); nevertheless, activity space measures only shows a simplified representation of people's spatial behaviors and may include areas with which people are unfamiliar (Chaix et al., 2012; Schönfelder & Axhausen, 2003). Table 3-1 summarizes the three spatial behavior measures in

terms of the definitions, characteristics, and pros and cons that are discussed in the above paragraphs. Tables 3-2a and 3-2b describe the techniques that are used for the spatial measures and the applications in empirical research for action area and PPA (Table 3-2a) and activity space (Table 3-2b).

Table 3-1 Summary of literature review

Spatial measure	Characteristic	Definition	Pros/Cons
Action area	The spatial extent of potential activity an individual perceives	The spatial extent of a set of locations and activity opportunities of which an individual is aware and each location is associated with the individual's preference (Axhausen, 2007; Horton & Reynolds, 1970; Schönfelder & Axhausen, 2003)	Pros: reflecting people's spatial awareness Cons: time-consuming; small sample
PPA	The spatial extent that an individual is capable of reaching	Potential path area (PPA) is based on the space-time prism that describes the spatial extent of how people seek and access feasible opportunities given certain time budget and other constraints (Golledge & Stimson, 1997; Hägerstrand, 1970; Lenntorp, 1976; Patterson & Farber, 2015).	Pros: accurately describing people's accessibilities to opportunities (Kwan, 1998; Patterson & Farber, 2015) Cons: computationally demanding; less variation in operationalization (Patterson & Farber, 2015)
Activity space	The spatial extent that an individual has actually reached	The locations and the spatial extents with which an individual has direct contact over his or her daily life (Golledge & Stimson, 1997; Horton & Reynolds, 1970; Patterson & Farber, 2015)	Pros: various methods of operationalization with less computation Cons: simplifying people's spatial behaviors; including unfamiliar areas

Table 3-2a Techniques and research domain for spatial measures

Spatial Measure	Technique	Research domain
Action area	GIS, participants define and draw their perceived boundaries	<u>Health</u> Crawford et al. (2014): using self-defined neighborhoods to explore the food environment exposure <u>Transportation-related</u> Perchoux et al. (2014): using the perceived boundaries to determine the degree of centering on residential neighborhoods
PPA	GIS, anchoring fixed points, certain time constraints, activity-travel diaries	<u>Health</u> Sherman et al. (2005): determining the polygon areas that can be reached within certain temporal thresholds for analyzing healthcare facilities Crawford et al. (2014): determining the accessible areas based on the road network and a series of distance ranges (0.50, 1.00, 1.50, and 2.00 miles) <u>Transportation-related</u> Kwan (1998): comparing PPA with the measure of conventional place accessibility to evaluate individual accessibility Kwan, (1999a, 1999b, 2000): implementing PPA to compare the gendered difference in men and women's accessibility to urban opportunities Tong et al. (2015): simulating people's space-time accessibilities for solving the transportation network design problem
Activity space	GIS, activity-travel diaries	See Table 3-2b for detail.

Table 3-2b Research domain for activity space

Activity Space Measure	Definition	Pros/Cons	Research Domain
SDC	The radius of a SDC is the standard distance between the visited activity sites and the mean center (Buliung & Kanaroglou, 2006; Levine, 2013)	Pros: intuitive; easy to understand Cons: unable to reflect spatial dispersion; very sensitive to outliers (Buliung & Kanaroglou, 2006; Levine, 2013)	<u>Transportation-related</u> Buliung & Kanaroglou (2006): using SDC to explore the the relationship between urban form and activity space
SDE	The elliptical activity space that is located on the mean center of activity patterns and constructed based on the bidirectional standard distances (Patterson & Farber, 2015; Perchoux et al., 2014; Tana, Kwan, & Chai, 2016; Yuill, 1971)	Pros: intuitive; able to reflect spatial dispersion (Buliung & Kanaroglou, 2006; Levine, 2013) Cons: unable to show and over-represent the actual spatial arrangement of geographic or human features (Schönfelder & Axhausen, 2003; Sherman et al., 2005)	<u>Health</u> Sherman et al. (2005): investigating the exposure to healthcare facilities Zenk et al. (2011): exploring the exposures to food environments and park facilities Crawford et al. (2014): analyzing the exposure to supermarkets and farmers' market for low-income women <u>Social segregation/network</u> Schönfelder & Axhausen (2003): using SDE for the spatial dispersion of trip destinations Järv, Muurisepp, et al. (2014): using the call records to understand the ethnic differences in people's daily, monthly, and annual activity spaces. Wang et al. (2015): using the call dataset records as proxy to delineate individual's activity space and explore people's social networks (Wang, Kang, Bettencourt, Liu, & Andris, 2015) <u>Transportation-related</u> Buliung & Kanaroglou (2006) and Newsome et al. (1998): using SDE to explore the the relationship between urban form and activity space Järv, Ahas, et al. (2014): using the call records to analyze people's daily and monthly activity spaces.

Activity Space Measure	Definition	Pros/Cons	Research Domain
MCP	The minimum convex polygon that contains all the visited sites with no internal angle exceeding 180 degrees (Ronald N. Buliung & Kanaroglou, 2006; Jones & Pebley, 2014; Levine, 2013; Perchoux et al., 2014; Tana et al., 2016; Worton, 1987)	Pros: intuitive Cons: not reflecting the territories that are familiar to an individual; encompassing areas to which the individual does not go (Chaix et al., 2012)	<u>Social segregation/network</u> Jones & Pebley (2014): analyzing people's exposures to different social characteristics <u>Transportation-related</u> Buliung & Kanaroglou (2006): using MCP to explore the the relationship between urban form and activity space Buliung et al. (2008): exploring people's spatial behaviors based on their daily activity patterns Fan & Khattak (2008): analyzing how urban form factors account for the size of activity space Manaugh & El-Geneidy (2012): defining local travel index for understanding spatial dispersion based on MCP Harding et al. (2013): understanding the association of the compactness of MCP and people's mode choice Harding et al. (2014): exploring how activity space changes along with time and built environments Perchoux et al. (2014): using the area and perimeter of MCP to explain the size of activity space Tana et al. (2016): comparing people's activity spaces from Beijing and Chicago and examining the effects of car ownership and urban forms
NB	The network-based (NB) areas where people physically traverse based on their travel paths (Patterson & Farber, 2015)	Pros: capturing the actual area that individual has reached Cons: demanding road network in detail	<u>Health</u> Sherman et al. (2005): investigating the exposure to healthcare facilities Zenk et al. (2011): exploring the exposures to food environments and park facilities <u>Social segregation/network</u> Schönfelder & Axhausen (2003): using the length of the shortest path network to reflect the spatial spread of the activity locations <u>Transportation-related</u> Perchoux et al. (2014): analyzing whether people tend to have relatively localized activities by considering the road network distances between home and activity places

Activity Space Measure	Definition	Pros/Cons	Research Domain
Others	Mixed measures, kernel density, census tract, buffer zone		<u>Social segregation/network</u> Schönfelder & Axhausen (2003): measuring the area covered by positive <i>kernel densities</i> to explore the vicinity of the visited locations Krivo et al. (2013): analyzing the non-home activity space disadvantage based on the <i>census tracts</i> Jones and Pebley (2014): analyzing people's exposures to different social characteristics based on <i>census tract</i> activity space Shareck et al. (2014): defining the activity space as <i>the 500-meter buffer zones</i> of the locations visited by the individuals to understand social isolation

3.2.3 Measuring Activity Space

Circle and ellipse, minimum convex polygon (MCP), and the network-based (NB) methods are prevalently used to estimate the geographic extent of activity space in various research domains (Buliung & Kanaroglou, 2006; Buliung et al., 2008; Chaix et al., 2012; Crawford et al., 2014; Fan & Khattak, 2008; Harding, Patterson, & Miranda-Moreno, 2013; Jones & Pebley, 2014; Manaugh & El-Geneidy, 2012; Patterson & Farber, 2015; Perchoux et al., 2014; Schönfelder & Axhausen, 2002, 2003; Shareck et al., 2014; Sherman et al., 2005; Tana et al., 2016; Wang et al., 2015; Zenk et al., 2011).

The standard deviation circle (SDC) is based on the circle method (Buliung & Kanaroglou, 2006; Levine, 2013). The radius of a SDC is the standard distance between the visited activity sites and the mean center (Levine, 2013). Given that SDC does not adapt to the spatial arrangement of activity patterns and is very sensitive to outlier, standard deviation ellipse (SDE) has been considered as an alternative to SDC (Buliung & Kanaroglou, 2006; Levine, 2013). SDE describes an elliptical activity space that is located on the mean center of activity patterns and constructed based on the bidirectional standard distances (Patterson & Farber, 2015; Perchoux et al., 2014; Tana et al., 2016; Yuill, 1971). Furthermore, Schönfelder and Axhausen (2003) and Buliung and Kanaroglou (2006) suggest that the area and the lengths of axes of SDE can reflect the spatial dispersion of individual's activity space.

The MCP method represents the minimum convex polygon that contains all the visited sites with no internal angle exceeding 180 degrees (Buliung & Kanaroglou, 2006; Jones & Pebley, 2014; Levine, 2013; Patterson & Farber, 2015; Tana et al., 2016; Worton, 1987). The compactness and spatial concentration of MCP are used to estimate the spatial dispersion of an individual's activity space (Harding et al., 2013; Manaugh & El-Geneidy, 2012). The NB

method indicates the areas where people physically traverse based on their travel paths (Patterson & Farber, 2015). Empirical studies that employ NB approach usually create buffers that surround people's travel paths to define the area of their activity spaces (Schönfelder & Axhausen, 2003; Sherman et al., 2005; Zenk et al., 2011). Chaix et al. (2012) suggest that a mixed approach utilizing the MCP and NB methods is a useful strategy for reflecting actual activity spaces.

Previous studies have also implemented other approaches to depict activity space. For example, Schönfelder and Axhausen (2003) employ the kernel density estimation to measure individual spatial patterns based on the visited locations. Shareck et al. (2014) defined activity space as the 500-meter buffer zones of the locations visited by individuals. In addition, census tract of locations visited is another approach to describe activity space. For example, Krivo et al. (2013) analyzed the activity disadvantage index based on the census tract in which an individual conducts his or her routine non-home activities. Jones and Pebley (2014) defined census tracts in which people's destinations were located as their activity spaces and analyzed people's exposures to different social characteristics.

3.2.4 Socio-economic Characteristics & Spatial Behavior

Previous studies suggest that individual and household demographic and socio-economic factors are associated with differences in people's spatial behaviors to various extents. Perchoux et al. (2014) indicated that the mobility and activity space of elderly people was more restricted because of their worsening health status and functional limitations that led to their lack of autonomy. Elderly people tend to have smaller activity spaces (Jones & Pebley, 2014; Tana et al., 2016) and center their activity spaces on their residential neighborhoods (Perchoux et al.,

2014). Fan and Khattak (2008) found that adults younger than 24 years of age or adults older than 65 years of age are more likely to have compact activity space because the young and elderly adults are not in the job market or possess insufficient autonomy. Nevertheless, the influence of age may remain unclear given other studies suggest that age does not significantly influence people's spatial behaviors (Järv, Ahas, et al., 2014; Krivo et al., 2013; Newsome et al., 1998; Schönfelder & Axhausen, 2002) and that elderly are likely to have greater activity spaces (Järv, Muurisepp, et al., 2014).

The presence of household children and associated parental responsibilities could create greater household space-time fixity and smaller activity spaces (Fan & Khattak, 2008; Harding et al., 2014). A study on social isolation indicates that people with children tend to conduct their non-home activities in disadvantaged areas (Krivo et al., 2013).

Income, employment status, and accessibility to an automobile play key roles to explaining spatial behavior. High-income households, employed people, and individuals owning cars are likely to have greater action space, larger activity spaces and more sprawling activity-travel patterns (Buliung & Kanaroglou, 2006; Crawford et al., 2014; Fan & Khattak, 2008; Harding et al., 2014; Manaugh & El-Geneidy, 2012; Newsome et al., 1998; Perchoux et al., 2014; Tana et al., 2016; Zenk et al., 2011). Nevertheless, Newsome et al. (1998), Schönfelder and Axhausen (2003), and Jones and Pebley (2014) did not find any significant effects of income and car ownership on the size of activity space.

3.2.5 Gender & Spatial Behavior

The household responsibility hypothesis (HRH) states that employed women shoulder more household responsibilities in childcare and maintenance tasks than men; as a result, employed women tend to face greater temporal constraints and have shorter commutes (Johnston-Anumonwo, 1992; Turner & Niemeier, 1997). The implication of HRH is that these women are more likely to have constrained activity space due to their inflexible schedules compared to men. Hayden (2002) argues that housewives living in suburban areas tend to center their activities more in private spheres while their husbands conduct their lives in-between private realms and urban public spaces. Empirical studies have confirmed that women have smaller activity spaces than men (Fan & Khattak, 2008; Perchoux et al., 2014; Tana et al., 2016). Comparisons of gendered differences in people's daily PPAs also indicate that women experience greater constraints and less accessibility to urban opportunities compared to men (Kwan, 1998, 1999b, 1999a, 2000).

However, the dissimilar spatial behaviors between men and women remain in question. Other studies found that there was no significant difference in the size of activity spaces between men and women (Järv, Ahas, et al., 2014; Järv, Muurisepp, et al., 2014; Jones & Pebley, 2014; Newsome et al., 1998; Schönfelder & Axhausen, 2002; Zenk et al., 2011). Based on people's spatial extents, Zenk et al. (2011) observed that men and women had no difference in the exposures to food environments and park facilities. Table 3-3 summarizes the empirical findings on gendered spatial behaviors.

3.2.6 Built Environment & Spatial Behavior

Research in transportation planning has examined the effect of built environment factors on travel behavior in terms of mode, frequency, time, and distance (Ewing & Cervero, 2001, 2010). Moving beyond the one-dimensional travel behavior focus, a few studies examined the relationships between urban form and spatial behavior. They found that urban participants were likely to have compact activity spaces and to center their activity spaces on their residential neighborhoods (Buliung & Kanaroglou, 2006; Crawford et al., 2014; Harding et al., 2014; Perchoux et al., 2014).

Suburbanization and sprawling development could be associated with larger activity spaces. Schönfelder and Axhausen (2003) suggest that people's activity spaces are spreading out over time as distances between residences and the city core increases. Compared to other service planning areas in Los Angeles, Jones and Pebley (2014), people living in Antelope Valley planning area, which has the lowest population density in Los Angeles, had the largest activity spaces. Crawford et al. (2014) indicates that urban residents could have greater accessibility than suburban residents because of the dense road networks in the urban core. In contrast, Newsome et al. (1998) did not observe any significant difference in the size of activity spaces for people living in downtown, central city, and suburbs.

Existing studies have also examine the effects of the “D” variables on activity space, including density, destination accessibility, design, and distance to transit. Fan and Khattak (2008) found that people living areas with higher population density were likely to have smaller activity spaces. Tana et al. (2016) obtained the similar results based on their Chicago dataset. People's activity spaces and activity-travel patterns became more compact with the increasing destination accessibility and decreasing distance between home and workplace (Fan & Khattak,

2008; Järv, Ahas, et al., 2014; Järv, Muurisepp, et al., 2014; Manaugh & El-Geneidy, 2012; Sherman et al., 2005; Tana et al., 2016). On the contrary, the Beijing study by Tana et al. (2016) indicates that an individual's activity space increases with the number of retail stores around the individual's home.

Fan and Khattak (2008) and Tana et al. (2016) examined the association between the street network design and activity space but obtained different results. Fan and Khattak found that the activity spaces became smaller when street nodes were more dense and well connected. However, individual activity space was greater as the roadway density increased based on the Chicago dataset of Tana et al. (2016). Regarding the distance to transit, activity space tended to be smaller when an individual's home was closer to the nearest railway station (Tana et al., 2016). Notably, no previous study considered the effect of land use diversity near residential locations on the size activity spaces.

These previous studies may have found different results regarding the built environment and spatial behavior in part because most of these studies use simplified measures to represent urban form (such as density), and have not adequately considered the associations between the “D” variables and spatial behaviors (Fan & Khattak, 2008; Harding et al., 2014; Tana et al., 2016). Analysis at neighborhood scale of such supplemental, policy-relevant factors could provide greater insight into how built environments impact the size and configuration of activity spaces (Buliung & Kanaroglou, 2006). Table 3-4 provides the summary of previous findings on built environments and activity space behaviors.

Table 3-3 Literature review on gender and spatial behavior

Gender	PPA	Activity space
Female (ref. male)	Kwan (1998, 1999a, 1999b, 2000): Women experience greater constraints and less accessibility to urban opportunities than do men	<u>Negative</u> Fan & Khattak (2008), Perchoux et al. (2014), and Tana et al. (2016): women tend to have smaller activity spaces than men <u>No significance</u> Newsome et al. (1998), Schönfelder & Axhausen (2003), Jones & Pebley (2014), Järv, Ahas, et al. (2014), and Järv, Muurisepp, et al. (2014): no differences in the activity space size between men and women Zenk et al. (2011): no differences in SDE sizes, exposures to food environments or park facilities between men and women

Table 3-4 Literature review on the association between built environment and activity space

Built environment	Activity space
Urban form	<u>Urban vs. suburban (ref.)</u> Buliung & Kanaroglou (2006), Crawford et al. (2014), Harding et al. (2014), Jones & Pebley (2014), and Perchoux et al. (2014), and Schönfelder & Axhausen (2003): smaller activity spaces and likely to center their activity spaces in their residential neighborhoods <u>No significance</u> Newsome et al. (1998): no significant influence on the size of activity space.
Density	<u>Increasing population density</u> Fan & Khattak (2008) and Tana et al. (2016): smaller activity space
Destination accessibility	<u>Increasing accessibility to opportunities</u> Positive Tana et al. (2016): people's activity space increases (<i>Beijing data</i>) <u>Negative</u> Fan & Khattak (2008) Järv, Ahas, et al. (2014), Järv, Muurisepp, et al. (2014), Manaugh & El-Geneidy (2012), Sherman et al. (2005), and Tana et al. (2016): activity space decreases
Design	<u>Increasing street connectivity</u> Positive Tana et al. (2016): greater activity space (<i>Chicago data</i>) <u>Negative</u> Fan & Khattak (2008): compact activity space
Distance to transit	<u>Increasing distance to railway</u> Tana et al. (2016): people's activity space decreases

3.3 Data and Methods

3.3.1 Research Objectives

This chapter moves beyond analysis of gendered differences in one-dimensional travel behavior measures to examine gendered differences in two (spatial) and three-dimensional (spatiotemporal) measures of spatial behavior through the following objectives:

1. Define people's spatial behaviors in different spatial indices: size, activity density, eccentricity, compactness, spatial concentration, and activity concentration
2. Examine differences between spatial behaviors for paired heterosexual couples, controlling for demographic and socio-economic factors
3. Assess whether differences between spatial behaviors by gender are reduced for couples living in areas with more compact urban design elements

This research makes important contributions given previous studies (as reviewed above) provide inconsistent results regarding gendered differences in spatial behaviors. Given the understanding of how urban form shapes activity space remains incomplete and needs more research (Buliung & Kanaroglou, 2006; Fan & Khattak, 2008; Harding et al., 2014; Tana et al., 2016), this research also integrates improved urban design measures (beyond typical density measures) to assess the impact of built environment factors on the size and configuration of activity spaces, and to assess whether more compact areas are associated with greater activity space equality within married heterosexual couples.

3.3.2 Survey and Built Environment Data

I used the 2010-2012 California Household Travel Survey (CHTS) (National Renewable Energy Laboratory, 2013) to analyze people's daily spatial patterns across the five counties in Southern California, including Los Angeles, Orange, Riverside, San Bernardino and Ventura. Because one primary interest of the dissertation is to understand gendered inequality, my analyses focused on the spatial behaviors of heterosexual paired household heads. Furthermore, Buliung et al. (2008) and Järv, Ahas, et al. (2014) suggest that people usually have very different spatial behaviors on weekdays and weekend days so I separated households that reported their travel logs on the assigned weekdays from those that recorded logs on the assigned weekend days.

The paired household heads were selected based on the following criteria. First, the age of the head was greater than 16 year-old but less than 65 year-old during the time they undertook their activities. Second, the heads performed their activities within the state of California, and they started and ended the activities at their homes. Third, the heads had visited at least more than 2 non-home places and all the places they visited, including home, were not in alignment. Fourth, the travel modes between different locations were ground transportation, including walking and biking. Lastly, the selected household heads included complete information regarding their genders, employment status, marital status, and the presence of child under 16 year-old in the households. After the data cleaning, 1,316 households and 745 households were obtained for weekday and weekend day data, respectively.

This dissertation also examines the influences of built environment factors on people's spatial behaviors and on gendered inequality in activity spaces. The analyses in the chapter incorporated the "D" variable (Ewing & Cervero, 2001, 2010): destination accessibility at regional level. Regional accessibility was stratified by low, low-medium, medium-high, and high

based on the 1st, 2nd, and 3rd quartiles of the variable for the 15,235 households over the SCAG region. Table 3-5 describes the stratified thresholds. Since the results from Chapter 2 show that Walk Score significantly accounted for people’s travel patterns, the Walk Score measure was also used for analyzing spatial behavior in the chapter. Definitions and sources of the built environment factors are included in Chapter 1.

Table 3-5 Stratified thresholds of street connectivity, regional accessibility, and local accessibility

Quartile	1st	2nd	3rd
Regional accessibility	150.44	247.28	308.27

3.3.3 Activity Space Measures and Indices

This research uses the “activity space” measures of SDE and MCP to study spatial behaviors for several reasons. First, action space and PPA measures were not used because they require information about perceived or simulated patterns which are not available in the 2010-2012 California Household Travel. Second, gendered differences in PPA has been exhaustively studied (Kwan, 1998, 1999a, 1999b, 2000) and further study is needed to assess gendered differences in activity space measures. Third, the NB approach captures people’s activity space (Sherman et al., 2005); however, the CHTS data used for this study lack information on participant travel trajectories which are necessary to calculate the NB method for analyzing activity space. Fourth, the SDE and MCP “activity space” measures are straightforward and

intuitive. Figure 3-1 illustrates the SDE and MCP that measure the daily activity spaces for a 44 year-old Hispanic female household head on the assigned weekday.

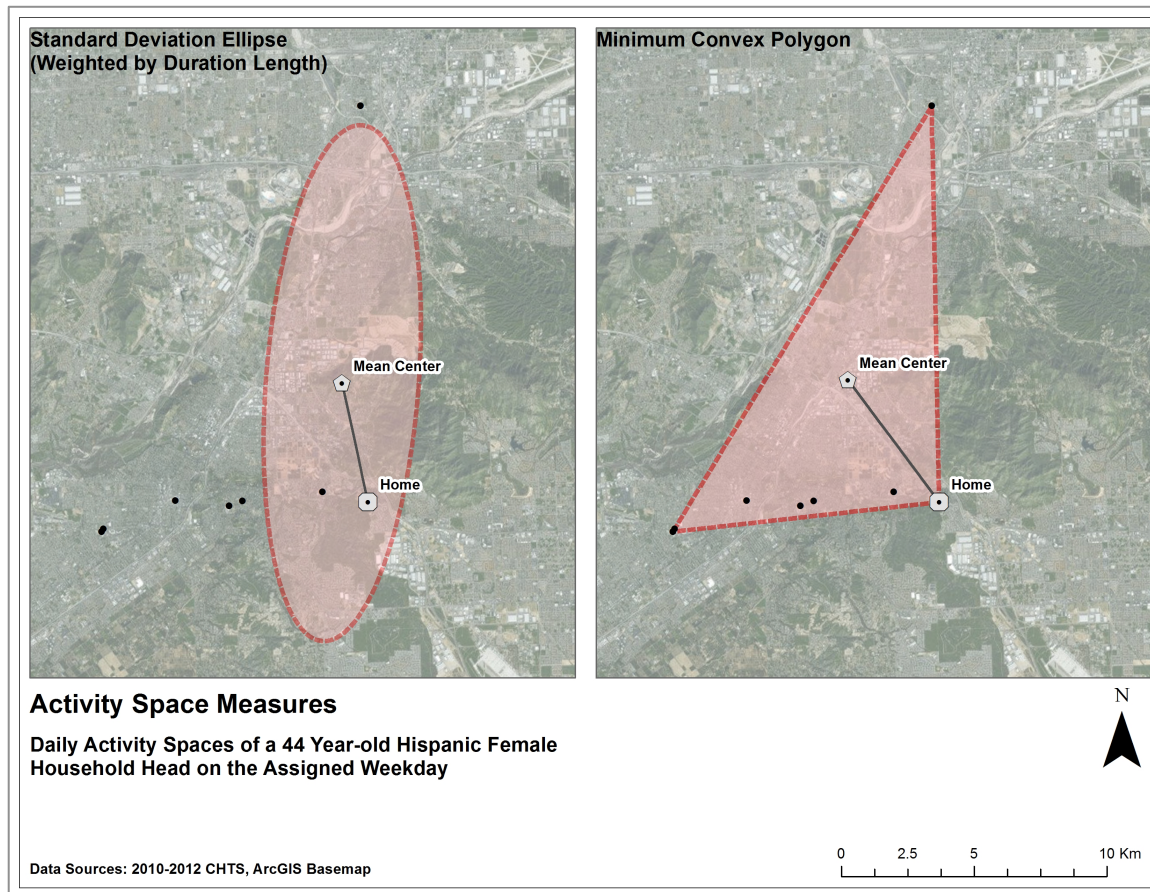


Figure 3-1 Example of SDE and MCP that delineate the daily activity space for a 44 year-old Hispanic female household head

The paragraphs below describe the definitions, the geoprocessing operations in ArcGIS, and the spatial indices for each activity space measure. Tables 3-6 and 3-7 summarize the measures and the spatial indices, respectively. Each spatial index is attributed to a particular spatial behavior category based on the feature of the spatial index. The categories are: size of area, degree of residential deconcentrating, compactness degree of, and degree of bounding non-home activities (Manaugh & El-Geneidy, 2012; Perchoux et al., 2014). Note that the geographic coordinate system of the raw data is WGS 84 (NuStats, 2013a) and the data were projected on NAD 1983 California (Teale) Albers (Meters) for geoprocessing in ArcGIS.

Standard Deviation Ellipse (SDE)

Since the standard deviation circle (SDC) measure is not able to reflect spatial arrangement and distributions of activity locations that are usually skewed in one direction (Levine, 2013), this chapter analyzes people's daily activity spaces in terms of the weighted SDE. Definition of the weighted SDE measure is shown as below (Buliung & Kanaroglou, 2006; ESRI, 2016a; Levine, 2013; Yuill, 1971).

The weight of each location was the total duration spent at the location. Note that the formula is only applicable for individual who visited more than 2 unique destinations that were not in alignment; thus K is at least greater than 2 (see the proof in Appendix E). For each individual, I implemented the Directional Distribution (Standard Deviation Ellipse) tool in the Spatial Statistics toolbox of ArcGIS to delineate an elliptical polygon that was centered on the weighted mean center based on the individual's daily activity locations (ESRI, 2016a).

$$\bar{X}_w = \frac{\sum_{k=1}^K w_k \cdot x_k}{\sum_{k=1}^K w_k}, \bar{Y}_w = \frac{\sum_{k=1}^K w_k \cdot y_k}{\sum_{k=1}^K w_k}$$

$$\tan \theta = \frac{A + C}{B}$$

$$A = \sum_{k=1}^K w_k (x_k - \bar{X}_w)^2 - \sum_{k=1}^K w_k (y_k - \bar{Y}_w)^2$$

$$B = 2 \cdot \sum_{k=1}^K w_k (x_k - \bar{X}_w) \cdot (y_k - \bar{Y}_w)$$

$$C = \sqrt{A^2 + B^2}$$

$$SD_X = \sqrt{2} \cdot \sqrt{\frac{\sum_{k=1}^K w_k ((x_k - \bar{X}_w) \cdot \cos \theta - (y_k - \bar{Y}_w) \cdot \sin \theta)^2}{\sum_{k=1}^K w_k}}$$

$$SD_Y = \sqrt{2} \cdot \sqrt{\frac{\sum_{k=1}^K w_k ((x_k - \bar{X}_w) \cdot \sin \theta - (y_k - \bar{Y}_w) \cdot \cos \theta)^2}{\sum_{k=1}^K w_k}}$$

$\bar{X}_w$ and $\bar{Y}_w$, the weighted mean center of SDE

SD_x and SD_y , the weighted standard deviation axes for the SDE

Major axis= max (SD_x , SD_y); minor axis= min (SD_x , SD_y)

Destinations 1 to K visited by the individual

w_k , the total activity duration spending at destination k by the individual

The major outputs of the weighted SDE included the weighted mean center, the major and minor axes of SDE, and the SDE area. Other spatial indices were calculated based on the outputs, including the distance between home and the weighted mean center (ESRI, 2016c), eccentricity (ECC_{SDE}), elongation (E_{SDE}), activity density (AD_{SDE}), and activity density weighted by eccentricity (ADE_{SDE}). ECC_{SDE} defines the ratio of the distance between home and the mean center to the length of the major axis of SDE (Perchoux et al., 2014).

E_{SDE} shows the ratio between the major axis and the minor axis of the SDE (Perchoux et al., 2014). Elongation is used to describe the dispersion of the activity space and can be regarded as the circularity ratio; the activity space is more dispersed as elongation is much greater than 1 (see the map on the left in Figure 3-2), otherwise the elongation of an activity space is close to 1 (see the map on the right in Figure 3-2). ECC_{SDE} represents the ratio of the distance between home and the weighted mean center of SDE to the major axis of SDE; the index shows the degree of how activity space deviates relative to an individual's home location.

AD_{SDE} is the ratio of the number of an individual's non-home activities to the weighted SDE area. AD_{SDE} can be interpreted as the density of non-home activities over the SDE surface; the index can help understand how an individual was spatially and temporarily bounded when he or she undertook daily activities out of home. AD_{SDE} and ECC_{SDE} are replicated from Perchoux et al. (2014); the authors measure an individual's activity density and eccentricity within his or her SDE. ADE_{SDE} is the ratio of AD_{SDE} to E_{SDE} , which is proposed to account for the degree of how an individual's non-home activities were spatially and temporally constrained by activity space and residence.

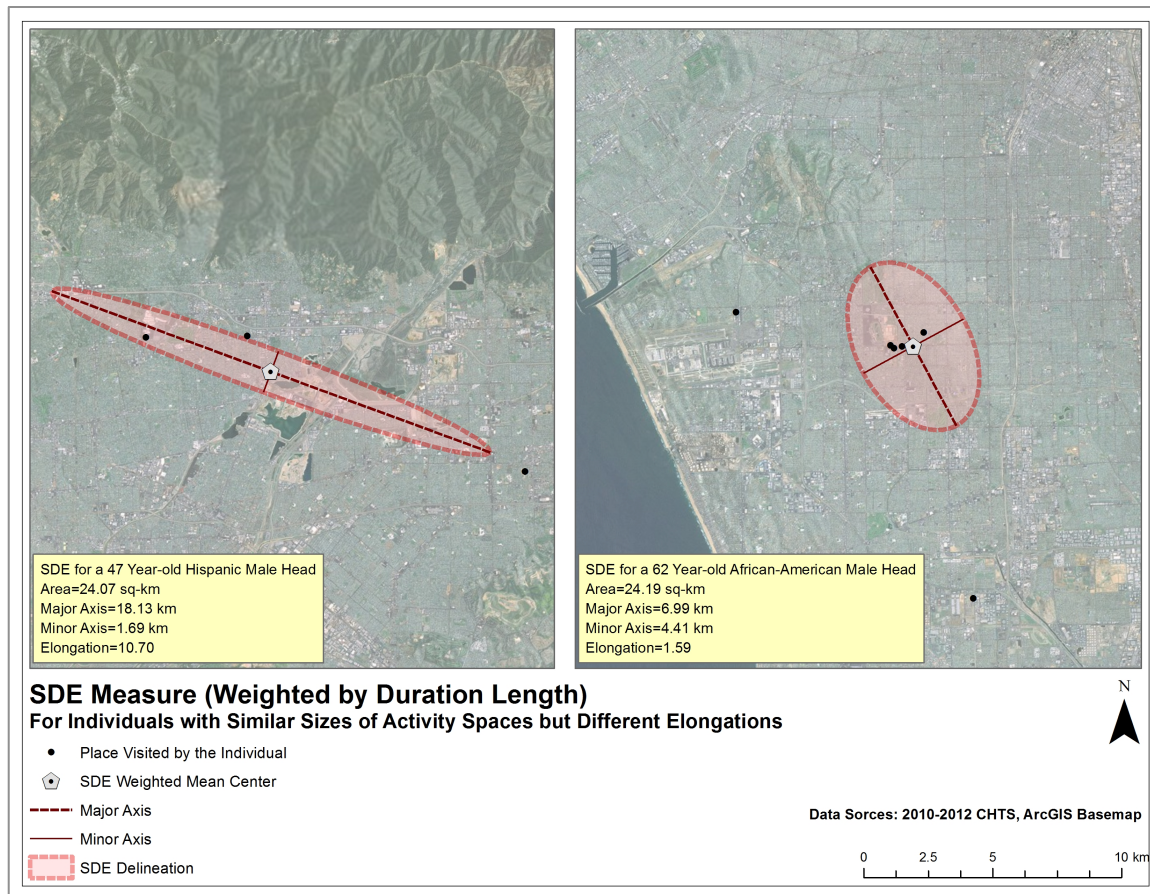


Figure 3-2 Example of SDE elongations for a 47 year-old Hispanic and a 62 year-old African-American male heads

Minimum Convex Polygon (MCP)

The MCP measure of an individual's daily activity space represent the minimum convex polygon that contains all the destinations visited by the individual (Beyer, n.d.; Buliung & Kanaroglou, 2006; Levine, 2013; Worton, 1987). However, the MCP measure is only applicable for individuals who visited more than 2 unique destinations that were not in alignment (Beyer, n.d.). I applied the Minimum Bounding Geometry tool for convex hull in the Data Management toolbox of ArcGIS to create MCP for each individual (ESRI, 2016b). The primary outputs were the mean center of MCP, the MCP area, and the MCP perimeter.

Based on these outputs, I computed 5 spatial indices to characterize people's spatial behaviors, including the distance between home and the mean center of MCP (ESRI, 2016c), compactness of MCP (C_{MCP}), spatial concentration of MCP (SC_{MCP}), activity space density (AD_{MCP}) and activity concentration (AC_{MCP}).

C_{MCP} is defined as the ratio of the MCP area to the square of the MCP perimeter, which also represent the circularity ratio (Harding et al., 2013; Manaugh & El-Geneidy, 2012; Perchoux et al., 2014). The spatial indicator captures the compact level of an individual's activity space. However, Manaugh and El-Geneidy (2012) argues that compactness does not fully explain spatial dispersal of activity space. The authors suggest using spatial dispersal to differentiate people with local activity spaces from people with widespread activity spaces. I improved Manaugh and El-Geneidy's formula and defined spatial concentration (SC_{MCP}) as following:

$$SC_{MCP} = \frac{A_{max}}{MCP\ Area} \cdot C_{MCP}$$

A_{max} , the max MCP area in the sample

Figure 3-3 explains the concept of spatial concentration by comparing different delineations of activity spaces. MCP-1 and MCP-2 in Figure 3-3 have similar compactness (C_{MCP}); however, MCP-2 is more spatially concentrated (SC_{MCP}) than MCP-1 because the area of MCP-2 is smaller. For MCP-1 and MCP-3 that have the same size of activity spaces, MCP-1 has greater spatial concentration because of its compact shape. Although the sizes and compactness of MCP-1 and MCP-4 are different, the polygons have the same degree of spatial concentration due to the extent to each direction. For example, MCP-1 is evenly distributed to every direction whereas MCP-4 is particularly dispersed along northeast and southwest. In this way, SC_{MCP} could

provide a more refined measure than the C_{MCP} measure introduced by Manaugh and El-Geneidy (2012).

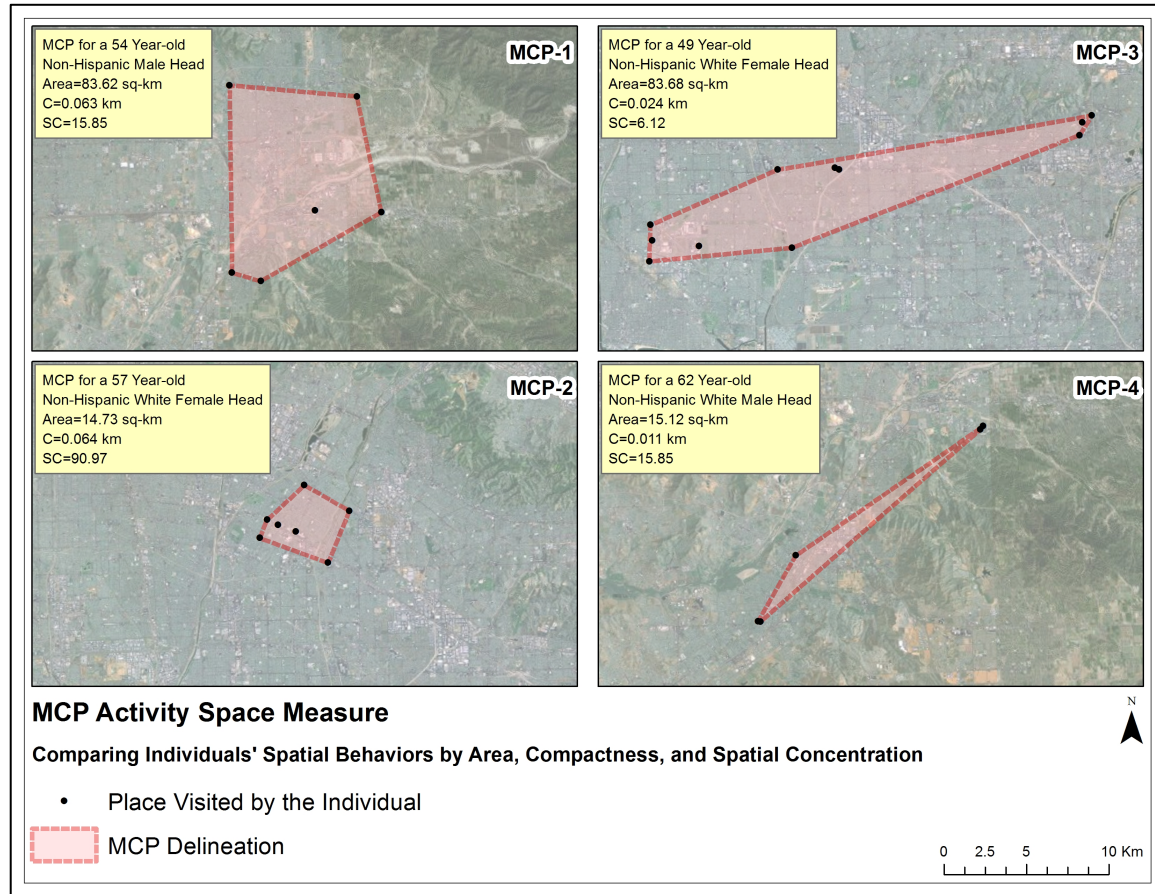


Figure 3-3 Comparisons between different MCP activity spaces

AD_{MCP} represents the number of non-home activities divided by the MCP area and the number of non-home activities divided by the product of the MCP area (Perchoux et al., 2014) and the total non-home activity duration, respectively. These indices are used to understand the extent to which an individual could be spatially and temporally bounded when undertaking non-home activities. AC_{MCP} is defined as the product of the number of non-home activities, SC_{MCP} , and the ratio of the in-home activity duration to the total non-home activity duration. The

measurement is expected to provide insights into how an individual's non-home activities are spatially restricted by activity space and are temporarily bounded by home location.

Table 3-6 Measures of activity spaces

Activity space measure	Definition	ArcGIS Geoprocessing tool	Key output	Reference
SDE	$\bar{X}_w = \frac{\sum_{k=1}^K w_k \cdot x_k}{\sum_{k=1}^K w_k} ; \bar{Y}_w = \frac{\sum_{k=1}^K w_k \cdot y_k}{\sum_{k=1}^K w_k}$ $\tan \theta = \frac{A + C}{B}$ $A = \sum_{k=1}^K w_k (x_k - \bar{X}_w)^2 - \sum_{k=1}^K w_k (y_k - \bar{Y}_w)^2$ $B = 2 \cdot \sum_{k=1}^K w_k (x_k - \bar{X}_w) \cdot (y_k - \bar{Y}_w)$ $C = \sqrt{A^2 + B^2}$ $SD_x = \sqrt{2} \cdot \sqrt{\frac{\sum_{k=1}^K w_k ((x_k - \bar{X}_w) \cdot \cos \theta - (y_k - \bar{Y}_w) \cdot \sin \theta)^2}{\sum_{k=1}^K w_k}}$ $SD_y = \sqrt{2} \cdot \sqrt{\frac{\sum_{k=1}^K w_k ((x_k - \bar{X}_w) \cdot \sin \theta - (y_k - \bar{Y}_w) \cdot \cos \theta)^2}{\sum_{k=1}^K w_k}}$ • SD_x and SD_y, the weighted standard deviation axes for the SDE • The major axis= $\max(SD_x, SD_y)$; the minor axis= $\min(SD_x, SD_y)$ • w_k, the total activity duration spending at destination k by the individual • The SDE equations are only applicable for individual who visited more than 2 unique destinations; thus K is at least greater than 2 (see the proof shown in the appendix).	Directional distribution (Standard deviation ellipse)	• The lengths of major and minor axes of the SDE • Area of SDE • Perimeter of SDE	(Buliung & Kanaroglou, 2006; ESRI, 2016a; Levine, 2013; Yuill, 1971)
MCP	• MCP of an individual's daily activity space is defined as the minimum convex polygon that contains all the destinations visited by the individual based the daily travel logs. • MCP is only applicable for individuals with more than 2 unique destinations.	Minimum bounding geometry	• Area of MCP • Perimeter of MCP	(Beyer, n.d.; Buliung & Kanaroglou, 2006; ESRI, 2016b; Levine, 2013; Worton, 1987)

Table 3-7 Spatial indices

Activity space	Spatial index	Definition	Spatial Behavior Category	Reference
SDE	SDE area	The size of SDE area weighted by activity duration	Size of activity space	(ESRI, 2016a)
	D_{SDE}	Distance between home and the weighted mean center	Degree of residential deconcentrating	(ESRI, 2016c)
	Eccentricity (ECC_{SDE})	$ECC_{SDE} = \frac{D_{SDE}}{\text{Major axis of SDE}}$	Degree of residential deconcentrating	Perchoux et al. (2014)
	Elongation (E_{SDE})	$E_{SDE} = \frac{\text{Major axis of SDE}}{\text{Minor axis of SDE}}$	Compactness degree	Perchoux et al. (2014)
	Activity density (AD_{SDE})	$AD_{SDE} = \frac{N_{non-home}}{\text{SDE area}}$	Degree of bounding non-home activities	Perchoux et al. (2014)
	Activity density weighted by eccentricity (ADE_{SDE})	$ADE_{SDE} = \frac{N_{non-home}}{\text{SDE area}} \cdot (ECC_{SDE}^{-1})$	Degree of bounding non-home activities	New proposed equation
MCP	MCP area	The size of MCP area	Size of activity space	(ESRI, 2016b)
	D_{MCP}	Distance between home and the mean center	Degree of residential deconcentrating	(ESRI, 2016c)
	Compactness (C_{MCP})	$C_{MCP} = \frac{\text{MCP Area}}{\text{MCP Perimeter}^2}$	Compactness degree	Harding et al. (2013) and Manaugh and El-Geneidy (2012)
	Spatial concentration (SC_{MCP})	$SC_{MCP} = \frac{A_{max}}{\text{MCP Area}} \cdot C_{MCP}$ A_{max} , the max MCP area in the sample	Compactness degree	Manaugh and El-Geneidy (2012)
	Activity space density (AD_{MCP})	$AD_{MCP} = \frac{N_{non-home}}{\text{MCP Area}}$	Degree of bounding non-home activities	Perchoux et al. (2014)
	Activity concentration (AC_{MCP})	$AC_{MCP} = N_{non-home} \cdot SC_{MCP} \cdot \frac{T^h}{T}$ T^h , T , the total time that an individual spending at home and out-of-home	Degree of bounding non-home activities	New proposed equation

3.3.4 Econometric Analysis

This subsection explains the statistical techniques that were implemented in this chapter. Descriptive statistics provide a summary of spatial behaviors for the full sample. Generalized least squares and binary logit models were used for analyzing individual spatial behaviors and gendered differences in spatial behaviors, respectively. Descriptive statistics and regressions were programmed in MATLAB and R.

Descriptive Statistics

The descriptive statistics report the mean and median of people's activity space measures and the mean and median gendered differences in paired heads' spatial behaviors. Hypothesis testing was performed to understand whether there existed significant differences among subgroups. Paired t-test and Wilcoxon signed rank were used to test whether male and female heads had significant differences in spatial behaviors (Washington et al., 2003). ANOVA and Kruskal-Wallis tests were respectively adopted to examine whether the mean and median spatial behaviors were significantly different by socio-demographics and by built environmental factors (Washington et al., 2003; Weisberg, 2005).

Generalized Least Squares (GLS) for Analyzing Individual Spatial Behaviors

Regression models were used to estimate the influence of covariates on spatial behaviors. Generalized least squares (GLS) models were used to analyze individual activity space behaviors since the assumption of homoscedasticity could be violated (Wooldridge, 2008).

Homoscedasticity of an ordinary least squares (OLS) model assumes that the variance of the unobserved errors should be a constant.

$$y = x\beta + \varepsilon$$

$$\text{var}(\varepsilon|X) = \sigma^2 I_n$$

$$\hat{\beta} = (x'x)^{-1}x'y$$

y, the $n \times 1$ observations

x, the $n \times k$ independent variables

$\beta, \hat{\beta}$, the $k \times 1$ unknown coefficient of interests and the $k \times 1$ estimated coefficients, respectively

ε , the $n \times 1$ unobserved random errors

The absence of homoscedasticity, namely heteroscedasticity, indicates the variance of the unobserved errors is not constant and can yield inefficient estimator and misleading inferences (Washington et al., 2003).

$$\text{var}(\varepsilon|X) = \Omega = \begin{bmatrix} \sigma_1^2 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \sigma_n^2 \end{bmatrix}$$

Therefore, GLS model was used to relax the homoscedasticity assumption. This chapter used the Bruesh-Pegan test to detect heteroskedasticity (Wooldridge, 2008). The Bruesh-Pegan test for heteroskedasticity obtains the squared OLS residuals ($\hat{e}^2$) for each observation, and then regresses the squared residuals on all the independent variables. The LM statistic using the χ^2 distribution is obtained based on the $R_{\hat{e}^2}^2$ of the regression (Wooldridge, 2008).

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots \beta_k x_k + \varepsilon$$

$$\hat{e} = y - \hat{y} = y - \hat{\beta}_0 + \hat{\beta}_1 x_1 + \hat{\beta}_2 x_2 + \cdots \hat{\beta}_k x_k$$

$$\hat{e}^2 = \delta_0 + \delta_1 x_1 + \delta_2 x_2 + \cdots \delta_k x_k + \text{error}$$

$$\text{LM statistic} = n \cdot R_{\hat{e}^2}^2, \text{ where } n \text{ is the sample size}$$

If the p-value of the LM statistics is smaller than the given significance level (0.05 was chosen for this chapter), the null hypothesis of homoscedasticity is rejected (Wooldridge, 2008). The Bruesh-Pegan test for heteroscedasticity of the study sample was performed in R using the “lmtest” package (Hothorn et al., 2015). When heteroscedasticity was detected, the feasible GLS procedure was implemented to correct for heteroscedasticity as suggested by Wooldridge (2008), otherwise the variance was regarded as homoscedastic.

The feasible GLS takes the natural log of the squared OLS residuals ($\ln \hat{\varepsilon}^2$) and runs the regression on all the independent variables. Then the exponential value of the fitted value, $\hat{h}$, was obtained for each observation. Finally, the feasible GLS regressed y on x by employing the weighted least squares (WLS) and using $\hat{h}$ as the weight. The estimated coefficients were calculated by minimizing the error term (Kleiber & Zeileis, 2008a; Weisberg, 2005; Wooldridge, 2008).

$$y = x\beta + \varepsilon$$

$$\text{var}(\varepsilon|X) = \sigma^2 w^{-1}$$

$$\hat{\beta} = (x'wx)^{-1}x'wy$$

$$w = \begin{bmatrix} 1/\hat{h}_1 & \dots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \dots & 1/\hat{h}_n \end{bmatrix}$$

Binary Logit Models for Analyzing Gendered Differences

The gendered differences in paired heads' spatial behaviors were analyzed in three binary cases, and these within-household differences were rounded as follows: Paired heads were considered

to have the same spatial behaviors when the difference fell between -0.5 and 0.5. The first model considered whether the spatial behavior of a male head is greater than his counterpart's (paired female head) spatial behavior. The regression models were processed in R (UCLA: Statistical Consulting Group, 2016).

$$y_1 = \begin{cases} 1, & \text{male head's spatial behavior} > \text{female head's spatial behavior} \\ 0, & \text{otherwise} \end{cases}$$

$$Prob(y_1 = 1|x) = prob(y_1^* > 0|x) = prob(x\beta_1 + \varepsilon > 0|x)$$

$$Prob(y_1 = 1|x) = \frac{e^{x\beta_1}}{1 + e^{x\beta_1}}$$

The second model assessed whether the paired heads are the same spatial behaviors.

$$y_2 = \begin{cases} 1, & \text{male head's spatial behavior} = \text{female head's spatial behavior} \\ 0, & \text{otherwise} \end{cases}$$

$$Prob(y_2 = 1|x) = prob(y_2^* > 0|x) = prob(x\beta_2 + \varepsilon > 0|x)$$

$$Prob(y_2 = 1|x) = \frac{e^{x\beta_2}}{1 + e^{x\beta_2}}$$

The third model analyzed whether a female head has greater spatial behavior than her counterpart (male head).

$$y_3 = \begin{cases} 1, & \text{female head's spatial behavior} > \text{male head's spatial behavior} \\ 0, & \text{otherwise} \end{cases}$$

$$Prob(y_3 = 1|x) = prob(y_3^* > 0|x) = prob(x\beta_3 + \varepsilon > 0|x)$$

$$Prob(y_3 = 1|x) = \frac{e^{x\beta_3}}{1 + e^{x\beta_3}}$$

Another approach would be to use ordinal logit regression instead of these binary models to assess how the control factors are associated with the within-household gendered differences. However, the preliminary version of this analysis found that the proportional odds assumption for the ordinal logit model was violated when the data were fitted. The proportional odds assumption states that each predictor should have the constant effect across the categories of the ordinal responses (Ari & Zeki, 2014; Greene & Hensher, 2010; Liu & Koirala, 2012). In other words, the relationship between the effect of a predictor and the odds at different response levels is linear (Harrell, 2015; Liu & Koirala, 2012).

Several methods are applicable for testing the validity of the proportional odds assumptions, such as the Brant test (Brant, 1990). Harrell (2015) recommended a graphical method that examines the ordinarily by plotting the mean of the predictor stratified by different levels of responses. Unfortunately, results of the graphical method suggested that the proportional odds assumption did not hold for the data. The results of validating the proportional odds assumption are documented in Appendix F.

Although Bender and Grouven (1998) has suggested using binary models based upon cumulative probabilities¹ as an alternative to ordinal logit model when the proportional odds assumption is not held (Bender & Grouven, 1998), it is easier and more straightforward to interpret the results of the models employed in this chapter. Therefore, this chapter analyzes the probability of three events: (1) the male's spatial behavior is greater than the paired female head's spatial behavior, (2) the paired heads have the same spatial behaviors, and (3) female

¹ For example, the alternative binary logit models based upon cumulative probabilities assessed the responses when (1) female head's spatial behavior is greater than or equal to ($\geq$) her counterpart's spatial behavior, and (2) female head's spatial behavior is greater than ($>$) her counterpart's spatial behavior.

head's spatial behavior is greater than the paired male head's spatial behavior. Appendix J provides the multinomial logistic estimations on how paired heads choose between these three responses for reference.

Propensity Score Matching for Remediating Residential Selection Bias

Previous studies have suggested the importance of being cautious about the endogeneity between the built environment variables and the unobserved residential preferences when trying to estimate the influences of built environmental factors on travel behaviors (Boarnet & Crane, 2001; Cao & Fan, 2012; Handy et al., 2006). For example, the endogeneity problem occurs when people choose to live in pedestrian-friendly communities because they prefer walking (Boarnet & Crane, 2001; Cao et al., 2009). Failure to account for the problem could lead to selection bias and possibly overestimate the effects of the built environmental factors (Cao et al., 2009; Mokhtarian & Cao, 2008).

This chapter further argues that a person who prefers to accomplish tasks in and not to move beyond the proximity of his or her residence may choose to live in an area with compact design elements, such as high accessibility, dense population, and mixed land use. In fact, some of the previous research on activity space did take people's travel and movement preferences into account in order to avoid selection bias (Fan & Khattak, 2008; Harding et al., 2014; Perchoux et al., 2014). Similar to Chapter 2, this chapter employed the propensity score matching (PSM) approach to remedy the endogeneity problem.

The PSM technique resembles a quasi-randomized experiment that matches a treatment unit with a control unit that has the closet propensity score to the treatment unit (Cao et al., 2009; d'Agostino, 1998; Mokhtarian & Cao, 2008; Rosenbaum & Rubin, 1983). The PSM analysis in

this chapter assigned the household living in a walkable community (walk score greater than or equal to 70) to the treatment group. The matching process was performed by using the MatchIt package in R (Ho et al., 2011, 2013). A control unit was chosen when the difference of the propensity scores between the control unit and a treated unit was less than 0.01 (Boarnet & Hsu, 2015; Cao & Fan, 2012). The treated units that could not find any matched control units were dropped from the PSM sample.

As the descriptive statistics shows that male and female heads' weekend spatial patterns were not very different by stratified built environmental factors compared to the weekday spatial behaviors, this chapter focuses the regression analysis on weekday periods. For the 1,316 households in the weekday sample, the matching approach paired 217 treatment units with 198 control units so there were 415 households selected for the PSM sample. The methodology that was used to obtain the PSM sample is provided in Appendix G. Note that the regression models fitted both the full dataset and the PSM sample, but the analyses in the Results section focuses on the PSM sample.

3.4 Results

3.4.1 Descriptive Statistics

This subsection summarizes household heads' spatial behaviors and the gendered differences in spatial behaviors based on the weekday sample (1,316 households) by the four spatial behavior categories: "Size of Activity Space", "Degree of Residential Deconcentrating", "Compactness Degree", and "Degree of Bounding Non-home Activities".

Figures 4 to 6 illustrate the median household heads' spatial behaviors. Tables 8 to 27 document the means and medians of paired heads' spatial patterns, including the comparisons across the presence of household children, employment status, regional accessibility, and walkability.

Hypothesis testing was employed to examine whether (1) paired heads have significantly different spatial behaviors, (2) paired heads have significantly different spatial behaviors across socio-demographics and built environmental factors, and (3) gendered differences vary significantly across socio-demographics and built environmental factors. The summary statistics of the weekend sample are provided in Appendix H.

Size of Activity Space

The size of activity spaces by gender for the weekday sample are shown in Tables 3-8 to 3-12. Male heads on average have greater activity spaces than female heads, and the hypothesis testing indicates that gendered differences in daily activity space measures are statistically significant. Regarding the presence of household children, it is found that the size of activity spaces of male

heads are not significantly different based on the presence of household children (Table 3-9). Female heads with children have significantly different median sizes of activity spaces compared to female heads without children. The within-household gendered differences in the median size of activity spaces are significantly different by the presence of household children and are greater for households without children.

Analysis of activity space size by employment status suggests that the greatest gendered difference in activity space areas occurs in households with an employed male head and an unemployed female head, followed by households with two employed heads (Table 3-10). Unemployed female heads are likely to have smaller activity spaces when their husbands are employed.

People living in areas with different built environmental factors have significantly different sizes of activity spaces (Tables 3-11 and 3-12). The sizes of the activity spaces are likely to decrease as regional accessibility and walkability of the households' residential area increase. Moreover, the gendered gaps in the size of the activity spaces consistently decrease as regional accessibility and walkability increase (Figures 3-4a and 3-4b). The values in the parentheses in the figure represent the percentage differences between male and female heads' median sizes of activity spaces. Hypothesis testing also finds that these identified trends are significantly different across the stratified built environments.

Table 3-8 Mean and median sizes of activity space

Size of activity space (km ²)	SDE area		MCP area	
	Mean	Median	Mean	Median
All heads	79.11	7.30	78.70	13.94
Male heads	98.38	10.56	96.73	16.79
Female heads	59.85	5.23	60.67	11.20
% Difference	-39.16%	-50.42%	-37.28%	-33.30%
Difference	-38.52	-0.77	-36.06	-0.68
Sig. ¹	***	***	***	***

Significance: * p < .1, ** p < .05, *** p < .01.

Table 3-9 Mean and median sizes of activity space by the presence of household children

Size of activity space by the presence of household children (km ²)		SDE area		MCP area	
		Mean	Median	Mean	Median
Paired heads with children (n=671)	Male heads	128.46	10.18	113.59	16.75
	Female heads	75.97	3.98	65.23	8.94
	% Difference	-40.87%	-60.90%	-42.57%	-46.60%
	Difference	-52.50	-1.66	-48.36	-2.53
	Sig. ¹	***	***	***	***
Paired heads without children (n=645)	Male heads	67.08	10.98	79.18	16.83
	Female heads	43.09	7.38	55.92	12.37
	% Difference	-35.76%	-32.77%	-29.37%	-26.52%
	Difference	-23.99	-0.07	-23.26	0.00
	Sig. ¹	***	***	***	***
<i>Hypothesis test for the presence of household children</i>	<i>Male heads²</i>				
	<i>Female heads²</i>		***		***
	<i>Gendered differences²</i>		***		***

Significance: * p < .1, ** p < .05, *** p < .01.

¹ Paired t-test and Wilcoxon signed rank were used to test whether male and female heads had significant differences in mean and median spatial behaviors, respectively

² ANOVA and Kruskal-Wallis tests were respectively adopted to examine whether the mean and median spatial behaviors were significantly different by the presence of children

Table 3-10 Mean and median sizes of activity space by employment status

Size of activity space by employment status (km ²)		SDE area		MCP area	
		Mean	Median	Mean	Median
Employed male and female heads (n=750)	Male heads	107.60	11.09	101.16	17.44
	Female heads	84.23	7.36	77.35	13.35
	% Difference	-21.71%	-33.63%	-23.54%	-23.48%
	Difference	-23.36	-0.18	-23.81	0.00
	Sig. ¹	***	***	***	***
Employed male and unemployed female heads (n=374)	Male heads	106.59	13.15	107.36	19.86
	Female heads	19.68	1.84	30.83	6.36
	% Difference	-81.54%	-86.03%	-71.28%	-67.97%
	Difference	-86.91	-6.46	-76.53	-7.14
	Sig. ¹	***	***	***	***
Unemployed male and employed female heads (n=126)	Male heads	30.74	3.73	42.96	10.69
	Female heads	26.95	6.56	39.25	11.60
	% Difference	-12.34%	75.78%	-8.65%	8.53%
	Difference	-3.79	1.16	-3.72	0.00
	Sig. ¹		**		
Unemployed male and female heads (n=66)	Male heads	76.20	6.09	88.69	13.46
	Female heads	73.24	4.74	81.08	11.86
	% Difference	-3.88%	-22.16%	-8.58%	-11.92%
	Difference	-2.96	0.00	-7.61	0.00
	Sig. ¹			*	
Hypothesis test for employment status	Male heads²		***		***
	Female heads²		***		***
	Gendered differences²	***	***	***	***

Significance: * p < .1, ** p < .05, *** p < .01.

¹ Paired t-test and Wilcoxon signed rank were used to test whether male and female heads had significant differences in mean and median spatial behaviors, respectively² ANOVA and Kruskal-Wallis tests were respectively adopted to examine whether the mean and median spatial behaviors were significantly different by employment status

Table 3-11 Mean and median sizes of activity space by regional accessibility

Size of activity space by regional accessibility (km ²)		SDE area		MCP area	
		Mean	Median	Mean	Median
Low regional accessibility (n=338)	Male heads	223.04	16.14	186.27	21.96
	Female heads	155.74	6.34	127.28	13.43
	% Difference	-30.17%	-60.74%	-31.67%	-38.85%
	Difference	-67.30	-0.58	-58.99	-0.66
	Sig. ¹	**	***	**	***
Low-medium regional accessibility (n=354)	Male heads	80.39	13.12	93.04	23.41
	Female heads	35.72	5.76	44.36	13.09
	% Difference	-55.56%	-56.13%	-52.32%	-44.08%
	Difference	-44.67	-1.93	-48.68	-2.94
	Sig. ¹	***	***	***	***
Medium-high regional accessibility (n=362)	Male heads	39.48	8.44	48.16	14.39
	Female heads	22.16	4.85	31.70	9.67
	% Difference	-43.87%	-42.58%	-34.18%	-32.76%
	Difference	-17.32	-0.90	-16.46	-0.74
	Sig. ¹	***	***	***	***
High regional accessibility (n=262)	Male heads	43.23	5.89	53.29	10.13
	Female heads	20.83	4.24	36.80	7.76
	% Difference	-51.81%	-28.03%	-30.95%	-23.44%
	Difference	-22.40	-0.06	-16.49	0.00
	Sig. ¹	**	***	*	**
Hypothesis test for regional accessibility	Male heads²		***	**	***
	Female heads²		***		***
	Gendered differences²		*	*	**

Significance: * p < .1, ** p < .05, *** p < .01.

¹ Paired t-test and Wilcoxon signed rank were used to test whether male and female heads had significant differences in mean and median spatial behaviors, respectively² ANOVA and Kruskal-Wallis tests were respectively adopted to examine whether the mean and median spatial behaviors were significantly different by socio-demographics and by regional accessibility

Table 3-12 Mean and median sizes of activity space by walkability

Size of activity space by walkability (km ²)		SDE area		MCP area	
		Mean	Median	Mean	Median
Car-dependent areas (n=699)	Male heads	148.61	16.11	141.89	24.12
	Female heads	95.48	7.38	87.54	15.41
	% Difference	-35.75%	-54.19%	-38.30%	-36.12%
	Difference	-53.13	-1.31	-54.34	-2.75
	Sig. ¹	***	***	***	***
Somewhat walkable areas (n=358)	Male heads	36.92	6.35	39.67	12.56
	Female heads	15.35	4.33	25.18	8.46
	% Difference	-58.42%	-31.76%	-36.51%	-32.68%
	Difference	-21.57	-0.22	-14.48	-0.20
	Sig. ¹	***	***	**	***
Very walkable areas or walker's paradise (n=259)	Male heads	47.76	5.16	53.71	8.62
	Female heads	25.22	3.44	37.18	7.29
	% Difference	-47.20%	-33.37%	-30.77%	-15.43%
	Difference	-22.54	-0.72	-16.53	-0.34
	Sig. ¹	***	***	**	**
Hypothesis test for walkability	Male heads²		***	**	***
	Female heads²		***		***
	Gendered differences²		*	**	**

Significance: * p < .1, ** p < .05, *** p < .01.

¹ Paired t-test and Wilcoxon signed rank were used to test whether male and female heads had significant differences in mean and median spatial behaviors, respectively

² ANOVA and Kruskal-Wallis tests were respectively adopted to examine whether the mean and median spatial behaviors were significantly different by walkability

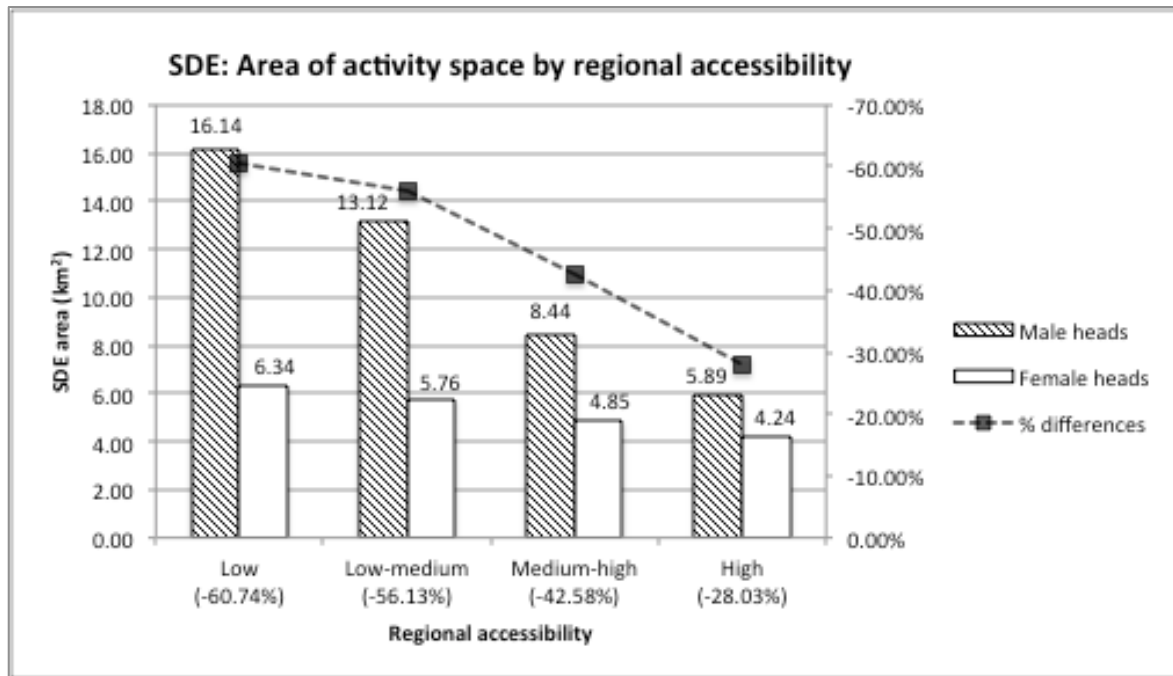


Figure 3-4a Decreasing gendered gaps in the sizes of activity spaces with increasing regional accessibility

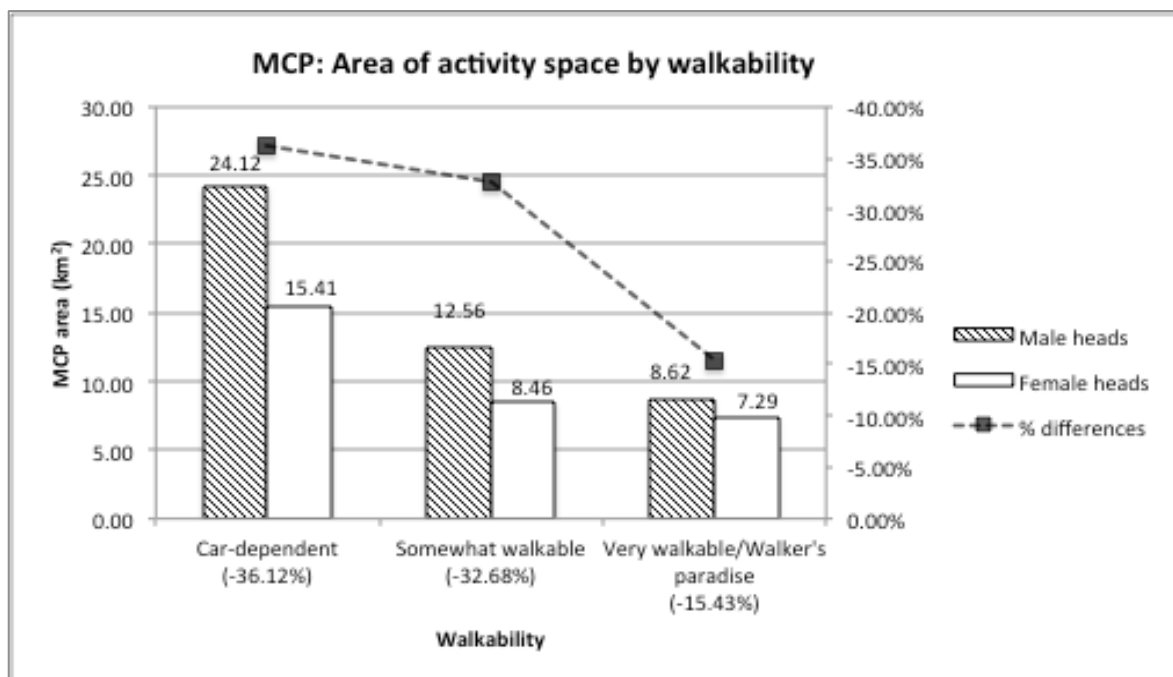


Figure 3-4b Decreasing gendered gaps in the sizes of activity spaces with increasing walkability

Degree of Residential Deconcentrating

This chapter used the “distance between home and centroid” to characterize the degree to which people move their activity spaces away from their residential locations. The results show that male and female heads have significantly different spatial behaviors: the centers of the activity spaces for male heads are on average further from their homes compared to those of female heads (Table 3-13).

Regarding the presence of household children, female heads with children tend to center their activities around their residential location more than other subgroups (Table 3-14). These comparisons across subgroups indicate that the presence of children can influence people’s spatial behaviors. In addition, the within-household gendered gaps are significantly different: households with children have more evident differences than household without children.

Table 3-15 describes paired heads’ activity deconcentrating patterns by employment status. Paired heads from the households with two employed heads or households with one employed and one unemployed head are likely to have significantly different degrees of residential deconcentrating. Hypothesis testing for employment status suggests that individuals and the within-household gendered gaps have significant differences in the degree to which household activity spaces extends farther from residences.

Table 3-16 and Table 3-17 documents the degree of residential activity space deconcentrating for individuals and gendered gaps vary by regional accessibility and walkability, respectively. The results show that people living in different built environments have very different distances between homes and activity space centroids (D_{SDE} and D_{MCP}). The within-household gendered gaps in the distance between homes and centroids are found to be significantly different across the stratified built environments. It is also found that the percentages of these gendered

differences are the smallest for paired heads living in areas with high regional accessibility and high walkability. In particular, the gendered gaps in D_{SDE} consistently decrease along with the increasing walkability (Figure 3-5).

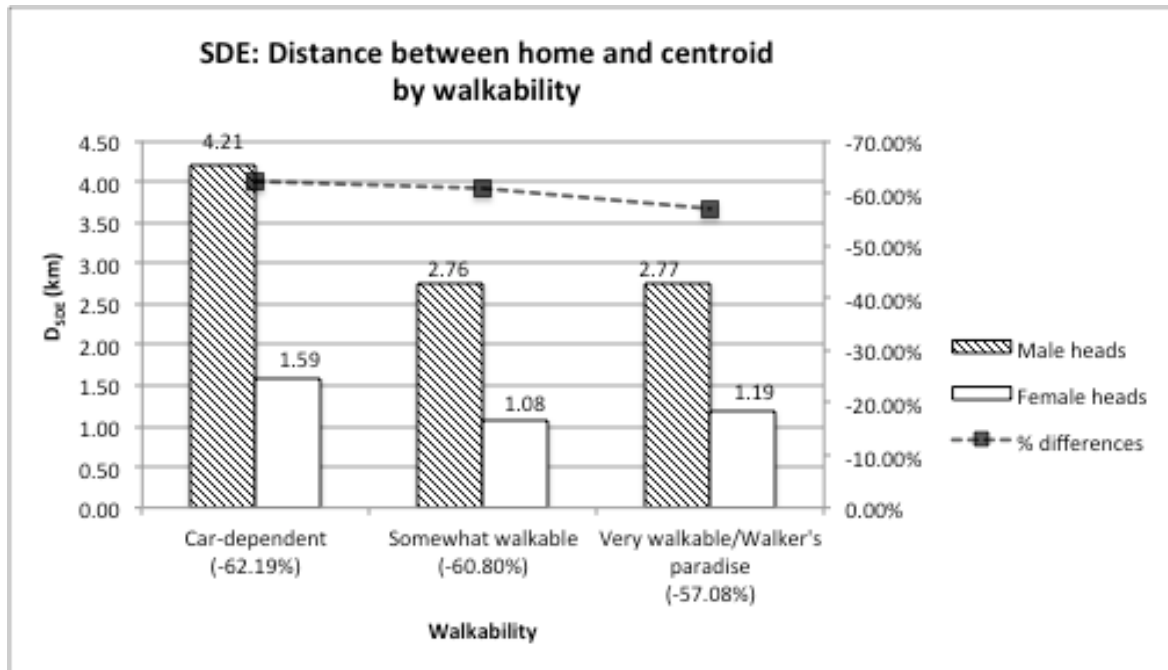


Figure 3-5 Distance between home and the weighted centroid by walkability for SDE (D_{SDE})

Table 3-13 Means and medians of the degree of residential deconcentrating

Degree of residential deconcentrating	D _{SDE} (km)		D _{MCP} (km)	
	Mean	Median	Mean	Median
All heads	5.36	2.19	8.12	4.62
Male heads	6.68	3.51	9.52	6.07
Female heads	4.03	1.35	6.73	3.79
% Difference	-39.70%	-61.61%	-29.31%	-37.54%
Difference	-2.65	-0.57	-2.79	-0.35
Sig. ¹	***	***	***	***

Significance: * p < .1, ** p < .05, *** p < .01.

Table 3-14 Means and medians of the degree of residential deconcentrating by the presence of household children

Degree of residential deconcentrating by the presence of household children		D _{SDE} (km)		D _{MCP} (km)	
		Mean	Median	Mean	Median
Paired heads with children (n=671)	Male heads	7.63	4.09	9.71	5.71
	Female heads	4.09	1.09	6.36	3.43
	% Difference	-46.38%	-73.47%	-34.53%	-39.90%
	Difference	-3.54	-1.04	-3.35	-0.63
	Sig. ¹	***	***	***	***
Paired heads without children (n=645)	Male heads	5.70	3.06	9.32	6.28
	Female heads	3.96	1.62	7.12	4.18
	% Difference	-30.40%	-47.15%	-23.66%	-33.35%
	Difference	-1.73	-0.11	-2.21	-0.01
	Sig. ¹	***	***	***	***
<i>Hypothesis test for the presence of household children</i>	<i>Male heads</i> ²	**	***		
	<i>Female heads</i> ²		***		***
	<i>Gendered differences</i> ²	***	***	**	**

Significance: * p < .1, ** p < .05, *** p < .01.

¹ Paired t-test and Wilcoxon signed rank were used to test whether male and female heads had significant differences in mean and median spatial behaviors, respectively² ANOVA and Kruskal-Wallis tests were respectively adopted to examine whether the mean and median spatial behaviors were significantly different by the presence of children

Table 3-15 Means and medians of the degree of residential deconcentrating by employment status

Degree of residential deconcentrating by employment status		D _{SDE} (km)		D _{MCP} (km)	
		Mean	Median	Mean	Median
Employed male and female heads (n=750)	Male heads	7.27	4.11	9.66	6.32
	Female heads	5.33	2.26	7.62	4.34
	% Difference	-26.68%	-45.13%	-21.11%	-31.23%
	Difference	-1.94	-0.40	-2.04	-0.03
	Sig. ¹	***	***	***	***
Employed male and unemployed female heads (n=374)	Male heads	7.55	4.41	10.34	6.51
	Female heads	1.53	0.35	4.73	2.47
	% Difference	-79.78%	-92.16%	-54.28%	-62.15%
	Difference	-6.03	-2.99	-5.61	-1.90
	Sig. ¹	***	***	***	***
Unemployed male and employed female heads (n=126)	Male heads	2.14	0.60	5.62	3.62
	Female heads	4.34	2.35	6.28	3.89
	% Difference	102.89%	292.52%	11.80%	7.44%
	Difference	2.20	1.16	0.66	0.04
	Sig. ¹	***	***		
Unemployed male and female heads (n=66)	Male heads	3.84	0.79	10.66	5.08
	Female heads	2.90	0.58	8.75	3.56
	% Difference	-24.53%	-26.25%	-17.85%	-29.88%
	Difference	-0.94	0.00	-1.90	0.00
	Sig. ¹		*	***	***
Hypothesis test for employment status	Male heads²	***	***	***	***
	Female heads²	***	***	***	***
	Gendered differences²	***	***	***	***

Significance: * p < .1, ** p < .05, *** p < .01.

¹ Paired t-test and Wilcoxon signed rank were used to test whether male and female heads had significant differences in mean and median spatial behaviors, respectively

² ANOVA and Kruskal-Wallis tests were respectively adopted to examine whether the mean and median spatial behaviors were significantly different by employment status

Table 3-16 Means and medians of the degree of residential deconcentrating by regional accessibility

Degree of residential deconcentrating by regional accessibility		D _{SDE} (km)		D _{MCP} (km)	
		Mean	Median	Mean	Median
Low regional accessibility (n=338)	Male heads	9.34	4.12	13.14	7.57
	Female heads	5.70	1.55	9.24	4.71
	% Difference	-39.02%	-62.46%	-29.68%	-37.69%
	Difference	-3.65	-0.65	-3.90	-0.08
	Sig. ¹	***	***	***	***
Low-medium regional accessibility (n=354)	Male heads	7.60	4.21	11.01	6.83
	Female heads	4.09	1.34	7.13	3.97
	% Difference	-46.25%	-68.07%	-35.28%	-41.89%
	Difference	-3.52	-0.93	-3.88	-0.61
	Sig. ¹	***	***	***	***
Medium-high regional accessibility (n=362)	Male heads	5.22	3.23	7.38	5.16
	Female heads	3.16	1.18	5.41	3.43
	% Difference	-39.45%	-63.33%	-26.76%	-33.43%
	Difference	-2.06	-0.68	-1.98	-0.61
	Sig. ¹	***	***	***	***
High regional accessibility (n=262)	Male heads	4.04	2.04	5.77	3.80
	Female heads	3.01	1.43	4.77	2.90
	% Difference	-25.57%	-29.92%	-17.36%	-23.64%
	Difference	-1.03	-0.09	-1.00	-0.12
	Sig. ¹	***	***	**	***
Hypothesis test for regional accessibility	Male heads²	***	***	***	***
	Female heads²	**		***	***
	Gendered differences²	***	***	***	*

Significance: * p < .1, ** p < .05, *** p < .01.

¹ Paired t-test and Wilcoxon signed rank were used to test whether male and female heads had significant differences in mean and median spatial behaviors, respectively

² ANOVA and Kruskal-Wallis tests were respectively adopted to examine whether the mean and median spatial behaviors were significantly different by regional accessibility

Table 3-17 Means and medians of the degree of residential deconcentrating by walkability

Degree of residential deconcentrating by walkability		D _{SDE} (km)		D _{MCP} (km)	
		Mean	Median	Mean	Median
Car-dependent areas (n=699)	Male heads	8.37	4.21	11.81	7.35
	Female heads	4.97	1.59	8.28	4.44
	% Difference	-40.68%	-62.19%	-29.94%	-39.53%
	Difference	-3.41	-0.72	-3.54	-0.37
	Sig. ¹	***	***	***	***
Somewhat walkable areas (n=358)	Male heads	4.91	2.76	7.23	4.48
	Female heads	2.86	1.08	4.92	3.17
	% Difference	-41.80%	-60.80%	-31.89%	-29.17%
	Difference	-2.05	-0.24	-2.31	-0.13
	Sig. ¹	***	***	***	***
Very walkable areas or walker's paradise (n=259)	Male heads	4.58	2.77	6.49	4.75
	Female heads	3.12	1.19	5.05	2.96
	% Difference	-31.77%	-57.08%	-22.27%	-37.61%
	Difference	-1.45	-0.67	-1.45	-0.64
	Sig. ¹	***	***	***	***
Hypothesis test for walkability	Male heads²	***	***	***	***
	Female heads²	**	***	***	***
	Gendered differences²	***	*	**	

Significance: * p < .1, ** p < .05, *** p < .01.

¹ Paired t-test and Wilcoxon signed rank were used to test whether male and female heads had significant differences in mean and median spatial behaviors, respectively² ANOVA and Kruskal-Wallis tests were respectively adopted to examine whether the mean and median spatial behaviors were significantly different by walkability

Compactness Degree

This chapter also measured people's compactness degree of activity spaces by elongation (E_{SDE}) and spatial concentration (SC_{MCP}). Female heads in general are found to have smaller E_{SDE} and greater SC_{MCP} than their husbands (Table 3-18); these results indicate that the delineations of female heads' activity spaces are relatively circular and compact and that female heads' activity spaces tend to be more spatially concentrated than male heads. Hypothesis testing suggests that male and female heads perform significantly different compactness degrees of their activity spaces.

Table 3-19 describes the compactness degrees of paired heads' activity spaces by the presence of household children. Male heads with children have greater E_{SDE} than male heads without children, suggesting that activity spaces of male heads without children are relatively compact and circular. Female heads with children have higher SC_{MCP} than female heads without children, suggesting that female heads tend to have spatially concentrated extents when they have children. Gendered gaps are not significantly different by the presence of children.

Table 3-20 shows that individuals and gendered differences have significantly different compactness degrees of activity spaces by comparing employment status. It is also found that gendered difference in SC_{MCP} is the greatest for the households with an employed male and an unemployed female head followed by the households with two employed heads.

The comparisons of the compactness degrees of activity spaces across the stratified regionally accessibility and walkability are shown in Tables 3-21 and 3-22. The results suggest that paired heads living in areas with different built environment categories have significantly different SC_{MCP} ; in particular, it is found that SC_{MCP} increases as walkability increase (shown in

Figure 3-6). However, gendered differences are only found to be statistically significant for the comparisons of the mean SC_{MCP} by walkability.

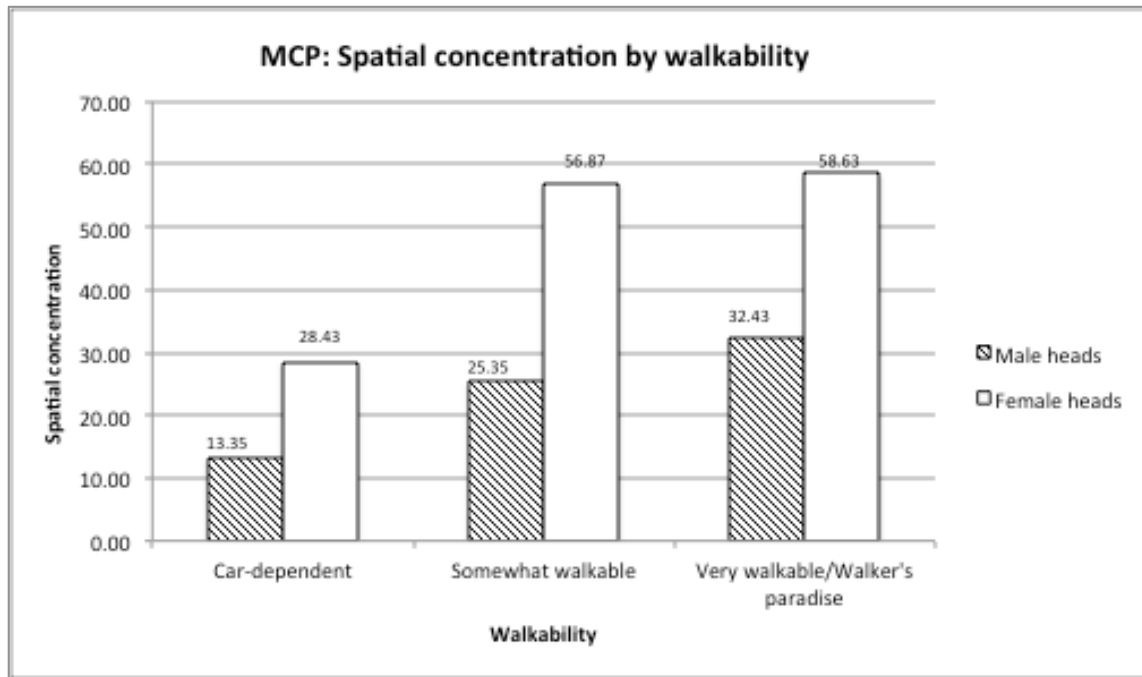


Figure 3-6 Spatial concentrations for male and female heads by walkability

Table 3-18 Means and medians of the compactness degree

Compactness degree	E _{SDE} ¹		SC _{MCP}	
	Mean	Median	Mean	Median
All heads	103.69	10.33	259.44	26.57
MHH	133.09	12.46	134.34	18.70
FHH	74.29	8.54	384.54	40.05
% Difference	-44.18%	-31.49%	186.25%	114.19%
Difference	-58.80	-0.29	250.20	2.44
Sig. ²	*	***	***	***

Significance: * p < .1, ** p < .05, *** p < .01.

Table 3-19 Means and medians of the compactness degree by the presence of household children

Compactness degree by the presence of household children		E _{SDE} ¹		SC _{MCP}	
		Mean	Median	Mean	Median
Paired heads with children (n=671)	Male heads	143.50	15.51	139.43	17.96
	Female heads	96.86	8.61	403.31	48.94
	% Difference	-32.50%	-44.47%	189.27%	172.51%
	Difference	-46.64	-1.06	263.89	6.75
	Sig. ²		***	***	***
Paired heads without children (n=645)	Male heads	122.25	10.25	129.05	19.28
	Female heads	50.81	8.44	365.01	33.17
	% Difference	-58.44%	-17.67%	182.85%	72.00%
	Difference	-71.44	-0.06	235.96	0.08
	Sig. ²	*	***		***
<i>Hypothesis test for the presence of household children</i>	<i>Male heads</i> ³		***		
	<i>Female heads</i> ³				***
	<i>Gendered differences</i> ³				

Significance: * p < .1, ** p < .05, *** p < .01.

¹ Note that small elongation means compact activity space² Paired t-test and Wilcoxon signed rank were used to test whether male and female heads had significant differences in mean and median spatial behaviors, respectively³ ANOVA and Kruskal-Wallis tests were respectively adopted to examine whether the mean and median spatial behaviors were significantly different by the presence of children

Table 3-20 Means and medians of the compactness degree by employment status

Compactness degree by employment status		E _{SDE}		SC _{MCP}	
		Mean	Median	Mean	Median
Employed male and female heads (n=750)	Male heads	163.63	14.53	140.70	17.58
	Female heads	96.38	9.64	271.03	31.68
	% Difference	-41.10%	-33.65%	92.63%	80.16%
	Difference	-67.25	-0.44	130.33	0.36
	Sig. ¹		***	**	***
Employed male and unemployed female heads (n=374)	Male heads	111.48	12.16	87.21	14.81
	Female heads	43.74	6.52	719.77	76.79
	% Difference	-60.77%	-46.38%	725.34%	418.40%
	Difference	-67.74	-2.84	632.56	30.12
	Sig. ¹		***	**	***
Unemployed male and employed female heads (n=126)	Male heads	52.12	6.33	250.94	37.99
	Female heads	65.90	10.99	142.88	35.66
	% Difference	26.45%	73.62%	-43.06%	-6.14%
	Difference	13.78	1.90	-108.06	0.00
	Sig. ¹		**		
Unemployed male and female heads (n=66)	Male heads	62.98	7.10	106.53	26.11
	Female heads	12.43	5.08	236.07	41.47
	% Difference	-80.26%	-28.52%	121.60%	58.81%
	Difference	-50.55	0.00	129.54	0.00
	Sig. ¹		**	**	*
Hypothesis test for employment status	Male heads²		***	**	***
	Female heads²		***		***
	Gendered differences²	*	***	*	***

Significance: * p < .1, ** p < .05, *** p < .01.

¹ Paired t-test and Wilcoxon signed rank were used to test whether male and female heads had significant differences in mean and median spatial behaviors, respectively² ANOVA and Kruskal-Wallis tests were respectively adopted to examine whether the mean and median spatial behaviors were significantly different by employment status

Table 3-21 Means and medians of the compactness degree by regional accessibility

Compactness degree by regional accessibility		E _{SDE}		SC _{MCP}	
		Mean	Median	Mean	Median
Low regional accessibility (n=338)	Male heads	170.12	12.87	108.93	13.67
	Female heads	124.35	9.46	224.16	28.40
	% Difference	-26.91%	-26.53%	105.78%	107.70%
	Difference	-45.78	-0.10	115.23	1.14
	Sig. ¹		***	***	***
Low-medium regional accessibility (n=354)	Male heads	171.83	14.57	85.82	13.05
	Female heads	44.71	8.80	164.07	36.49
	% Difference	-73.98%	-39.61%	91.17%	179.62%
	Difference	-127.12	-0.45	78.24	4.79
	Sig. ¹	*	***	***	***
Medium-high regional accessibility (n=362)	Male heads	83.60	12.51	131.74	21.10
	Female heads	57.60	7.68	451.03	47.05
	% Difference	-31.10%	-38.59%	242.36%	122.93%
	Difference	-26.00	-0.84	319.29	2.53
	Sig. ¹		***	***	***
High regional accessibility (n=262)	Male heads	101.33	9.92	236.25	30.85
	Female heads	72.74	7.95	797.45	54.88
	% Difference	-28.21%	-19.90%	237.55%	77.90%
	Difference	-28.59	0.00	561.20	3.19
	Sig. ¹				***
Hypothesis test for regional accessibility	Male heads²			***	***
	Female heads²				***
	Gendered differences²				

Significance: * p < .1, ** p < .05, *** p < .01.

¹ Paired t-test and Wilcoxon signed rank were used to test whether male and female heads had significant differences in mean and median spatial behaviors, respectively² ANOVA and Kruskal-Wallis tests were respectively adopted to examine whether the mean and median spatial behaviors were significantly different by regional accessibility

Table 3-22 Means and medians of the compactness degree space by walkability

Compactness degree by walkability		E _{SDE}		SC _{MCP}	
		Mean	Median	Mean	Median
Car-dependent areas (n=699)	Male heads	162.27	12.58	72.33	13.35
	Female heads	82.89	8.35	143.14	28.43
	% Difference	-48.92%	-33.60%	97.88%	112.92%
	Difference	-79.39	-0.30	70.80	1.78
	Sig. ¹		***	***	***
Somewhat walkable areas (n=358)	Male heads	91.00	13.75	166.90	25.35
	Female heads	51.92	8.65	335.88	56.87
	% Difference	-42.95%	-37.10%	101.24%	124.29%
	Difference	-39.08	-0.99	168.97	1.91
	Sig. ¹		***	***	***
Very walkable areas or walker's paradise (n=259)	Male heads	112.48	11.95	256.67	32.43
	Female heads	82.00	9.23	1.10E+03	58.63
	% Difference	-27.10%	-22.75%	329.86%	80.80%
	Difference	-30.48	0.00	846.64	10.64
	Sig. ¹			*	***
Hypothesis test for walkability	Male heads²			***	***
	Female heads²			***	***
	Gendered differences²			***	

Significance: * p < .1, ** p < .05, *** p < .01.

¹ Paired t-test and Wilcoxon signed rank were used to test whether male and female heads had significant differences in mean and median spatial behaviors, respectively² ANOVA and Kruskal-Wallis tests were respectively adopted to examine whether the mean and median spatial behaviors were significantly different by walkability

Degree of Bounding Non-home Activities

The degree of bounding non-home activities are characterized by activity density (AD_{SDE} , AD_{MCP}), activity density weighted by eccentricity (ADE_{SDE}), and activity concentration (AC_{MCP}). Results in Table 3-23 show that female heads have more constrained non-home activities than male heads. Female heads' non-home activities are also found to be relatively bounded by home compared to male heads. Hypothesis testing suggests male and female heads have significantly different spatial behaviors in terms of the degree of bounding non-home activities.

Table 3-24 compares the degree of bounding non-home activities by the presence of household children. Female heads with children are found to have more bounded non-home activities than female heads without children whereas there are no significant differences between male heads with and without children. Gendered differences in the degrees of bounding non-home activities are significantly different by the presence of children: households with children have greater percentage differences than the households without children.

Paired heads' employment status is also related to individual spatial behaviors and gendered differences in the degree of bounding non-home activities (Table 3-25). Paired heads from the households with at least one employed head have significantly different degrees of bounding non-home activities, but unemployed paired heads are not found to have significant differences. The results also identify that the greatest gendered differences occur in households with an employed male head and an unemployed female head.

People's degree of bounding non-home activities is likely to increase with regional accessibilities and walkability (Tables 3-26 and 3-27). These spatial behaviors are significantly different across the stratified built environments. Hypothesis testing does not show that gendered gaps have significant differences across the stratified built environments.

Table 3-23 Means and medians of the degree of bounding non-home activities

Degree of bounding non-home activities	AD _{SDE}		ADE _{SDE}		AD _{MCP}		AC _{MCP}	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
All heads	70.29	0.53	630.55	1.43	5.07	0.27	1.37E+04	246.80
Male heads	9.18	0.34	157.65	0.81	2.09	0.20	6.15E+03	126.33
Female heads	131.40	0.80	1103.44	2.49	8.04	0.35	2.13E+04	523.23
% Difference	1331.79%	136.50%	599.93%	208.32%	285.04%	76.17%	246.86%	314.18%
Difference	122.22	0.06	945.79	0.27	5.95	0.03	1.52E+04	85.33
Sig. ¹		***		***		***	***	***

Significance: * p < .1, ** p < .05, *** p < .01.

Table 3-24 Means and medians of the degree of bounding non-home activities by the presence of household children

Degree of bounding non-home activities by the presence of household children		AD _{SDE}		ADE _{SDE}		AD _{MCP}		AC _{MCP}	
		Mean	Median	Mean	Median	Mean	Median	Mean	Median
Paired heads with children (n=671)	Male heads	10.57	0.37	220.28	0.80	1.56	0.21	7.68E+03	120.42
	Female heads	240.80	1.15	1959.24	4.17	13.18	0.49	3.19E+04	846.12
	% Difference	2178.51%	208.75%	789.43%	418.57%	745.46%	133.05%	315.08%	602.66%
	Difference	230.23	0.20	1738.96	0.85	11.62	0.06	2.42E+04	200.89
	Sig. ¹		***		***		***	***	***
Paired heads without children (n=645)	Male heads	7.73	0.32	92.50	0.81	2.64	0.19	4.56E+03	133.97
	Female heads	17.59	0.52	213.15	1.62	2.70	0.29	1.04E+04	359.99
	% Difference	127.56%	62.36%	130.44%	99.40%	2.21%	47.67%	127.28%	168.71%
	Difference	9.86	0.01	120.66	0.05	0.06	0.00	5.80E+03	16.50
	Sig. ¹		**		***		**	*	***
<i>Hypothesis test for the presence of household children</i>	<i>Male heads</i> ²								*
	<i>Female heads</i> ²		***		***		***	***	***
	<i>Gendered differences</i> ²		***		***		***	**	***

Significance: * p < .1, ** p < .05, *** p < .01.

¹ Paired t-test and Wilcoxon signed rank were used to test whether male and female heads had significant differences in mean and median spatial behaviors, respectively

² ANOVA and Kruskal-Wallis tests were respectively adopted to examine whether the mean and median spatial behaviors were significantly different by the presence of children

Table 3-25 Means and medians of the degree of bounding non-home activities by employment status

Degree of bounding non-home activities by employment status		AD _{SDE}		ADE _{SDE}		AD _{MCP}		AC _{MCP}	
		Mean	Median	Mean	Median	Mean	Median	Mean	Median
Employed male and female heads (n=750)	Male heads	7.98	0.32	102.78	0.71	2.39	0.19	5662.77	104.88
	Female heads	12.48	0.55	112.30	1.40	2.56	0.29	1.32E+04	276.29
	% Difference	56.41%	69.61%	9.27%	96.10%	6.93%	51.25%	132.29%	163.43%
	Difference	4.50	0.02	9.53	0.10	0.17	0.01	7.49E+03	18.72
	Sig. ¹		***		***		***	*	***
Employed male and unemployed female heads (n=374)	Male heads	2.87	0.23	21.28	0.58	0.88	0.17	2.08E+03	79.86
	Female heads	434.69	2.17	3631.91	12.32	22.42	0.70	4.43E+04	2623.78
	% Difference	15059.34%	833.44%	16968.16%	2033.69%	2438.85%	321.06%	2029.34%	3185.56%
	Difference	431.83	0.90	3610.63	6.41	21.54	0.20	4.22E+04	1509.32
	Sig. ¹		***		***		***	***	***
Unemployed male and employed female heads (n=126)	Male heads	28.89	1.17	691.65	5.20	2.32	0.38	2.01E+04	1420.66
	Female heads	4.35	0.57	29.50	1.58	1.15	0.34	7534.96	204.99
	% Difference	-84.94%	-51.11%	-95.74%	-69.61%	-50.44%	-9.37%	-62.56%	-85.57%
	Difference	-24.54	-0.19	-662.15	-1.08	-1.17	-0.02	-1.26E+04	-401.21
	Sig. ¹	*	***		***	*	**	*	***
Unemployed male and female heads (n=66)	Male heads	20.91	0.57	534.56	2.08	5.02	0.24	8113.51	686.55
	Female heads	6.66	0.89	88.72	5.06	2.06	0.26	1.08E+04	1059.77
	% Difference	-68.14%	56.22%	-83.40%	143.78%	-58.98%	11.16%	32.74%	54.36%
	Difference	-14.25	0.00	-445.84	0.00	-2.96	0.00	2.66E+03	0.00
	Sig. ¹								
Hypothesis test for employment status	Male heads²	***	***	***	***		***	***	***
	Female heads²		***		***		***	***	***
	Gendered differences²		***	*	***		***	***	***

Significance: * p < .1, ** p < .05, *** p < .01.

¹ Paired t-test and Wilcoxon signed rank were used to test whether male and female heads had significant differences in mean and median spatial behaviors, respectively² ANOVA and Kruskal-Wallis tests were respectively adopted to examine whether the mean and median spatial behaviors were significantly different by employment status

Table 3-26 Means and medians of the degree of bounding non-home activities by regional accessibility

Degree of bounding non-home activities by regional accessibility		AD _{SDE}		ADE _{SDE}		AD _{MCP}		AC _{MCP}	
		Mean	Median	Mean	Median	Mean	Median	Mean	Median
Low regional accessibility (n=338)	Male heads	4.42	0.21	120.06	0.54	1.10	0.14	5.35E+03	84.07
	Female heads	76.16	0.56	1385.34	1.89	3.74	0.26	2.97E+04	372.63
	% Difference	1622.79%	163.26%	1053.89%	251.60%	239.55%	93.37%	455.62%	343.24%
	Difference	71.74	0.03	1265.28	0.23	2.64	0.01	2.44E+04	43.75
	Sig. ¹		***		***	*	***	**	***
Low-medium regional accessibility (n=354)	Male heads	6.39	0.25	45.09	0.59	2.80	0.14	3.12E+03	93.85
	Female heads	11.12	0.75	149.54	2.23	1.69	0.32	7.47E+03	392.81
	% Difference	73.99%	192.96%	231.66%	276.41%	-39.82%	128.90%	139.65%	318.55%
	Difference	4.73	0.14	104.45	0.45	-1.12	0.04	4.36E+03	120.86
	Sig. ¹		***		***		***	**	***
Medium-high regional accessibility (n=362)	Male heads	13.14	0.46	344.60	0.92	1.81	0.24	8.64E+03	154.03
	Female heads	379.38	0.83	2472.31	2.68	19.74	0.42	3.19E+04	676.40
	% Difference	2787.68%	78.76%	617.44%	191.19%	991.39%	75.12%	268.87%	339.13%
	Difference	366.24	0.10	2127.70	0.42	17.93	0.04	2.32E+04	157.59
	Sig. ¹		***		***		***	**	***
High regional accessibility (n=262)	Male heads	13.61	0.66	99.93	1.72	2.78	0.36	7.85E+03	262.64
	Female heads	22.56	1.12	137.31	3.05	6.02	0.52	1.47E+04	680.66
	% Difference	65.80%	70.29%	37.40%	77.37%	116.18%	43.22%	87.27%	159.16%
	Difference	8.95	0.02	37.37	0.02	3.24	0.04	6.85E+03	44.73
	Sig. ¹						**		***
Hypothesis test for regional accessibility	Male heads²		***		***		***		***
	Female heads²		***		**		***	*	***
	Gendered differences²								

Significance: * p < .1, ** p < .05, *** p < .01.

¹ Paired t-test and Wilcoxon signed rank were used to test whether male and female heads had significant differences in mean and median spatial behaviors, respectively² ANOVA and Kruskal-Wallis tests were respectively adopted to examine whether the mean and median spatial behaviors were significantly different by regional accessibility

Table 3-27 Means and medians of the degree of bounding non-home activities by walkability

Degree of bounding non-home activities by walkability		AD _{SDE}		ADE _{SDE}		AD _{MCP}		AC _{MCP}	
		Mean	Median	Mean	Median	Mean	Median	Mean	Median
Car-dependent areas (n=699)	Male heads	4.23	0.21	49.04	0.51	1.70	0.13	4.01E+03	81.65
	Female heads	17.61	0.54	240.19	1.61	1.88	0.26	1.16E+04	341.71
	% Difference	316.10%	162.39%	389.77%	215.73%	10.89%	94.28%	190.06%	318.52%
	Difference	13.38	0.05	191.15	0.25	0.18	0.02	7.61E+03	54.44
	Sig. ¹	*	***		***		***	**	***
Somewhat walkable areas (n=358)	Male heads	17.55	0.62	418.59	1.40	2.51	0.29	8.45E+03	191.29
	Female heads	78.82	0.95	1326.03	3.43	5.18	0.42	2.87E+04	716.04
	% Difference	349.13%	53.09%	216.79%	144.95%	106.19%	41.82%	239.70%	274.32%
	Difference	61.27	0.06	907.44	0.28	2.67	0.04	2.02E+04	72.35
	Sig. ¹	***	***		***		***	*	***
Very walkable areas or walker's paradise (n=259)	Male heads	10.95	0.77	90.10	1.74	2.56	0.42	8.77E+03	224.08
	Female heads	511.18	1.37	3125.57	4.13	28.63	0.62	3.74E+04	827.78
	% Difference	4568.33%	77.38%	3369.07%	137.38%	1016.51%	47.91%	326.43%	269.42%
	Difference	500.23	0.16	3035.47	0.37	26.07	0.04	2.86E+04	177.71
	Sig. ¹		***		***		***	**	***
Hypothesis test for walkability	Male heads²	***	***	**	***		***	*	***
	Female heads²		***		***		***	**	***
	Gendered differences²					*			

Significance: * p < .1, ** p < .05, *** p < .01.

¹ Paired t-test and Wilcoxon signed rank were used to test whether male and female heads had significant differences in mean and median spatial behaviors, respectively² ANOVA and Kruskal-Wallis tests were respectively adopted to examine whether the mean and median spatial behaviors were significantly different by walkability

3.4.2 Multivariate Analysis Part 1: Factors Associated with Male and Female Activity Spaces

This section separately provides the estimations of male and female heads' spatial behaviors in order to understand whether men and women respond differently to built environments (Crane, 2007). Based on the propensity score matching (PSM) sample, the analyses regressed the logarithm values of individual spatial behaviors on covariates by using generalized least squares (GLS) models. The heteroscedasticity problem was remedied when the Bruesh-Pegan test rejected its null hypothesis. These results are also compared with the analyses based on the full dataset (Appendix I) to assess whether influences of the built environments disappeared as residential selection was taken into account.

The independent variables that were used in the regression models controlled for socio-demographics and built environments. Table 3-28 summarizes the covariates for the full data and the PSM data. The socio-demographic variables were the presence of household children under 15 years old, household income, the number of household vehicles, head's age, ethnicity, possession of valid driver license, and employment status. The built environment variables included regional accessibility and walk score.

Similar to the "Descriptive Statistics" section, this section discusses the regression results by the four spatial behavior features: "Size of Activity Space", "Degree of Residential Deconcentrating", "Compactness Degree", and "Degree of Bounding Non-home Activities". Below are the analyses. Table 3-29 provides an overview that describes the influence of key factors on male and female heads' spatial behaviors. Table 3-29¹ summarizes that the presence of

¹ In Table 29, less constrained spatial behaviors occur when there are plus signs for the size of activity space and the degree of residential deconcentrating and minus signs for compactness degree and the degree of bounding non-home activities.

household children, being in a low household income, and having a greater residential area Walk Score are the key factors that are associated with constrained spatial behaviors; on the other hand, the number of household vehicles, possessing a drivers license, and being employed are associated with less constrained household heads' activity space behaviors. The subsections below describe the estimated results in detail.

Table 3-28 Summary statistics of the independent variables for the weekday sample

Independent variables	Full sample	PSM sample
Household characteristics		
The presence of kids under 15 years old (1/0)	0.51	0.51
HH income: \$0-\$49,999 (1/0)	0.21	0.24
HH income: \$50,000-\$99,999 (1/0)	0.57	0.57
HH income: greater than \$99,999 (1/0)	0.22	0.19
The number of vehicles in household	2.24	2.04
Male household head's characteristics		
Age	48.91	47.47
Hispanic (1/0)	0.24	0.28
Valid driver license (1/0)	0.98	0.99
Employed (1/0)	0.85	0.87
Female household head's characteristics		
Age	46.88	45.70
Hispanic (1/0)	0.25	0.27
Valid driver license (1/0)	0.94	0.94
Employed (1/0)	0.67	0.74
Regional accessibility		
Low (1/0)	0.26	0.19
Low-medium (1/0)	0.27	0.17
Medium-high (1/0)	0.28	0.29
High (1/0)	0.20	0.34
Walkable neighborhood		
Walk Score	44.72	59.47
Sample size	1316	415
Treated units	-	217
Control units	-	198

Table 3-29 Overview: influences of key factors on male and female heads' spatial behaviors

Spatial behavior	Size of activity space		Degree of residential deconcentrating		Compactness degree		Degree of bounding non-home activities	
	Male head	Female head	Male head	Female head	Male head	Female head	Male head	Female head
Socio-demographic factors								
The presence of kids under 15 years old	—	—	—	—		+	+	+
Lower household income			—					
The number of household vehicles	+		+		—		—	
Valid driver license							—	—
Employed		+	+	+		—	—	—
Built environmental factor								
Walk Score	—	—	—	—	+	+	+	+

Size of Activity Space

Table 3-30 documents the estimation results of male and female heads' size of activity spaces. The adjusted R^2 and F-test suggest that models had good fit to the data. Regarding socio-demographics, the presence of children decreased the activity space size for female heads for more than 80% and it had greater influence on female heads than on male heads. Male head's activity space area is increased by more than 30% when the number of household vehicles is increased by one unit. Employed female heads tend to have greater activity spaces than unemployed heads female heads.

The influence of built environmental factors on activity space size, in particular Walk Score, remains significance after selection bias is accounted for (see Appendix I, Table I-1 for the estimated results of the full data). A one unit increase in walk score is associated with a 1.2% to 1.8% decrease in activity spaces for male and female heads. Male and female heads seem to have different responses to residential area Walk Score: this factor has slightly greater influences on female heads' size of activity spaces compared to male heads' size of activity space.

Table 3-30 Male and female heads spatial behaviors in terms of the size of activity space

Size of the activity space	ln(SDE area)				ln (MCP area)			
	Male		Female		Male		Female	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-0.028		-1.382		0.649		-1.084	
Household characteristics								
Presence of children	-0.508	*	-1.218	***	-0.223		-0.837	***
HH income: \$0-\$49,999	-0.360		-0.267		-0.242		-0.311	
HH income: \$50,000-\$99,999	-0.294		-0.086		-0.093		0.024	
Number of vehicles	0.397	**	-0.097		0.325	**	-0.043	
Head's characteristics								
Age	0.086		0.182		0.076		0.200	*
Square age	-0.001		-0.002	*	-0.001		-0.003	*
Hispanic	0.154		-0.260		0.014		-0.286	
Valid driver license	0.555		0.532		0.733		0.436	
Employed	0.397		1.117	***	-0.076		0.670	**
Regional accessibility								
Low-medium	0.153		0.079		0.080		0.357	
Medium-high	0.069		0.157		0.007		0.393	
High	0.127		0.295		0.036		0.451	
Walkable neighborhood								
Walk Score	-0.014	**	-0.017	***	-0.012	**	-0.018	***
Sample size	415		415		415		415	
Breush-Pegan test	0.63		0.02		0.78		0.06	
Adjusted R²	0.03		0.13		0.02		0.11	
P-value of F-statistic	0.0222		1.48E-09		0.0418		3.22E-08	

Significance: * p < .1, ** p < .05, *** p < .01.

Degree of Residential Deconcentrating

Table 3-31 provides the estimated results of the degree of residential deconcentrating for male and female heads. F-test shows that the models fit the data well. Results indicate that socio-demographics have significant influence on how people situate their activity centers. The presence of household children is consistently associated with having activity centers closer to home, particularly in the female head models. The male head models suggest that lower categories of household income are associated with having activity centers close to home.

In most of the male and female head models, being employed was significantly associated with locating their activity space centers farther from residences and the influence of the employment variable is much greater for female heads than for male heads. A one unit increase in the number of household vehicles is associated with 20% to 23% increase in male heads' distances between home and activity centroids. Compared to the results based on the full data (Appendix I, Table I-2), Walk Score remains a significant factor once selection bias is accounted for (Table 3-31). Distances between homes and the centroids of activity spaces are decreased by nearly 1% as Walk Score has one unit increase.

Table 3-31 Male and female heads spatial behaviors in terms of the degree of residential deconcentrating

Degree of centering activity space on residence	ln (D _{SDE})				ln (D _{MCP})			
	Male		Female		Male		Female	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-2.525		-0.716		-0.676		0.286	
Household characteristics								
Presence of children	-0.197		-0.894	***	-0.204	*	-0.580	***
HH income: \$0-\$49,999	-0.626	**	0.094		-0.245		0.110	
HH income: \$50,000-\$99,999	-0.423	*	0.001		-0.141		0.092	
Number of vehicles	0.232	*	-0.086		0.202	**	0.026	
Head's characteristics								
Age	0.120		0.058		0.088	*	0.070	
Square age	-0.001		-0.001		-0.001	*	-0.001	*
Hispanic	0.228		-0.253		0.105		-0.293	**
Valid driver license	0.363		-0.036		0.395		0.232	
Employed	1.122	***	1.559	***	0.184		0.396	***
Regional accessibility								
Low-medium	-0.034		0.393		0.092		0.157	
Medium-high	0.212		0.136		0.052		0.247	
High	0.086		0.268		-0.083		0.145	
Walkable neighborhood								
Walk Score	-0.011	**	-0.009	**	-0.006	**	-0.008	***
Sample size	415		415		415		415	
Breush-Pegan test	0.38		0.10		0.14		0.21	
Adjusted R²	0.09		0.20		0.06		0.13	
P-value of F-statistic	1.85E-06		6.98E-16		0.0004		1.11E-09	

Significance: * p < .1, ** p < .05, *** p < .01.

Degree of Compactness

The estimated results on the compactness degree of activity spaces are shown in Table 3-32. The results of adjusted R^2 and F-test suggest that the models for estimating E_{SDE} do not fit the data well but the models for estimating household heads' spatial concentrations have a good fit with the data.

For male heads, the spatial concentration is decreased by 32% along with one unit increase in number of vehicles. For female heads, the presence of children is associated with a 95% increase in spatial concentration; on the other hand, being employed is associated with 65% of decreases in spatial concentration in the female head SC_{MCP} model.

Comparisons between model results with the full data (Appendix I, Table I-3) and models with the PSM data (Table 3-32) indicate that the influence of built environmental factors, Walk Score in particular, remains significance when self-selection is accounted for. A one-unit increase in Walk Score increases male and female heads' spatial concentration by 1.4% and 1.2%, respectively.

Table 3-32 Male and female heads' spatial behaviors in terms of the compactness degree

Compactness degree	ln(E _{SDE})				ln(SC _{MCP})			
	Male		Female		Male		Female	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	0.208		3.709	**	6.412	***	6.438	***
Household characteristics								
Presence of children	0.163		-0.068		0.158		0.951	***
HH income: \$0-\$49,999	-0.293		0.433		0.266		0.106	
HH income: \$50,000-\$99,999	-0.073		0.100		0.016		-0.066	
Number of vehicles	0.029		0.047		-0.320	**	-0.065	
Head's characteristics								
Age	0.092		-0.099		-0.121		-0.147	
Square age	-0.001		0.001		0.001		0.002	*
Hispanic	0.123		0.003		-0.119		0.223	
Valid driver license	-0.103		0.083		-0.649		-0.637	
Employed	0.641	***	0.406	**	-0.230		-0.651	***
Regional accessibility								
Low-medium	-0.213		0.266		-0.032		-0.431	
Medium-high	0.143		-0.115		-0.093		-0.222	
High	-0.031		-0.228		-0.037		-0.164	
Walkable neighborhood								
Walk Score	-0.003		0.008	**	0.014	***	0.012	**
Sample size	415		415		415		415	
Breush-Pegan test	0.43		1.00		0.39		0.50	
Adjusted R²	0.01		0.01		0.04		0.11	
P-value of F-statistic	0.1275		0.2894		0.0032		1.85E-08	

Significance: * p < .1, ** p < .05, *** p < .01.

Degree of Bounding Non-home Activities

The analyses on the degree of bounding non-home activities focus on ADE_{SDE} (SDE activity density weighted by eccentricity) and AC_{MCP} (activity concentration) because these spatial indices not only characterize the degree of bounding non-home activities but also describe whether non-home activities are spatially and temporally bounded by home. Table 3-33 provides the estimation results. Overall the models fit the data well.

The presence of children variable again suggests that household heads, particularly female heads with children, are more spatially and temporally bounded by home when they undertake non-home activities. For male heads, a one-unit increase in the number of household vehicles is associated with a 35% to 43% decrease in the degree of bounding non-home activities. In the ADE_{SDE} models, employed household heads have non-home activities that are 119% to 175% less bounded than unemployed heads; the influences of being employed are greater on female heads than on male heads. In the AC_{MCP} models, the possession of valid driver license was associated with non-home activities which were less spatially and temporally bounded by 147%-187%.

Compared to the results based on the full dataset (Appendix I, Table I-4), Walk Score remains significant impacts when selection-bias is accounted for. An increasing walk score has positive associations with the degree of bounding non-home activities. A one unit increase in Walk Score were associated with an increase the activity density and the activity concentration by 1.5% to 2%.

Table 3-33 Male and female heads' spatial behaviors in terms of the degree of bounding non-home activities

Degree of bounding non-home activities	ln(ADE _{SDE})				ln(AC _{MCP})			
	Male		Female		Male		Female	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	3.707		2.460		10.433	***	8.573	***
Household characteristics								
Presence of children	0.677	**	1.504	***	0.409		1.525	***
HH income: \$0-\$49,999	0.521		0.375		0.490		0.161	
HH income: \$50,000-\$99,999	0.490		0.095		0.272		-0.015	
Number of vehicles	-0.433	**	0.190		-0.350	*	0.001	
Head's characteristics								
Age	-0.118		-0.135		-0.165		-0.140	
Square age	0.002		0.002		0.002		0.002	
Hispanic	-0.294		0.195		-0.337		0.252	
Valid driver license	-0.961		-0.186		-1.099		-0.141	
Employed	-1.186	***	-1.750	***	-1.472	***	-1.867	***
Regional accessibility								
Low-medium	-0.139		0.039		-0.061		-0.540	
Medium-high	-0.188		-0.018		-0.413		-0.224	
High	-0.169		-0.363		-0.322		-0.398	
Walkable neighborhood								
Walk Score	0.018	***	0.018	***	0.020	***	0.015	**
Sample size	415		415		415		415	
Breush-Pegan test	0.89		0.02		0.75		0.24	
Adjusted R²	0.06		0.18		0.09		0.19	
P-value of F-statistic	0.0001		7.54E-14		1.65E-06		2.65E-15	

Significance: * p < .1, ** p < .05, *** p < .01.

3.4.3 Multivariate Analysis Part 2: Gendered Differences in Spatial Behaviors

This section analyzes factors associated with within-household gendered differences in spatial behaviors based on the PSM data sample. I employ three binary logit models to understand how socio-demographics and built environmental variables affect paired heads' spatial behaviors relative to their counterparts (see Table 3-28 for the socio-demographic and built environmental variables). For each activity space outcome category, the first model analyzes the probability that a male head's spatial behavior is greater than his counterpart's (paired female head) spatial behavior; the second model analyzes the probability that the paired heads have the same spatial behavior; the third model analyzes the probability that the spatial behavior of a female head is greater than her counterpart (paired male head). Note that the within-household differences were rounded half to even in the following way: Paired heads were regarded as having the same spatial behaviors when the differences fell between -0.5 and 0.5. Table 3-34 provides the distributions of the responses for paired heads in terms of spatial behaviors. These models can be described as follows:

Model 1 (MHH Greater): male head's spatial behavior > female head's spatial behavior

Model 2 (MHH=FHH): male head's spatial behavior = female head's spatial behavior

Model 3 (FHH Greater): female head's spatial behavior > male head's spatial behavior

Tables 3-35a and 3-35b summarize the patterns of the associations between the key factors and gendered differences for the SDE and MCP measures of activity space, respectively. Overall, the presence of children, the number of household vehicles, having an employed male

head, and a higher near-residence Walk Score are associated with a greater likelihood that female heads will have more constrained spatial behaviors relative to male heads. Being lower income, having an employed female head, and higher residential regional accessibility is associated with a greater likelihood that female heads' spatial behaviors will be less constrained relative to male heads.

The subsections below analyze the within-household gendered differences in spatial behaviors by “Size of Activity Space”, “Degree of Residential Deconcentrating”, “ Compactness Degree”, and “Degree of Bounding Non-home Activities”. The goodness-of-fit tests overall show that the models fit the data, except for the D_{SDE} and E_{SDE} models. These analyses are also compared with the estimations on the full data in order to investigate whether built environmental factors remain significant after residential selection is taken into account using the PSM sample. Results based on the full data are documented in Appendix I.

Table 3-34 Sample distributions for the responses of gendered differences in terms of spatial behaviors

Sample distribution	Size of area		Degree of residential deconcentrating		Compactness degree		Degree of bounding non-home activities	
	SDE	MCP	SDE	MCP	SDE elongation	MCP spatial concentration	SDE activity density	MCP activity concentration
MHH Greater ¹	208	194	209	198	200	137	112	127
MHH=FHH ²	67	58	103	100	55	62	105	31
FHH Greater ³	140	163	103	117	160	216	198	257
Total	415	415	415	415	415	415	415	415

Table 3-35a Overview: influences of key factors on the within-household gendered differences in SDE spatial behaviors

SDE	Size of activity space			Degree of residential deconcentrating			Compactness degree ⁴			Degree of bounding non-home activities		
	MHH Greater	MHH=F HH	FHH Greater	MHH Greater	MHH=F HH	FHH Greater	MHH Greater	MHH=F HH	FHH Greater	MHH Greater	MHH=F HH	FHH Greater
Presence of children											-	+
Lower HH income						+	+			+	-	
Number of HH vehicles	+	-		+								+
Employed MHH				+		-	-		+	-		+
Employed FHH	-		+	-		+				+		-
Regional accessibility		-								+		
Walk Score							+		-			

¹ Male household head (MHH) has greater spatial behavior than his counterpart (female household head, FHH)

² Paired male and female household heads have the same spatial behaviors

³ Female household head (FHH) has greater spatial behavior than her counterpart (MHH)

⁴ Note that elongation represents the compactness for SDE; greater elongation means less compact activity space is less compact. A positive estimated coefficient for FHH Greater means that FHH would have greater elongation than MHH, so the table here interprets that MHH's compactness degree is greater than FHH

Table 3-35b Overview: influences of key factors on the within-household gendered differences in MCP spatial behaviors

MCP	Size of activity space			Degree of residential deconcentrating			Compactness degree			Degree of bounding non-home activities		
	MHH Greater	MHH=F HH	FHH Greater	MHH Greater	MHH=F HH	FHH Greater	MHH Greater	MHH=F HH	FHH Greater	MHH Greater	MHH=F HH	FHH Greater
Presence of children	+							-	+		-	
Lower HH income										+		-
Number of HH vehicles				+	-				+			
Employed MHH										-		+
Employed FHH	-		+	-		+	+		-	+	-	-
Regional accessibility		-	+		-	+	+			+	-	
Walk Score						-						

Size of Activity Space

Table 3-36 provides the estimated results of gendered differences in the size of activity spaces. Several socio-demographic factors are significant. Results suggest the presence of children and increasing household vehicles increases the likelihood that a male head's activity space is greater than his paired female head. A greater number of household vehicles and possessing valid driver license decrease the likelihood that paired heads will have same activity space size. Having an employed female head decreases the likelihood that the MHH will have a larger activity space, and increases the likelihood that the FHH will have a larger activity space. That is, once employed, female heads are likely to expand their activity spaces relative to their husbands.

Compared to the estimations based on the full dataset (Appendix I, Table I-6), regional accessibility remains significant in the models after residential selection is accounted for using the PSM sample. Residential areas with higher regional accessibility are associated with a decreased likelihood that paired heads will have the same activity spaces and with an increased likelihood that female heads will have greater MCP activity spaces than their husbands.

Table 3-36 Gendered difference in the sizes of activity spaces

Size of activity space	SDE area						MCP area					
	MHH Greater		MHH=FHH		FHH Greater		MHH Greater		MHH=FHH		FHH Greater	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-15.410		7.080	**	-5.559	*	-12.820		5.881	*	-6.783	**
Household characteristics												
Presence of children	0.089		-0.015		-0.063		0.530	**	-0.597		-0.274	
HH income: \$0-\$49,999	-0.283		0.378		0.031		-0.186		0.269		0.023	
HH income: \$50,000-\$99,999	-0.348		-0.016		0.414		-0.246		-0.302		0.398	
Number of vehicles	0.396	**	-0.553	**	-0.109		0.218		-0.313		-0.059	
Male head's characteristics												
Age	-0.032		-0.105		0.109		-0.152		-0.149		0.243	
Square age	0.000		0.001		-0.001		0.001		0.001		-0.002	
Hispanic	0.247		-0.392		-0.041		-0.138		0.146		0.074	
Valid driver license	15.200		-1.393		-0.685		15.310		-1.885	*	-0.279	
Employed	0.503		-0.489		-0.150		-0.053		0.076		0.019	
Female head's characteristics												
Age	0.022		-0.117		0.034		0.039		-0.011		-0.028	
Square age	0.000		0.001		-0.001		0.000		0.000		0.000	
Hispanic	-0.258		0.262		0.114		-0.009		-0.345		0.186	
Valid driver license	0.648		-1.105	**	0.807		0.218		-0.795		0.504	
Employed	-1.338	***	0.010		1.745	***	-1.043	***	-0.130		1.284	***
Regional accessibility												
Low-medium	0.275		-1.292	**	0.405		-0.156		-0.919	*	0.650	*
Medium-high	0.181		-0.958	*	0.387		-0.108		-1.070	**	0.676	*
High	-0.125		-0.469		0.418		-0.223		-1.037	*	0.769	*
Walkable neighborhood												
Walk Score	0.002		0.003		-0.004		0.002		0.008		-0.006	
Sample size	415		415		415		415		415		415	
Log likelihood	-262.06		-162.35		-238.93		-270.29		-154.30		-256.23	
McFadden pseudo R²	0.09		0.12		0.10		0.06		0.08		0.08	
P-value of Chi-Square	4.97E-05		1.03E-03		2.89E-05		0.02		0.08		6.54E-04	

Significance: * p < .1, ** p < .05, *** p < .01.

Degree of Residential Deconcentrating

The results of the gendered differences in the degree of residential deconcentrating are shown in Table 3-37. Household income between \$50,000 to \$99,999 increases the likelihood that a female head will have greater distance between home and SDE activity space centroid than her counterpart. Higher number of household vehicles is positively associated with the probability that the MHH will have greater residential deconcentrating in both models but is negatively associated with the probability of gender equality in the D_{MCP} model. This suggests male heads are more likely to locate their activity space further from home than his wife.

Household heads' employment status has a remarkably significant influence on gendered differences in the distances between residential locations and activity centroids. In a *ceteris paribus* condition, the influence of having an employed male head is positive and negative in the MHH Greater and FHH Greater models for D_{SDE} , respectively. This suggests that these employed male heads are more likely to move their SDE activity centers farther from home than their wives. The influence of having an employed female head is negative and positive in the MHH Greater and FHH Greater models, respectively, which suggests that being employed can encourage female heads to move her activity center farther away from home than her husband. In addition, paired heads are less likely to have the same distances between home and MCP centroid when female head possesses valid driver license.

Compared to the estimated coefficients based on the full data (Appendix I, Table I-7), regional accessibility and Walk Score remain statistically significant influences in the MHH=FHH and FHH Greater models for D_{MCP} . Living in areas with low-medium and medium-high regional accessibility is associated with a lower likelihood that household pairs will have the same distances between home and MCP centroid compared to those living in low regional

accessibility areas. Female heads are more likely to locate their MCP activity center further from residences than their husbands with increasing regional accessibility; however, it is less likely that a female head will move her MCP centroid distant from home relative to her husband when Walk Score increases.

Table 3-37 Gendered difference in the degrees of residential deconcentrating

Degree of residential deconcentrating	D _{SDE}						D _{MCP}					
	MHH Greater		MHH=FHH		FHH Greater		MHH Greater		MHH=FHH		FHH Greater	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-18.210		1.803		0.978		-19.110		3.956		-14.760	
Household characteristics												
Presence of children	0.254		0.011		-0.276		0.417		-0.204		-0.286	
HH income: \$0-\$49,999	-0.633		0.300		0.427		-0.463		0.020		0.612	
HH income: \$50,000-\$99,999	-0.326		-0.222		0.731	**	-0.379		0.154		0.336	
Number of vehicles	0.358	**	-0.255		-0.229		0.327	**	-0.565	***	0.066	
Male head's characteristics												
Age	-0.068		0.057		0.033		-0.059		0.068		-0.010	
Square age	0.000		-0.001		0.001		0.000		-0.001		0.001	
Hispanic	-0.028		-0.001		0.014		0.031		-0.092		0.011	
Valid driver license	14.900		-0.945		-0.964		15.400		-1.251		-1.165	
Employed	1.331	***	-0.363		-1.069	***	0.165		-0.013		-0.183	
Female head's characteristics												
Age	0.188		-0.099		-0.149		0.170		-0.129		-0.060	
Square age	-0.001		0.001		0.001		-0.001		0.001		0.000	
Hispanic	-0.030		-0.140		0.144		0.300		-0.119		-0.295	
Valid driver license	-0.254		-0.022		0.507		0.400		-1.314	**	16.150	
Employed	-1.110	***	-0.104		2.156	***	-0.582	**	-0.041		0.874	***
Regional accessibility												
Low-medium	-0.151		-0.255		0.478		-0.095		-0.853	**	0.951	**
Medium-high	0.102		-0.273		0.140		-0.201		-0.952	**	1.194	***
High	-0.165		-0.253		0.501		-0.231		-0.696		1.036	**
Walkable neighborhood												
Walk Score	0.001		0.002		-0.004		0.006		0.005		-0.013	**
Sample size	415		415		415		415		415		415	
Log likelihood	-256.81		-225.49		-197.33		-270.29		-213.17		-223.96	
McFadden pseudo R²	0.11		0.03		0.15		0.06		0.07		0.09	
P-value of Chi-Square	1.09E-06		0.72		3.82E-08		0.01		0.02		3.24E-04	

Significance: * p < .1, ** p < .05, *** p < .01.

Compactness Degree

The analyses in this subsection focus on the gendered differences in E_{SDE} (elongation) and in SC_{MCP} (spatial concentration) (Table 3-38). Recall that smaller elongation represents a more compact and circular shape of activity space. Household income below \$49,999 is positively associated with E_{SDE} in the FHH Greater model, suggesting that female heads in low income households are less likely to have compact activity spaces compared to their husbands.

The presence of children and male head's possession of driver license are negatively associated with the likelihood of gender equality in compactness degree for both MHH=FHH models. The presence of children and more household vehicles are positively associated with the likelihood that a female heads' activity space is more spatially concentrated than their husbands.

Employment status again demonstrates significant influences on the within-household gendered differences. Having an employed male head is positively and negatively associated with E_{SDE} in the MHH Greater and FHH Greater models, respectively. Having an employed female head is positively and negatively associated with SC_{MCP} in the MHH Greater and FHH Greater models. These results overall indicate that heads' activity spaces are less compact than their counterpart when they are employed.

The built environmental variables are significantly related to gendered differences after selection bias is taken into account using the PSM sample (see Appendix I, Table I-8 for the estimations on the full data). Living in areas with higher regional accessibility is associated with a higher likelihood that lead male heads will have higher compactness degrees of activity spaces (for the SC_{MCP} MHH Greater model). Walk Score has a negative and positive influence on MHH Greater and FHH Greater, respectively (for E_{SDE}). Higher Walk Score in general suggests the shape of female head's activity space to be less compact than her counterpart's activity space.

Table 3-38 Gendered difference in the compactness degrees

Compactness degree	ESDE						SC _{MCP}					
	MHH Greater		MHH=FHH		FHH Greater		MHH Greater		MHH=FHH		FHH Greater	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-5.966	**	1.771		2.776		-1.256		1.528		-16.560	
Household characteristics												
Presence of children	0.012		-0.934	**	0.430		-0.219		-0.836	**	0.613	**
HH income: \$0-\$49,999	-0.576		-0.392		0.794	**	0.258		-0.129		-0.162	
HH income: \$50,000-\$99,999	-0.289		-0.061		0.351		0.371		-0.079		-0.286	
Number of vehicles	0.180		-0.335		-0.016		-0.167		-0.317		0.312	*
Male head's characteristics												
Age	0.143		0.178		-0.239		0.123		0.038		-0.141	
Square age	-0.001		-0.002		0.002		-0.001		-0.001		0.001	
Hispanic	0.393		-0.170		-0.322		0.017		-0.223		0.080	
Valid driver license	-0.259		-1.277		1.447		-0.918		-1.907	*	15.700	
Employed	1.155	***	-0.780	*	-0.655	**	0.050		-0.446		0.251	
Female head's characteristics												
Age	0.087		-0.097		-0.034		-0.206		0.074		0.158	
Square age	-0.001		0.001		0.000		0.002		-0.001		-0.001	
Hispanic	-0.074		-0.212		0.179		-0.175		-0.009		0.140	
Valid driver license	0.377		-0.987		0.160		1.727		-0.925		-0.019	
Employed	-0.080		-0.674	*	0.440		1.525	***	-0.471		-0.898	***
Regional accessibility												
Low-medium	0.015		-0.863	*	0.420		1.013	**	-0.702		-0.414	
Medium-high	0.269		-0.634		0.075		0.795	*	-0.675		-0.255	
High	0.370		-0.609		-0.066		0.947	**	-0.832		-0.311	
Walkable neighborhood												
Walk Score	-0.014	**	0.001		0.015	***	-0.004		-0.004		0.007	
Sample size	415		415		415		415		415		415	
Log likelihood	-269.12		-149.71		-260.92		-235.56		-160.65		-266.34	
McFadden pseudo R²	0.06		0.08		0.06		0.11		0.08		0.07	
P-value of Chi-Square	6.03E-03		0.12		0.02		1.15E-05		0.05		1.13E-03	

Significance: * p < .1, ** p < .05, *** p < .01.

Degree of Bounding Non-home Activities

This subsection analyzes the gendered differences in weighted activity densities (ADE_{SDE}) and activity concentrations (AC_{MCP}). The estimated results are shown in Table 3-39. The presence of children and a greater number of household vehicles is associated with the likelihood that a female head's non-home activities are more spatially and temporally bound than to her counterpart (the ADE_{SDE} FHH Greater model). Having an income between \$50,000 and \$99,999 was associated with greater bounding of non-home activities for male heads.

Employment status again was an statistically significant variable in explaining gendered differences. Having an employed male decreases the likelihood that male heads will have greater spatial and temporal bounding of non-home activities, having an employed female increases this likelihood. Noticeably, the estimated coefficients of employed female head are greater than the estimated coefficients of employed male head.

Compared to the estimations based on the full sample (see Appendix I, Table I-9), the regression results of the PSM sample suggest that built environmental factors become less significant when residential selection is accounted for. Low-medium regional accessibility is associated with a lower likelihood that a paired heads will have the same degrees of bounding of non-home activities. High regional accessibility is positively associated with MHH Greater in the ADE_{SDE} and AC_{MCP} models, suggesting that male heads are likely to have more spatially and temporally bounded non-home activities relative to female heads when they live in areas with high regional accessibility.

Table 3-39 Gendered difference in the degrees of bounding non-home activities

Degree of bounding non-home activities	ADE _{SDE}						AC _{MCP}					
	MHH Greater		MHH=FHH		FHH Greater		MHH Greater		MHH=FHH		FHH Greater	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-0.671		0.638		-1.922		-0.448		2.880		-2.852	
Household characteristics												
Presence of children	0.354		-1.142	***	0.681	**	-0.020		-1.543	***	0.400	
HH income: \$0-\$49,999	0.205		-0.415		0.150		0.563		-0.399		-0.299	
HH income: \$50,000-\$99,999	0.578	*	-0.537	*	-0.030		0.817	**	-0.136		-0.651	**
Number of vehicles	-0.291		-0.085		0.283	*	-0.131		-0.459		0.280	
Male head's characteristics												
Age	0.094		-0.022		-0.053		0.000		0.120		-0.039	
Square age	-0.001		0.001		0.000		0.000		-0.001		0.000	
Hispanic	0.268		-0.029		-0.218		-0.107		0.014		0.099	
Valid driver license	-0.857		-0.597		1.234		-0.644		-1.509		1.687	
Employed	-1.008	***	0.111		0.817	**	-1.250	***	-0.349		1.269	***
Female head's characteristics												
Age	-0.128		0.078		0.015		-0.040		-0.079		0.055	
Square age	0.001		-0.001		0.001		0.000		0.000		0.000	
Hispanic	-0.443		0.238		0.147		-0.041		0.496		-0.162	
Valid driver license	0.303		-0.431		0.127		-0.643		-0.990		0.907	*
Employed	1.489	***	0.366		-1.270	***	2.526	***	-1.139	**	-1.414	***
Regional accessibility												
Low-medium	0.515		-0.284		-0.127		0.601		-1.757	**	0.096	
Medium-high	0.235		-0.467		0.191		0.691		-1.060		-0.191	
High	0.830	*	-0.663		-0.157		0.945	**	-1.244		-0.391	
Walkable neighborhood												
Walk Score	-0.001		-0.003		0.004		-0.005		-0.001		0.006	
Sample size	415		415		415		415		415		415	
Log likelihood	-216.68		-219.26		-259.70		-215.65		-90.57		-244.10	
McFadden pseudo R²	0.10		0.07		0.10		0.16		0.18		0.11	
P-value of Chi-Square	6.05E-05		0.03		1.26E-05		9.02E-10		0.0026		6.02E-07	

Significance: * p < .1, ** p < .05, *** p < .01.

3.5 Supplemental Insights: What Do Activity Space and Travel Behavior Mean to Gendered Equality?

The estimated results above show that being employed and living in higher regional accessibility areas significantly increase the likelihood that female heads will have greater activity spaces and distances between homes and centroids than male heads and decrease the likelihood that paired heads will have the same activity space behaviors. As the relativeness of spatial behaviors can be influenced by the identified factors, some interesting questions are raised (1) how do paired heads share their duties by the relativeness of their activity space behaviors? And (2) what are the factors associated with the tendency that paired heads share their trips together? This supplemental section expects to provide insights for these questions in order to understand what activity space and travel behavior mean to gendered equality.

3.5.1 The Share of Duties by Non-home Activity Purpose

This subsection analyzes the distributions of non-home activity purposes¹ for the 415 households with paired heads based on the PSM data. Households are categorized by the three binary responses in terms of MCP activity space size: MHH Greater, MHH=FHH, and FHH Greater. Table 3-40 summarize of socio-demographic and built-environmental characteristics for the three groups of households. Table 3-41 combines the key factors, the average number of employed heads and the share of living in higher regional accessibility, with the distributions of non-home activity by activity purpose for the 415 paired heads of the three groups.

¹ In 2010-2012 CHTS, each visited place corresponds with up to three activities with unique identifiers. If a survey participant reported up to three activities at a location, the primary activity purpose of the place is defined by the activity that took the longest activity duration.

Among the three groups, the average number of employed male head is between 0.83 and 0.88. The average number of employed female heads is the lowest for the MHH Greater group (0.64) and is the greatest for the FHH Greater Group (0.88). The FHH Greater group has the highest rates of living in medium-high and high regional accessibility areas, followed by the MHH Greater group and the MHH=FHH Greater group.

For the MHH Greater group, the percentage difference¹ is the greatest for work-related activities (-19.68%), followed by shopping (8.61%) and passenger-serving tasks (7.68%). This identifies that male heads in this group are responsible for work activities whereas female heads in this group primarily take care of household-related tasks.

For households in the FHH Greater group, the differences in the shares of work-related (-6.26%), shopping (4.19%), and passenger-serving (3.82%) activities become relatively smaller than the differences for the MHH Greater group. Furthermore, compared to the paired heads in the MHH Greater group, female heads in the FHH Greater group undertake less shopping and passenger-serving activities whereas their male counterparts have slight increases in these two activities. The results may imply that female heads are likely to increase the extents of their daily activities and their husband are more willing to share tasks with them as they are employed and living in higher regional accessibility areas.

For households in the MHH=FHH group, the percentage difference by activity purpose is relative small compared to the differences for the other two groups. When paired heads have the same sizes of activity spaces, they are very likely to do shopping together.

¹ Percentage difference=female head's percentage-male head's percentage

Table 3-40 Summary statistics for MHH Greater, FHH=MHH, and FHH Greater groups

Activity space behavior Group (PSM sample)	Area of MCP		
	MHH Greater	MHH=FHH	FHH Greater
Number of households	194	58	163
Household characteristics			
The presence of kids under 15 years old	0.56	0.41	0.49
HH income: \$0-\$49,999	0.25	0.38	0.17
HH income: \$50,000-\$99,999	0.54	0.45	0.65
HH income: greater than \$99,999	0.21	0.17	0.18
The number of vehicles in household	2.07	1.83	2.07
Male household head's characteristics			
Age	47.17	47.40	47.86
Hispanic	0.27	0.34	0.26
Valid driver license	1.00	0.95	0.99
Employed	0.88	0.83	0.87
Female household head's characteristics			
Age	45.66	45.79	45.71
Hispanic	0.28	0.33	0.25
Valid driver license	0.93	0.86	0.98
Employed	0.64	0.66	0.88
Regional accessibility			
Low	0.20	0.29	0.15
Low-Medium	0.17	0.16	0.18
Medium-High	0.29	0.22	0.31
High	0.34	0.33	0.36
Walkable neighborhood			
Walk Score	59.60	58.45	59.69

Table 3-41 Distributions of non-home activity purposes

Gendered difference in MCP activity space size		MHH Greater (n=194)			MHH=FHH (n=58)			FHH Greater (n=163)		
Being employed	Male	0.88			0.83			0.87		
	Female	0.64			0.66			0.88		
Regional accessibility	Med-high	0.29			0.22			0.31		
	High	0.34			0.33			0.36		
Mean distributions by non-home activity purpose		MHH	FHH	Percentage Difference	MHH	FHH	Percentage Difference	MHH	FHH	Percentage Difference
Work-related ¹		36.27%	16.59%	-19.68%	15.65%	11.15%	-4.50%	30.72%	24.46%	-6.26%
School-related ²		0.77%	0.98%	0.20%	0.00%	0.00%	0.00%	0.92%	0.09%	-0.83%
Shopping ³		10.28%	18.90%	8.61%	24.47%	22.21%	-2.26%	11.57%	15.76%	4.19%
Meals ⁴		9.45%	7.44%	-2.01%	7.25%	10.95%	3.70%	11.87%	9.05%	-2.82%
Household-related ⁵		2.82%	3.19%	0.37%	5.14%	5.34%	0.20%	2.52%	2.46%	-0.05%
Social activities ⁶		6.56%	7.04%	0.48%	6.28%	6.43%	0.14%	7.57%	6.66%	-0.91%
Passenger serving ⁷		13.87%	21.55%	7.68%	13.76%	15.49%	1.72%	15.30%	19.12%	3.82%
Mode transfer ⁸		5.06%	5.09%	0.03%	2.79%	5.20%	2.41%	3.88%	6.07%	2.19%
Other ⁹		14.92%	19.22%	4.30%	24.66%	23.24%	-1.42%	15.65%	16.33%	0.67%
Total Percentage		100.00%	100.00%	0.00%	100.00%	100.00%	0.00%	100.00%	100.00%	0.00%

¹ Work-related: any work-related activities, including job duties, training, meeting, and meals at work

² School-related: any school-related activities, including going to school, meals at school, after-school activities (e.g. non-class related sports and library)

³ Shopping: any school-related activities, including grocery, household maintenance, and shopping for specialty items (e.g. appliance and electronics)

⁴ Meals: any meal-related activities, including preparing and eating meals, drive-through meals, and dining out

⁵ Household-related: any household-related errands, such as stopping by bank and dry cleaning

⁶ Social activities: including work-sponsored social activities, entertainment (e.g. movies), visiting friends and relatives, social clubs...etc.

⁷ Passenger-serving: including dropping off and picking up passengers

⁸ Mode transfer: changing type of transportation (e.g. walking to a bus stop)

⁹ Other: not the activities listed above

3.5.2 The Share of Automobile Trips

As paired heads could have same spatial behaviors, this subsection is inspired to analyze the likelihoods that paired heads share their automobile trips¹ together. Two definitions are used to characterize whether paired heads share automobile trips: (1) paired heads are on the same automobile trip for at least once (binary) and (2) the percentage of sharing same automobile trips² for paired heads. The sharing variables were estimated by binary logit and Tobit regression models for the 415 PSM households, respectively. Table 3-42 describes the results of the estimations on the sharing variables.

The summary statistics of the sharing variables indicate that 36.63% of the 415 households (152 households) have shared automobile trips for at least once. For paired heads who have shared automobile trips, the average percentage of sharing automobile trips is 22.80%. The estimated results consistently show that the presence of children, increasing number of household vehicles, and employed male head are likely to decrease the likelihoods and the percentage that paired heads are on the same automobile trips.

¹ In 2010-2012 CHTS, only automobile-based travel allows to identify the persons who were on the same trip

² Percentage of sharing same automobile trips: $2 \times \text{number of shared auto trips} \div \text{male and female heads' total number of auto trips}$

Table 3-42 Estimated results for the shared automobile trips

Sharing automobile trip	Sharing variable 1: Paired heads on the same automobile trip at least once (1/0)		Sharing variable 2: Percentage of sharing same automobile trips for paired heads	
	Mean=36.63%		Mean=22.80%	
	Binary logit		Tobit	
	Coef.	Sig.	Coef.	Sig.
Intercept	2.109		1.486	
Household characteristics				
Presence of children	-0.842	***	-0.344	***
HH income: \$0-\$49,999	0.026		0.026	
HH income: \$50,000-\$99,999	-0.007		-0.008	
Number of vehicles	-0.451	**	-0.156	**
Male head's characteristics				
Age	-0.004		0.003	
Square age	0.000		0.000	
Hispanic	-0.052		-0.007	
Valid driver license	-0.118		-0.100	
Employed	-0.704	**	-0.299	**
Female head's characteristics				
Age	-0.011		-0.030	
Square age	0.000		0.000	
Hispanic	0.364		0.124	
Valid driver license	-0.332		-0.172	
Employed	-0.046		-0.084	
Regional accessibility				
Low-medium	-0.019		-0.065	
Medium-high	-0.404		-0.182	
High	-0.238		-0.123	
Walkable neighborhood				
Walk Score	0.006		0.002	
Sample size	415		415	
Log likelihood	-254.13		-306.76	
McFadden pseudo R²	0.07		0.01	
P-value of Chi-Square	5.25E-03		6.18E-04	

3.6 Discussion

This chapter investigates the weekday spatial behaviors of married couples in Los Angeles in terms of the size of activity space, the degree of residential deconcentrating, the compactness degree of activity space, and the degree of bounding non-home activities. Descriptive statistics, GLS, and binary logit models were used to understand how socio-demographic factors and built environmental variables are associated with spatial behaviors and gendered differences in spatial patterns. This chapter provides several insights into gendered differences in activity spaces.

First, male and female heads do perform different spatial behaviors. Similar to the studies by Fan and Khattak, (2008), Perchoux et al., (2014), and Tana et al., (2016), this chapter finds that male heads tend to have larger activity spaces than female heads, and that female heads have relatively more geographically constrained behaviors. Compared to male heads, female heads are more likely to situate their activity centers near their residential location, have more circular and concentrated activity spaces, and have non-home activities which are more spatially and temporally bound near their residence.

Second, socio-demographics provide greater explanatory powers than built environmental factors. The presence of young children and employment status are the most influential factors in determining individuals' spatial behaviors and gendered differences in spatial patterns. The presence of children is strongly associated with more constrained activity space behaviors and undertaking activities closer to home for female heads, but these factors are not as consistently influential on the spatial behaviors of male heads. This implies that, consistent with previous research, female heads are more likely to take primary responsibility for child-related tasks, and that women with young children experience spatial constraints because

traditional gender role constraints expect women to be more responsible for childcare tasks (Palm & Pred, 1974; Tivers, 1988).

Employed people are found to be less bound in their activity spaces relative to unemployed people; the result is consistent with previous findings (Fan & Khattak, 2008; Perchoux et al., 2014; Zenk et al., 2011). Furthermore, being employed has greater impacts on the activity spaces of female heads compared to male heads. In terms of gendered differences, when one household head is employed it seems to somewhat relax this person's spatial behavior constraints compared to his or her paired counterpart. This suggests that the relativeness of paired heads' spatial behaviors is strongly affected by the employment statuses after controlling for other socio-demographic and built environmental factors.

In addition, results in the supplemental section consistently show the significant influences of the socio-demographic variables. The presence of children, greater number of household vehicles, and employed male heads suggest that paired heads are unlikely to share the same automobile trips. Combining the results from the estimations on individual spatial behaviors and the gendered differences in spatial patterns, it can be interpreted that male heads may have more dominating power in using household vehicles. In particular, as household vehicle accessibility decreases the likelihood of sharing automobile trips, future policy may need to consider encouraging carpooling through controlling vehicles acquired by households.

Third, the effects of socio-demographics on activity space behaviors could vary when the features of the visited locations are taken into account. This chapter used the time spend at the visited locations as weights to characterize the relative importance of each location for SDE but weights were not used for measuring MCP. For example, although the effects of being employed on D_{SDE} and D_{MCP} are both positive, the magnitudes of being employed in the D_{SDE} models are

more than ten times greater than the magnitudes of being employed in the D_{MCP} models. Future studies on activity space behaviors should carefully interpret the influence of variable of interest before and after the weighting measure is applied.

Fourth, similar to Fan and Khattak's research on people's daily activity spaces (Fan & Khattak, 2008), this chapter shows that built environmental factors overall remain significant influences when residential selection is accounted for. Walk Score is a relatively strong predictor for estimating individual's spatial patterns and regional accessibility is comparatively significant to gendered differences in spatial behaviors. However, two questions may be raised due to different significant levels of Walk Score and regional accessibility in the individual and gendered difference models: (1) Why was Walk Score so consistently significant in the individual models but that it was not for the gendered differences? (2) Why was regional accessibility so consistently significant in the gendered difference models but that it was not for the individual models?

In fact, Walk Score did show significant impacts on male and female heads' activity space behaviors; however, the magnitudes of the estimated coefficients were very close in the male and female separate models so effects of walk score were counteracted in the gendered difference models. As walk score lose its dominating explanatory power, regional accessibility became significant in the gendered difference models.

Walk Score in this dissertation is regarded as an integrated measure of local destination accessibility and street design (Carr et al., 2011). Similar to previous research that investigated the effects of local accessibility and street connectivity on activity space behavior (Fan & Khattak, 2008), results indicate that increasing the near-residence Walk Score is associated with smaller, compact, and bounded activity spaces for both male and female household heads. In

addition, both men and women are more likely to center their activities closer to residential neighborhoods if they live in areas with a higher Walk Score, indicating that people are likely to utilize nearby resources when available.

In addition to answering whether the influence of built environmental factors differs for the spatial behaviors of male and female heads, results suggest that Walk Score has greater effects on reducing female head's activity space size than on decreasing male head's activity space size; however, results are less consistent concerning whether Walk Score influences the degree of residential deconcentrating, compactness degree, and the degree of bounding non-home activities.

Built environmental characteristics were also significantly related to within-household gendered differences. Overall results show that higher regional accessibility encourages female heads to expand their activity space and move their activities beyond residential neighborhoods relative to the paired male heads. In particular, combining the results of the estimations for gendered differences and the results of the activity distributions in the supplemental sections, it can be inferred that being employed and living in higher regional accessibility can increase the likelihoods that female heads have greater spatial extents and paired heads more equally share duties.

In response to feminist geographers who have raised concerns that urban sprawl might differentiate men and women's spatial behaviors and "lock" or restrict women to their immediate neighborhoods (Hayden, 2002; Johnson & Johnson, 2008; Laws, 1997; Little et al., 1988), results suggest that areas with higher regional accessibility could provide women with greater opportunities to expand their activity spaces beyond their neighborhoods and to enjoy greater spatial freedom to pursue opportunities and amenities in urban space relative to men.

Furthermore, results suggest that local and regional transportation and land use plans such as SCAG's 2016-2040 RTP/SCS which seeks to ensure that employment opportunities are increasingly accessible in high quality transit corridors could help increase women's access to opportunities and allow them to become less restricted spatially relative to men.

3.7 Future Research

This chapter draws several suggestions for future research on spatial behaviors. First, residential selection bias should be considered in the analysis of spatial behavior in order to avoid overestimating the effects of built environments. Second, although this chapter demonstrates that built environments are significant in explaining individual spatial behaviors and the within-household gendered differences in spatial patterns, further research is encouraged to explore the effects of built environmental factors on spatial behaviors since the understanding in this field remains limited (Fan & Khattak, 2008; Harding et al., 2014; Tana et al., 2016). Third, future research should investigate the influence of built environment measures at different spatial scales on spatial behaviors instead of limiting built environmental factors to features within the 0.25-mile and 0.5-mile of residential locations. For example, one recent study suggests that households living within 1-km of new transit stations had very different transit use behaviors compared to households living beyond 1-km of new transit stations (Spears, Boarnet, & Houston, 2016).

Fourth, rather than focusing on the built environmental factors near a single reference location, future research should investigate the influences of built environmental factors of other anchored locations, such as work place, on people's spatial behaviors. For example, Maat and

Timmermans showed that the built environmental features in the vicinity of people's work locations could play a key role in the activity and travel patterns of the employed. (Maat & Timmermans, 2006). After all, people are not always restricted within their residential neighborhoods and are likely exposed to different types of opportunities near non-residential activity locations (Jones & Pebley, 2014; Shareck et al., 2014; Zenk et al., 2011).

Fifth, analyses in this chapter are based on people's one-day travel logs, which may poorly represent people's spatial behaviors (Chaix et al., 2012). Future research should consider using longitudinal surveys that could better provide a comprehensive understanding for people's daily activity spaces.

Lastly, network-based approaches to measuring activity space boundaries could be used as an alternative method to analyze people's spatial patterns if GPS trajectory data are available and could provide a more direct measure of the areas where people physically travel based on their travel paths (Patterson & Farber, 2015). Unlike the SDE and MCP approaches that have been criticized due to overgeneralizing and not reflecting people's actual spatial arrangements, the network-based method might substantially represent the areas that people reach and are familiar with (Chaix et al., 2012; Schönfelder & Axhausen, 2003; Sherman et al., 2005).

CHAPTER 4: Conclusions

4.1 Overview

This dissertation addressed two primary areas of research in order to help identify potential urban design and sustainability policies which could help improve gender equality in access to urban environments and associated opportunities. First, it examined whether men and women responded to built environments differently in terms of their daily mobility patterns; second, it aimed to understand whether elements of compact design (more walkable and accessible areas) could help improve gendered equality in mobility.

These research questions were investigated for a sample of paired heterosexual couples in southern California in two stages based on the 2010-2012 California Household Travel Survey (CHTS) data (National Renewable Energy Laboratory, 2013). The analyses used the propensity score matching data in order to account for residential selection bias.

Chapter 2 examined the within-household gendered travel patterns in daily trip frequencies and travel distances by all modes, walking, driving, and automobile mode. Chapter 3 moved beyond the one-dimensional measure of travel behavior and further examined the within-household gendered spatial behaviors in terms of the size of activity spaces, the degree of residential deconcentrating, the compactness degree, and the degree of bounding non-home activities.

This chapter first reviews the methodologies and the key findings with respect to each of research questions. Then it provides a discussion of the overall contributions and policy

implications of the research as well implications for future research which would extend the results and the conclusions of this dissertation.

4.2 Do Built Environments Account for Different Travel and Activity Space Behaviors for Men and Women?

This dissertation examined whether the influences of built environmental factors differs for men and women in terms of their daily travel and spatial patterns. In Chapter 2, male and female heads were found to respond to destination accessibility at local and regional levels with different travel behaviors. Based on the negative binomial and Tobit regressions in Chapter 2, regional accessibility and Walk Score appeared to be the most important built environmental factors associated with gendered travel patterns. Regional accessibility at low-medium and high regional levels had relatively greater negative influence on a female head's travel distance and VMT per capita compared to its influence for a male head; medium-high regional accessibility showed greater negative influences on male heads than on female heads.

Increases in near-residence Walk Scores was associated with a reduction in male head's daily driving distance, implying that providing a walkable and accessible neighborhood could possibly decrease male dependences on driving. In addition, higher Walk Score was more likely to encourage male heads' walking trips than the walking trips of female heads. The gendered differences in walking patterns could be due to the fact that men and women tended to perceive the safety of the surrounding environments differently (Clifton & Dill, 2005; Clifton & Livi, 2005).

Chapter 3 implemented generalized least squares models to separately estimate effects of regional accessibility and Walk Score on male and female heads' activity space behaviors. Both

male and female heads were associated with a decrease in their activity space size, a decrease in the number of activities close to home, and both have spatially concentrated activities which increase with an increasing Walk Score.

The results suggested that male and female heads were likely to respond to built environments with different sizes of activity spaces: Walk Score was found to have greater influences on the size of female heads' activity spaces than for the size of male head's activity spaces. This might imply that women compared to men are more likely to utilize nearby resources to complete daily tasks. Nevertheless, it remains unclear whether the effects of built environments differed for male and female heads' with regards to the degree of residential deconcentrating, compactness degree, and degree of bounding non-home activities.

After controlling for other factors, the presence of household children under 15 years old, being employed, and the number of household vehicles differed across gendered spatial behaviors. In Chapter 2, the estimated coefficients of the number of household children on female head's trip frequencies by all modes, driving, and automobile mode were nearly two times greater than the estimated impact of the number of household children on male head's trip frequencies.

In Chapter 3, the presence of household children showed greater influence on female heads' spatial behaviors compared to its influence on male heads' spatial behaviors. Overall, results suggested that the presence of children was more likely to lead to smaller and more compact activity spaces, more residential centering, and greater bounding of activity spaces for female heads than for male heads.

The results from Chapters 2 and 3 together suggest that female household heads still undertake a disproportionate level of child-related tasks and activities, such as chauffeuring trips.

Female heads were more likely to restrain their activities in the vicinity of their residential neighborhood because “coupling constraints” forced them to be more geographically due to the needs of their children (Hägerstrand, 1970; Tivers, 1988).

Compared to male heads, being employed is more likely to lead female heads to expand the extent of their activity spaces, move their activity centers farther from residences, and undertake activities that are free from spatial and temporal constraints. These findings suggest that being employed can help encourage women to expand their accesses to different opportunities. In addition, a number of household vehicles was only a significant influence on increasing the spatial activity extent for male heads and less likely to share automobile trips with female heads, which implies that male heads are more likely to dominate vehicular use compared to female heads.

4.3 The Associations Between Gender Equality, Built Environments and Other Factors

This dissertation hypothesized that elements of compact design can help promote gendered equality in terms of daily mobility patterns. Chapter 2 used negative binomial and Tobit models to examine the within-household gendered inequality in daily trip frequencies and daily travel distances, respectively. In this analyses gendered inequality was defined as the absolute value of the difference in paired heads’ travel behaviors in order to provide a more relative and standardized measure of absolute inequality between household heads compared to measures available in the literature.

Chapter 2 results indicated that regional accessibility and Walk Score were significantly related to gendered inequality in paired heads’ travel patterns after controlling for socio-

demographic factors. Gendered inequality in trip frequency by all modes was increased with increased regional accessibility but the inequality in driving trip frequencies was decreased with increasing Walk Score. Higher Walk Score and regional accessibility were associated with reduced gendered inequality in daily travel distance and in particular motorized travel distance, suggesting that men and women were likely to enjoy relatively equal mobility access as destination accessibility in local and regional scales increased.

Chapter 3 analyzed the gendered differences in spatial behaviors based on three binary logit models in order to investigate the conditions that (1) male heads had greater activity space behavior than their paired female heads (MHH Greater model), (2) the paired male and female heads had the same activity space behaviors (MHH=FHH model), and (3) female heads had greater activity space behavior than their paired male heads (FHH Greater model).

The results indicate that female heads in areas of higher regional accessibility were associated with spatial extents farther from home and less bounded activities relative to their paired male heads. Feminist planners have expressed concerns that land use segregation and societal expectations on women to take care of household tasks would together lead women to likely experience constraints in terms of their spatial activity patterns whereas men were likely to enjoy the freedom of being unbounded (Hayden, 2002; Laws, 1997; Little et al., 1988; Tivers, 1988). Chapter 3 results addressed feminist planners' concerns and indicate that living in accessible areas can be key to freeing women from the spatial and temporal constraints relative to their husbands.

Employment status appear to be the most important factor for explaining gendered inequalities in travel patterns and gendered differences in activity space behaviors among the socio-demographic variables. Chapter 2 identified that having an employed male head was

associated with increasing inequality among paired household heads in travel distance. On the other hand, having an employed female head was associated with reduced inequality in driving distance. Chapter 3 results suggest that having an employed head was not associated with this employed head having relatively unconstrained activity space behaviors compared to his or her counterpart.

Furthermore, the supplemental insights in Chapter 3 indicated that living in higher regional accessibility areas and being employed (female head) are not only the factors to encourage female heads to increase their spatial extents relative to their husbands but are associated with moving toward the gendered equality in sharing duties.

4.4 Contributions and Policy Implications

This dissertation investigated whether elements of compact developments, specifically accessible and walkable built environments, help improve gender equality between married heterosexual household heads in terms of travel patterns and activity spaces, assuming that these indicators are related to access to urban environments and associated opportunities. This research contributes to the travel and activity space literatures and planning practice in several ways.

First, providing an accessible and walkable environment could help reduce motorized travel, encourage active travel modes, increase accesses to opportunities, and provide people efficient living environments. In this dissertation, built environmental factors remained important influences on individual mobility patterns even after accounting for residential selection bias. Results suggest that future land use and transportation policies should continue to encourage compact development approaches which could reduce dependency on automobile

modes. However, given that socio-economic factors remain very important, results indicating the important influence of the built environment should be carefully interpreted in order to avoid potential overestimations of its influence.

Second, as the tendency of sharing automobile trip could be decreased by the number of household vehicles, future transportation demand management policy may consider encouraging carpooling through controlling vehicles acquired by households in order to meet the planning goals of reducing drive-alone trips, air pollution, and greenhouse gas emissions (SCAG, 2016).

Third, this dissertation seeks to answer the question raised by Crane (2007): “Do women respond to neighborhood and urban design features differently than men?” (Crane, 2007). This dissertation also addresses the related concerns by Hanson (2010): (1) do policy options produce individual effectiveness for a particular subpopulation or collective influences on whole population, and (2) how do gender and mobility interact along with social and geographical contexts?

The overall results indicate that men and women respond to neighborhood and urban design features with different travel and spatial behaviors. For example, male heads were more likely to increase their walking frequency than female heads as the near-residence walkability was improved. Compared to male heads, female heads might be more willing to utilize the nearby services rather than seeking opportunities outside of the immediate neighborhoods when local opportunities were adequate.

Planners and policy makers who consider implementing sustainable community design strategies to curb automobile uses, encourage active transportation, and promote equality in access to opportunities should keep in mind that the effects of built environments are not always homogeneous. They could be heterogeneous even for men and women with similar backgrounds

due to different societal expectations and/or dissimilar perceptions of public safety of the surrounding environments. To ensure the effectiveness of land use and transportation design policies, proposed policies should be carefully evaluated to assess the potential impact on different subgroups, such as men and women, before the implementation of the new plan.

Fourth, this dissertation contributes to policy debates by informing feminist geographers that promoting compact design with greater regional accessibility and walkability could be results in greater equity in access to opportunities and sharing duties for men and women and could potentially help counteract built environmental forces which oppress women (Hanson, 2010; Hayden, 1980, 2002; Laws, 1997; Little et al., 1988; Tivers, 1988).

The findings of this dissertation suggest that elements of compact design, specifically walkability and regional accessibility, could help improve gendered equality in daily travel patterns. Increasing regional accessibility also encourages women to expand their activity space and therefore could increase their access to various opportunities. Living in areas with greater accessibility at regional level also implies that men and women could share their duties toward a more even way.

Lastly, given findings that the presence of children and employment significantly influenced female heads' mobility patterns, should women stay at home for child-related tasks or move beyond their residential neighborhoods for job opportunities? As previous studies indicate, employed women usually strike a balance between these two choices by working near their residence (Johnston-Anumonwo, 1992; Little et al., 1988). In addition to increasing employment opportunities on a regional scope, future policies should consider promoting affordable childcare in employment centers in order to enable women to obtain equal access to opportunities.

4.5 Future Research

Future research is needed to provide insights on the interaction of gendered mobility and built environments. First, future research should investigate how built environmental measures at different spatial scales are associated with gendered mobility patterns. For example, rather than using the traditional 0.25-mile buffer to characterize near-residency built environmental characteristics, Spears, Boarnet, and Houston (2016) found that using the 1-km buffer can better explain the distinct transit-use behaviors for residents near a new light rail transit service (Spears et al., 2016). Understanding how men and women respond differently to urban form at different spatial scales may help provide valuable insights for gendered mobility patterns and related policies.

Second, since not all people have the flexibility or ability to choose their residential neighborhoods to accommodate their desired travel and activity patterns and nearby opportunity structures (Jones & Pebley, 2014; Shareck et al., 2014; Zenk et al., 2011), future research should analyze the influences of built environmental factors near any non-home primary destination (such as work or school locations) which could influence gendered mobility patterns. The land use characteristic near the workplace, for instance, has been identified as a key factor in an employed people's activity and travel patterns (Maat & Timmermans, 2006).

Lastly, future research should expand this analysis by using data that includes travel mode, destination, and purpose information for multiple days. Hanson & Huff (1986) have argued that people's behaviors are "neither completely random nor completely habitual but is in fact cyclical." A one-day data collection window such as the one used for the CHTS data used in this dissertation may not be able to adequately represent people's travel and spatial behaviors (Chaix et al., 2012). Future analysis based on a multiple-day travel log or diary may help provide

a more inclusive understanding of gendered mobility patterns, and could provide insights for developing a more effective land use policies for encouraging development patterns which could promote greater gender equality in travel and activity spaces.

Appendix A: Propensity Score Matching (PSM) and Estimation Methods for Chapter 2

The background section of Chapter 2 has identified that travel behaviors are related to built environment characteristics. However, it is not clear whether people's travel preferences affect their residential choices or individuals adapt their travel behaviors to the surrounding urban designs (Cao et al., 2009). The unobserved attitudes toward preferable travel modes are possible to be correlated with built environments and lead to endogeneity; this is the so-called residential self-selection biases (Cao et al., 2009). In order to remedy the selection bias, Chapter 2 employed propensity score matching (PSM) that mimics a quasi-experimental environment for non-randomized observations; the technique helps compare the outcomes of treated and control units equally (d'Agostino, 1998; Rosenbaum & Rubin, 1983). The following paragraphs introduce the mechanism of PSM and the results of the PSM estimations for matching treated and control units for regression samples in the Chapter 2.

Mechanism of Propensity Score Matching (PSM)

Propensity score represents the conditional probability of a unit that is assigned to the treated group given a set of observed variables (Cao et al., 2009; Rosenbaum & Rubin, 1983). I considered three types of treatments and predicted the probabilities that households received the treatments for their residential choices, respectively.

Treatment 1: The household's residence was located within 0.25 miles of any transit stop

Treatment 2: Single-family residential use was more 50% in household's block group

Treatment 3: Household lived in a walkable neighborhood

The first two treatments were referred to the previous study that employed PSM (Boarnet & Hsu, 2015). The third treatment designated that household with walk score greater than 70 received the treatment. Below describes the propensity score model (Rosenbaum & Rubin, 1983).

$$Prob(y_i = 1|x_i) = F(x_i\beta)$$

where it is assumed that $Prob(y_1, \dots, y_n|x_1, \dots, x_n) = \prod_{i=1}^N F(x_i\beta)^{y_i}(1 - F(x_i\beta))^{(1-y_i)}$

$y_i=1$ when household i received the treatment, 0, otherwise

$F(\cdot)$ denotes the cumulative distribution function

x_i and β represent the observed covariates for household i and the coefficients, respectively

Household's propensity score was calculated based on the socio-demographic covariates, including the number of household heads' children under 15 years old, household's income level, the number of household's vehicles, head's age and square age, ethnicity groups, the possession of driver license, and the status of being employed. The PSM estimations were conducted through applying the MatchIt package in R (Ho et al., 2011, 2013; Randolph et al., 2014) where the binomial models were estimated based on probit link function. The matching technique employed "the nearest neighbor" that paired a treated household with a control household with the closet propensity score to the treatment household. I used 0.01 as the caliper for pairing the treated and control units as suggested by previous research (Cao & Fan, 2012).

PSM Estimations for the 3,588 Households with Paired-Heads Living in Los Angeles

The subsection briefly describes the means and the mean differences of the propensity scores and observed covariates before and after matching for the 3,588 households in Analysis I. Tables A-1, A-2, and A-3 provide the matching results based on the treatment designations of households that chose to reside in the location within 0.25 miles of any transit stop (Treatment 1), live in the block group with more than 50% of single-family residential use (Treatment 2), and dwell in a walkable neighborhood (Treatment 3), respectively. The matching technique paired the 2,283 households receiving Treatment 1 with 790 control units, the 1,437 households receiving Treatment 2 with 946 control units, and the 983 households receiving Treatment 3 with 745 control units.

The overall summaries show that the mean differences in propensity scores and covariates between treated and control groups are improved after PSM was implemented. Compared to the complete dataset, the differences of the covariates in the matched data of Treatment 1 are on averaged improved by 42-98%, except for the male head's employed status. The mean differences of the matched data in Treatment 2 are all reduced in the matched sample by 39-99%. The differences of most of the covariates between the treated and control units in Treatment 3 are improved by 50-98%, the mean differences in African-American ethnicity increase.

PSM Estimations for the Households with No Artificial Zero-Gaps

Following the matching process for the households in Analysis I, I implemented the matching technique again for the households with no artificial zero gaps in all modes of transportation,

walking, driving, and automobile travel. The matched households were the samples for analyzing the gendered inequalities in travel patterns. Tables A-4 to A-6 present the matching summaries for the 3,174 households with no artificial zeros in all modes of transportation by Treatments 1 to 3: 2,020 Treatment 1 households were paired with 714 control households, 1,280 Treatment 2 households were paired with 831 control households, and 860 Treatment 3 households were paired with 677 control households. The differences of the matched data are improved by 40-100% compared to the data before matching. However, it should be noted that female head's employed status in the matched data of Treatment 2 and head's African-American ethnicity in the matched data of Treatment 3 have greater differences than the data before matching.

Among the 711 households with no artificial zero gaps in walking, 252, 176, and 244 households that were designated to Treatments 1, 2, and 3 were paired with 92, 130, and 144 control households, respectively (Tables A-7 to A-9). The mean differences of Treatment 1's matched data are 16-100% less than the mean differences before matching. For matched data based on Treatment 2, the mean differences of the variables before and after matching are improved by 26-100%, except for head's African-American ethnicity and male head's employed status. Regarding the matched data in Treatment 3, the mean differences of the observed covariates between treated and control groups are improved by 40-99% excluding male head's employed status.

Tables A-10 to A-12 summarize the PSM results for the 2,966 households with no artificial zeros in driving. PSM matched 1,867 Treatment 1 units with 682 control units, 1,239 Treatment 2 units with 781 control units, and 780 Treatment 3 units with 599 control units. For Treatments 1 and 2, the summary statistics show that the similarities of the covariates of treated and control groups are increased by 30-100% after PSM was employed. The mean differences of

the matched data in Treatment 3 are also improved by 47-99% except head's African-American ethnicity and female head's employed status.

Lastly, the matching results for the 3,019 households with no artificial zeros in automobile travel are documented in Tables A-13 to A-15. Among the 3,019 households, 1,890, 1,250, and 799 households that received Treatments 1, 2, and 3 were paired with 668, 812, and 614 control households, respectively. The overall mean differences of the covariates between the treated and control units are improved by 8-99%; however, female head's employed status in Treatment 2 and heads' African-American ethnicity in Treatment 3 become less similar among treated and control units in the matched data than in all data.

Recommendation

In order to remedy the residential selection bias, the chapter employs PSM to generate the matched data for regression analyses. Three treatments are considered for predicting household's residential choices, respectively. Treatment 1 defines that household's residence was located within 0.25 miles of any transit stop. Treatment 2 is designated to the households that lived in the block groups with more than 50% of single-family residential use. Treatment 3 is assigned to households that lived in a walkable neighborhood. Since the summary statistics after matching in general show that the mean differences of the covariates between treated and control groups were improved to various extents, the regression analyses in the chapter are suggested to focus on the matched data based on Treatment 3 for the following reason.

Near-residence transit stop and the percentage of single-family use may only be able to reflect the neighborhood characteristics of household's residence in one dimension. The dummy

that indicates household living within 0.25 miles of any transit stop does not provide enough information regarding the convenience, accessibility, and quality of the nearby transit service. The dichotomous variable that identifies the percentage of nearby single-family use only tells the primary land use in the surrounding area rather than showing the composite attribute of the nearby built environments. Thus, it is difficult to say that household chose its residential location based on the shallow information.

On the other hand, walkable neighborhood is a composite index that represents the near-residence walkability. Walk score is measured based on street network and accessibility to amenities within 30 minutes of walking distance (“Walk Score Methodology,” 2016). The measure describes not only street connectivity but also local destination accessibility. I believe that walkable neighborhood provides more composite and complete information related to household’s residential choice than the other two binaries. Therefore, it is recommended to use the matched data based on Treatment 3 for the regression analyses.

Table A-1 PSM result for household's residence within 0.25 miles of any transit stop

Treatment 1: <i>Household's residence was located within 0.25 miles of any transit stop</i>	Summary of balance for all data			Summary of balance for matched data			Percent balance improvement
	Means Treated	Means Control	Mean Difference	Means Treated	Means Control	Mean Difference	Mean Difference
Propensity score	0.75	0.69	0.07	0.73	0.73	0.00	99.97
HH characteristics							
The number of children	0.70	0.50	0.19	0.63	0.63	0.01	97.25
HH income: \$0-\$49,999 (1/0)	0.32	0.15	0.17	0.24	0.24	0.01	95.86
HH income: \$50,000-\$99,999 (1/0)	0.52	0.57	-0.05	0.57	0.58	0.00	96.38
Number of vehicles	2.03	2.33	-0.30	2.12	2.15	-0.03	88.71
Male head's characteristics							
Age	53.32	56.54	-3.22	54.27	54.19	0.07	97.74
Square age	3015.28	3345.33	-330.05	3107.95	3106.30	1.65	99.50
Hispanic (1/0)	0.32	0.15	0.17	0.25	0.25	0.00	97.95
African-American (1/0)	0.06	0.02	0.03	0.04	0.05	0.00	93.10
Valid driver license (1/0)	0.95	0.98	-0.04	0.97	0.97	0.01	86.25
Employed (1/0)	0.73	0.73	0.00	0.74	0.72	0.02	-320.06
Female head's characteristics							
Age	50.70	53.77	-3.07	51.57	51.79	-0.22	92.86
Square age	2727.80	3025.78	-297.99	2807.81	2838.91	-31.10	89.56
Hispanic (1/0)	0.33	0.17	0.15	0.27	0.27	0.00	97.73
African-American (1/0)	0.05	0.02	0.02	0.04	0.04	-0.01	75.15
Valid driver license (1/0)	0.86	0.97	-0.10	0.93	0.92	0.01	88.63
Employed (1/0)	0.56	0.61	-0.05	0.59	0.56	0.03	41.86
Sample size		Control			Treated		Total
All		955			2,633		3,588
Matched		790			2,283		3,073
Unmatched		165			350		515
Discarded		0			0		0

Table A-2 PSM result for household residing in the block group with more than 50% of single-family residential use

Treatment 2: <i>Household's residence was located in the block group with more than 50% of single-family residential use</i>	Summary of balance for all data			Summary of balance for matched data			Percent balance improvement
	Means Treated	Means Control	Mean Difference	Means Treated	Means Control	Mean Difference	Mean Difference
Propensity score	0.46	0.37	0.09	0.46	0.46	0.00	99.99
HH characteristics							
The number of children	0.57	0.70	-0.13	0.57	0.58	-0.01	94.54
HH income: \$0-\$49,999 (1/0)	0.16	0.35	-0.19	0.16	0.16	0.01	97.03
HH income: \$50,000-\$99,999 (1/0)	0.58	0.50	0.09	0.58	0.60	-0.01	86.25
Number of vehicles	2.31	1.98	0.33	2.28	2.27	0.01	95.78
Male head's characteristics							
Age	56.55	52.56	3.99	56.44	56.40	0.04	99.04
Square age	3343.30	2939.49	403.81	3329.54	3321.77	7.77	98.08
Hispanic (1/0)	0.18	0.33	-0.16	0.18	0.17	0.01	95.97
African-American (1/0)	0.04	0.05	-0.01	0.04	0.04	0.00	76.66
Valid driver license (1/0)	0.98	0.94	0.05	0.98	0.98	0.00	98.48
Employed (1/0)	0.71	0.74	-0.03	0.72	0.73	-0.01	57.63
Female head's characteristics							
Age	53.98	49.84	4.14	53.84	53.82	0.02	99.63
Square age	3048.62	2642.56	406.06	3030.40	3026.98	3.43	99.16
Hispanic (1/0)	0.20	0.34	-0.14	0.20	0.19	0.01	91.69
African-American (1/0)	0.03	0.04	-0.01	0.03	0.03	0.00	86.55
Valid driver license (1/0)	0.96	0.85	0.11	0.96	0.96	0.00	96.19
Employed (1/0)	0.58	0.57	0.01	0.59	0.60	-0.01	38.88
Sample size		Control			Treated		Total
All		2,134			1,454		3,588
Matched		946			1,437		2,383
Unmatched		1,188			17		1,205
Discarded		0			0		0

Table A-3 PSM result for household residing in a walkable neighborhood

Treatment 3: <i>Household's residence was located in a walkable neighborhood</i>	Summary of balance for all data			Summary of balance for matched data			Percent balance improvement
	Means Treated	Means Control	Mean Difference	Means Treated	Means Control	Mean Difference	Mean Difference
Propensity score	0.36	0.27	0.09	0.34	0.34	0.00	99.98
HH characteristics							
The number of children	0.76	0.60	0.16	0.73	0.75	-0.01	91.23
HH income: \$0-\$49,999 (1/0)	0.39	0.22	0.17	0.36	0.37	-0.01	92.98
HH income: \$50,000-\$99,999 (1/0)	0.45	0.57	-0.12	0.48	0.47	0.01	95.80
Number of vehicles	1.81	2.24	-0.43	1.89	1.95	-0.06	85.07
Male head's characteristics							
Age	51.08	55.47	-4.39	51.65	51.48	0.18	95.95
Square age	2785.76	3235.67	-449.91	2839.60	2825.79	13.81	96.93
Hispanic (1/0)	0.36	0.23	0.13	0.33	0.30	0.03	76.63
African-American (1/0)	0.05	0.05	0.01	0.05	0.07	-0.02	-192.97
Valid driver license (1/0)	0.92	0.97	-0.06	0.95	0.94	0.01	78.20
Employed (1/0)	0.77	0.72	0.05	0.77	0.75	0.01	70.59
Female head's characteristics							
Age	48.50	52.78	-4.28	49.06	48.52	0.54	87.46
Square age	2508.77	2931.70	-422.93	2560.31	2508.25	52.06	87.69
Hispanic (1/0)	0.37	0.25	0.13	0.35	0.35	0.00	98.38
African-American (1/0)	0.04	0.04	0.00	0.04	0.05	-0.01	-292.31
Valid driver license (1/0)	0.80	0.93	-0.13	0.85	0.83	0.01	88.81
Employed (1/0)	0.56	0.58	-0.02	0.58	0.57	0.01	49.95
Sample size		Control			Treated		Total
All		2,531			1,057		3,588
Matched		745			983		1,728
Unmatched		1,786			74		1,860
Discarded		0			0		0

Table A-4 PSM result for household's residence within 0.25 miles of any transit stop: Households with no artificial zero gaps in all modes of transportation

Treatment 1:	Summary of balance for all data			Summary of balance for matched data			Percent balance improvement
<i>Household's residence was located within 0.25 miles of any transit stop</i>	Means Treated	Means Control	Mean Difference	Means Treated	Means Control	Mean Difference	Mean Difference
Propensity score	0.75	0.68	0.07	0.73	0.73	0.00	99.99
HH characteristics							
The number of children	0.73	0.54	0.19	0.67	0.70	-0.03	83.59
HH income: \$0-\$49,999 (1/0)	0.30	0.14	0.16	0.23	0.24	0.00	98.78
HH income: \$50,000-\$99,999 (1/0)	0.52	0.56	-0.04	0.57	0.56	0.01	77.00
Number of vehicles	2.03	2.33	-0.29	2.12	2.17	-0.05	83.85
Male head's characteristics							
Age	52.79	55.96	-3.16	53.70	53.84	-0.14	95.57
Square age	2955.71	3269.95	-314.24	3045.12	3067.21	-22.09	92.97
Hispanic (1/0)	0.32	0.14	0.18	0.25	0.26	0.00	98.02
African-American (1/0)	0.05	0.02	0.03	0.04	0.04	0.00	85.92
Valid driver license (1/0)	0.95	0.99	-0.04	0.98	0.97	0.01	82.72
Employed (1/0)	0.75	0.75	0.01	0.75	0.75	0.00	85.11
Female head's characteristics							
Age	50.12	53.29	-3.18	51.04	51.10	-0.06	98.16
Square age	2663.88	2965.62	-301.74	2749.60	2760.19	-10.59	96.49
Hispanic (1/0)	0.33	0.17	0.16	0.27	0.26	0.01	95.19
African-American (1/0)	0.04	0.02	0.02	0.04	0.04	-0.01	74.71
Valid driver license (1/0)	0.87	0.98	-0.11	0.93	0.93	0.00	99.54
Employed (1/0)	0.58	0.63	-0.05	0.61	0.61	0.00	96.73
Sample size		Control			Treated		Total
All		848			2,326		3,174
Matched		714			2,020		2,734
Unmatched		134			306		440
Discarded		0			0		0

Table A-5 PSM result for household residing in the block group with more than 50% of single-family residential use: Households with no artificial zero gaps in all modes of transportation

Treatment 2: <i>Household's residence was located in the block group with more than 50% of single-family residential use</i>	Summary of balance for all data			Summary of balance for matched data			Percent balance improvement
	Means Treated	Means Control	Mean Difference	Means Treated	Means Control	Mean Difference	Mean Difference
Propensity score	0.46	0.37	0.09	0.46	0.46	0.00	99.97
HH characteristics							
The number of children	0.60	0.73	-0.13	0.60	0.54	0.06	51.38
HH income: \$0-\$49,999 (1/0)	0.16	0.33	-0.18	0.16	0.17	-0.01	93.91
HH income: \$50,000-\$99,999 (1/0)	0.58	0.50	0.08	0.58	0.59	-0.01	87.79
Number of vehicles	2.31	1.98	0.34	2.28	2.29	-0.01	97.44
Male head's characteristics							
Age	56.06	51.97	4.10	55.98	56.59	-0.61	85.09
Square age	3283.68	2871.49	412.19	3274.65	3335.65	-61.00	85.20
Hispanic (1/0)	0.18	0.33	-0.15	0.18	0.18	0.00	100.00
African-American (1/0)	0.04	0.05	-0.01	0.04	0.03	0.00	68.57
Valid driver license (1/0)	0.98	0.94	0.04	0.98	0.99	0.00	94.17
Employed (1/0)	0.73	0.77	-0.04	0.73	0.73	0.00	95.93
Female head's characteristics							
Age	53.50	49.23	4.27	53.39	53.85	-0.46	89.23
Square age	2988.45	2576.37	412.08	2976.45	3022.05	-45.60	88.93
Hispanic (1/0)	0.20	0.34	-0.14	0.20	0.20	0.01	95.06
African-American (1/0)	0.03	0.04	-0.01	0.03	0.03	0.00	84.60
Valid driver license (1/0)	0.96	0.85	0.11	0.96	0.96	0.00	97.09
Employed (1/0)	0.60	0.58	0.02	0.60	0.58	0.02	-31.31
Sample size		Control			Treated		Total
All		1,879			1,295		3,174
Matched		831			1,280		2,111
Unmatched		1,048			15		1,063
Discarded		0			0		0

Table A-6 PSM result for household residing in a walkable neighborhood: Households with no artificial zero gaps in all modes of transportation

Treatment 3: <i>Household's residence was located in a walkable neighborhood</i>	Summary of balance for all data			Summary of balance for matched data			Percent balance improvement
	Means Treated	Means Control	Mean Difference	Means Treated	Means Control	Mean Difference	Mean Difference
Propensity score	0.36	0.27	0.09	0.34	0.34	0.00	100.00
HH characteristics							
The number of children	0.79	0.63	0.16	0.76	0.73	0.03	80.71
HH income: \$0-\$49,999 (1/0)	0.39	0.21	0.18	0.33	0.34	-0.01	96.71
HH income: \$50,000-\$99,999 (1/0)	0.45	0.57	-0.12	0.48	0.48	0.01	93.40
Number of vehicles	1.81	2.24	-0.43	1.92	1.94	-0.02	95.38
Male head's characteristics							
Age	50.55	54.95	-4.40	51.33	51.13	0.19	95.58
Square age	2726.65	3172.18	-445.53	2801.05	2785.64	15.40	96.54
Hispanic (1/0)	0.36	0.23	0.13	0.32	0.30	0.02	84.42
African-American (1/0)	0.05	0.04	0.01	0.04	0.06	-0.02	-146.68
Valid driver license (1/0)	0.92	0.98	-0.05	0.96	0.94	0.02	71.54
Employed (1/0)	0.79	0.74	0.05	0.78	0.77	0.01	76.52
Female head's characteristics							
Age	47.97	52.24	-4.26	48.75	49.01	-0.26	93.97
Square age	2453.45	2867.70	-414.25	2523.49	2553.92	-30.43	92.65
Hispanic (1/0)	0.38	0.25	0.13	0.34	0.32	0.02	86.17
African-American (1/0)	0.04	0.04	0.00	0.04	0.05	-0.01	-237.54
Valid driver license (1/0)	0.81	0.94	-0.13	0.86	0.86	0.00	99.11
Employed (1/0)	0.58	0.60	-0.02	0.60	0.58	0.01	41.69
Sample size		Control			Treated		Total
All		2,230			944		3,174
Matched		677			860		1,537
Unmatched		1,553			84		1,637
Discarded		0			0		0

Table A-7 PSM result for household's residence within 0.25 miles of any transit stop: Households with no artificial zero gaps in walking

Treatment 1:	Summary of balance for all data			Summary of balance for matched data			Percent balance improvement
<i>Household's residence was located within 0.25 miles of any transit stop</i>	Means Treated	Means Control	Mean Difference	Means Treated	Means Control	Mean Difference	Mean Difference
Propensity score	0.84	0.70	0.14	0.80	0.80	0.00	99.99
HH characteristics							
The number of children	0.91	0.58	0.34	0.68	0.75	-0.07	79.93
HH income: \$0-\$49,999 (1/0)	0.45	0.14	0.31	0.32	0.28	0.04	88.29
HH income: \$50,000-\$99,999 (1/0)	0.40	0.48	-0.09	0.51	0.51	0.00	100.00
Number of vehicles	1.63	2.30	-0.67	1.81	1.78	0.04	94.66
Male head's characteristics							
Age	50.22	55.38	-5.16	53.54	53.33	0.21	95.85
Square age	2687.35	3178.12	-490.77	3011.17	2986.41	24.76	94.95
Hispanic (1/0)	0.42	0.14	0.29	0.30	0.31	0.00	98.62
African-American (1/0)	0.05	0.03	0.02	0.04	0.04	0.00	78.02
Valid driver license (1/0)	0.87	0.98	-0.12	0.93	0.90	0.03	73.06
Employed (1/0)	0.76	0.81	-0.05	0.73	0.71	0.01	75.68
Female head's characteristics							
Age	47.41	52.80	-5.39	51.19	50.27	0.92	82.91
Square age	2393.55	2884.36	-490.81	2745.06	2649.24	95.82	80.48
Hispanic (1/0)	0.42	0.20	0.22	0.33	0.30	0.03	85.48
African-American (1/0)	0.04	0.03	0.01	0.05	0.04	0.01	15.75
Valid driver license (1/0)	0.71	0.95	-0.25	0.79	0.85	-0.06	77.46
Employed (1/0)	0.52	0.61	-0.09	0.54	0.58	-0.04	60.16
Sample size		Control			Treated		Total
All		132			579		711
Matched		92			252		344
Unmatched		40			327		367
Discarded		0			0		0

Table A-8 PSM result for household residing in the block group with more than 50% of single-family residential use: Households with no artificial zero gaps in walking

Treatment 2: <i>Household's residence was located in the block group with more than 50% of single-family residential use</i>	Summary of balance for all data			Summary of balance for matched data			Percent balance improvement
	Means Treated	Means Control	Mean Difference	Means Treated	Means Control	Mean Difference	Mean Difference
Propensity score	0.40	0.25	0.15	0.37	0.37	0.00	99.95
HH characteristics							
The number of children	0.80	0.87	-0.08	0.78	0.73	0.06	26.23
HH income: \$0-\$49,999 (1/0)	0.20	0.48	-0.28	0.23	0.22	0.01	95.94
HH income: \$50,000-\$99,999 (1/0)	0.52	0.37	0.15	0.51	0.49	0.02	88.47
Number of vehicles	2.23	1.55	0.68	2.06	2.06	-0.01	99.16
Male head's characteristics							
Age	54.20	49.91	4.28	53.56	54.07	-0.51	88.06
Square age	3074.99	2654.18	420.81	3006.99	3044.43	-37.44	91.10
Hispanic (1/0)	0.22	0.43	-0.21	0.24	0.27	-0.03	83.56
African-American (1/0)	0.05	0.04	0.01	0.05	0.02	0.03	-171.47
Valid driver license (1/0)	0.97	0.86	0.11	0.96	0.98	-0.02	84.56
Employed (1/0)	0.80	0.76	0.03	0.79	0.84	-0.05	-30.77
Female head's characteristics							
Age	51.48	47.12	4.35	50.70	50.85	-0.15	96.61
Square age	2776.55	2362.32	414.23	2696.03	2701.36	-5.33	98.71
Hispanic (1/0)	0.21	0.45	-0.24	0.23	0.24	-0.01	95.24
African-American (1/0)	0.04	0.04	0.01	0.05	0.03	0.01	-64.00
Valid driver license (1/0)	0.90	0.69	0.21	0.89	0.89	0.00	100.00
Employed (1/0)	0.60	0.51	0.09	0.62	0.57	0.05	42.06
Sample size		Control			Treated		Total
All		501			210		711
Matched		130			176		306
Unmatched		371			34		405
Discarded		0			0		0

Table A-9 PSM result for household residing in a walkable neighborhood: Households with no artificial zero gaps in walking

Treatment 3: <i>Household's residence was located in a walkable neighborhood</i>	Summary of balance for all data			Summary of balance for matched data			Percent balance improvement
	Means Treated	Means Control	Mean Difference	Means Treated	Means Control	Mean Difference	Mean Difference
Propensity score	0.55	0.40	0.15	0.51	0.51	0.00	99.99
HH characteristics							
The number of children	0.92	0.79	0.13	0.94	0.92	0.02	87.82
HH income: \$0-\$49,999 (1/0)	0.52	0.28	0.24	0.44	0.41	0.03	86.59
HH income: \$50,000-\$99,999 (1/0)	0.35	0.48	-0.13	0.41	0.39	0.02	84.36
Number of vehicles	1.43	2.04	-0.60	1.61	1.62	-0.01	97.96
Male head's characteristics							
Age	48.50	53.61	-5.11	50.25	49.89	0.36	92.94
Square age	2512.72	3019.28	-506.56	2681.59	2661.02	20.57	95.94
Hispanic (1/0)	0.46	0.28	0.18	0.41	0.37	0.04	77.27
African-American (1/0)	0.04	0.05	-0.01	0.04	0.04	0.00	40.06
Valid driver license (1/0)	0.84	0.93	-0.09	0.87	0.90	-0.02	71.77
Employed (1/0)	0.77	0.77	0.00	0.78	0.74	0.04	-1240.14
Female head's characteristics							
Age	45.61	50.94	-5.33	47.45	46.83	0.63	88.24
Square age	2220.50	2724.05	-503.55	2382.26	2331.02	51.24	89.82
Hispanic (1/0)	0.48	0.30	0.18	0.42	0.43	-0.01	95.41
African-American (1/0)	0.03	0.05	-0.02	0.03	0.04	-0.01	48.74
Valid driver license (1/0)	0.66	0.84	-0.18	0.72	0.75	-0.04	79.44
Employed (1/0)	0.51	0.55	-0.04	0.52	0.53	-0.02	59.47
Sample size		Control			Treated		Total
All		373			338		711
Matched		144			244		388
Unmatched		229			94		323
Discarded		0			0		0

Table A-10 PSM result for household's residence within 0.25 miles of any transit stop: Households with no artificial zero gaps in driving

Treatment 1:	Summary of balance for all data			Summary of balance for matched data			Percent balance improvement
<i>Household's residence was located within 0.25 miles of any transit stop</i>	Means Treated	Means Control	Mean Difference	Means Treated	Means Control	Mean Difference	Mean Difference
Propensity score	0.74	0.68	0.06	0.72	0.72	0.00	100.00
HH characteristics							
The number of children	0.73	0.54	0.19	0.64	0.70	-0.06	70.50
HH income: \$0-\$49,999 (1/0)	0.27	0.14	0.13	0.21	0.22	-0.01	92.73
HH income: \$50,000-\$99,999 (1/0)	0.55	0.57	-0.02	0.60	0.59	0.00	91.14
Number of vehicles	2.11	2.34	-0.22	2.16	2.21	-0.05	78.64
Male head's characteristics							
Age	52.84	55.91	-3.07	53.90	54.15	-0.25	91.80
Square age	2958.34	3265.07	-306.73	3063.52	3092.53	-29.01	90.54
Hispanic (1/0)	0.29	0.14	0.16	0.23	0.23	0.00	98.98
African-American (1/0)	0.05	0.02	0.03	0.04	0.04	0.00	96.37
Valid driver license (1/0)	0.98	0.99	-0.01	0.99	0.98	0.00	88.05
Employed (1/0)	0.76	0.75	0.02	0.76	0.75	0.01	62.07
Female head's characteristics							
Age	50.19	53.24	-3.04	51.16	51.47	-0.31	89.90
Square age	2669.75	2959.29	-289.54	2760.69	2795.54	-34.85	87.96
Hispanic (1/0)	0.31	0.16	0.15	0.25	0.26	-0.01	93.89
African-American (1/0)	0.04	0.02	0.02	0.04	0.04	0.00	100.00
Valid driver license (1/0)	0.90	0.98	-0.07	0.95	0.94	0.01	86.26
Employed (1/0)	0.60	0.63	-0.03	0.61	0.59	0.02	30.85
Sample size		Control			Treated		Total
All		824			2,142		2,966
Matched		682			1,867		2,549
Unmatched		142			275		417
Discarded		0			0		0

Table A-11 PSM result for household residing in the block group with more than 50% Of single-family residential use: Households with no artificial zero gaps in driving

Treatment 2: <i>Household's residence was located in the block group with more than 50% of single-family residential use</i>	Summary of balance for all data			Summary of balance for matched data			Percent balance improvement
	Means Treated	Means Control	Mean Difference	Means Treated	Means Control	Mean Difference	Mean Difference
Propensity score	0.47	0.39	0.08	0.47	0.47	0.00	99.95
HH characteristics							
The number of children	0.60	0.74	-0.14	0.60	0.57	0.03	81.96
HH income: \$0-\$49,999 (1/0)	0.15	0.30	-0.15	0.15	0.15	0.00	99.46
HH income: \$50,000-\$99,999 (1/0)	0.58	0.53	0.05	0.59	0.60	-0.02	68.39
Number of vehicles	2.32	2.07	0.25	2.29	2.31	-0.02	91.59
Male head's characteristics							
Age	56.07	51.94	4.13	55.99	56.33	-0.34	91.71
Square age	3281.67	2867.93	413.74	3272.75	3307.74	-34.99	91.54
Hispanic (1/0)	0.17	0.31	-0.13	0.18	0.18	-0.01	93.93
African-American (1/0)	0.04	0.05	-0.01	0.04	0.03	0.01	22.80
Valid driver license (1/0)	0.99	0.98	0.01	0.99	0.99	0.00	81.65
Employed (1/0)	0.73	0.78	-0.05	0.74	0.77	-0.03	38.40
Female head's characteristics							
Age	53.50	49.22	4.28	53.40	53.71	-0.31	92.72
Square age	2987.73	2574.99	412.74	2976.57	3008.45	-31.88	92.28
Hispanic (1/0)	0.20	0.32	-0.12	0.20	0.20	-0.01	94.54
African-American (1/0)	0.03	0.04	-0.01	0.03	0.03	0.00	70.63
Valid driver license (1/0)	0.97	0.89	0.07	0.97	0.97	0.00	97.81
Employed (1/0)	0.61	0.61	0.00	0.61	0.61	0.00	57.58
Sample size		Control			Treated		Total
All		1,707			1,259		2,966
Matched		781			1,239		2,020
Unmatched		926			20		946
Discarded		0			0		0

Table A-12 PSM result for household residing in a walkable neighborhood: Households with no artificial zero gaps in driving

Treatment 3: <i>Household's residence was located in a walkable neighborhood</i>	Summary of balance for all data			Summary of balance for matched data			Percent balance improvement
	Means Treated	Means Control	Mean Difference	Means Treated	Means Control	Mean Difference	Mean Difference
Propensity score	0.33	0.26	0.07	0.32	0.32	0.00	99.99
HH characteristics							
The number of children	0.80	0.63	0.17	0.77	0.68	0.09	47.10
HH income: \$0-\$49,999 (1/0)	0.34	0.20	0.14	0.30	0.32	-0.02	85.26
HH income: \$50,000-\$99,999 (1/0)	0.48	0.58	-0.10	0.51	0.51	0.00	98.69
Number of vehicles	1.95	2.26	-0.32	2.00	2.01	0.00	99.19
Male head's characteristics							
Age	50.44	54.95	-4.51	51.05	51.82	-0.77	82.93
Square age	2712.19	3171.24	-459.05	2771.41	2850.97	-79.56	82.67
Hispanic (1/0)	0.33	0.22	0.11	0.30	0.32	-0.02	82.73
African-American (1/0)	0.05	0.04	0.00	0.05	0.04	0.01	-27.44
Valid driver license (1/0)	0.98	0.99	-0.01	0.98	0.98	0.00	79.07
Employed (1/0)	0.81	0.74	0.07	0.80	0.79	0.01	87.01
Female head's characteristics							
Age	47.94	52.23	-4.29	48.50	49.35	-0.84	80.29
Square age	2447.60	2866.78	-419.19	2499.08	2580.03	-80.94	80.69
Hispanic (1/0)	0.35	0.24	0.11	0.32	0.33	-0.01	94.30
African-American (1/0)	0.04	0.04	0.00	0.04	0.03	0.01	-25.61
Valid driver license (1/0)	0.86	0.95	-0.08	0.89	0.88	0.01	82.81
Employed (1/0)	0.60	0.61	-0.01	0.62	0.58	0.03	-314.69
Sample size		Control			Treated		Total
All		2,141			825		2,966
Matched		599			780		1,379
Unmatched		1,542			45		1,587
Discarded		0			0		0

Table A-13 PSM result for household's residence within 0.25 miles of any transit stop: Households with no artificial zero gaps in automobile travel

Treatment 1:	Summary of balance for all data			Summary of balance for matched data			Percent balance improvement
<i>Household's residence was located within 0.25 miles of any transit stop</i>	Means Treated	Means Control	Mean Difference	Means Treated	Means Control	Mean Difference	Mean Difference
Propensity score	0.74	0.68	0.06	0.72	0.72	0.00	99.99
HH characteristics							
The number of children	0.73	0.54	0.19	0.64	0.64	0.00	99.44
HH income: \$0-\$49,999 (1/0)	0.28	0.14	0.14	0.21	0.21	0.00	96.59
HH income: \$50,000-\$99,999 (1/0)	0.54	0.57	-0.03	0.59	0.58	0.01	54.34
Number of vehicles	2.09	2.34	-0.25	2.15	2.20	-0.05	79.32
Male head's characteristics							
Age	52.86	55.96	-3.11	54.00	53.73	0.27	91.23
Square age	2960.53	3270.44	-309.91	3073.44	3050.05	23.39	92.45
Hispanic (1/0)	0.30	0.14	0.16	0.23	0.24	0.00	97.08
African-American (1/0)	0.05	0.02	0.03	0.04	0.03	0.00	85.84
Valid driver license (1/0)	0.97	0.99	-0.02	0.98	0.99	0.00	71.71
Employed (1/0)	0.76	0.75	0.02	0.75	0.76	-0.01	62.95
Female head's characteristics							
Age	50.19	53.27	-3.08	51.31	51.09	0.22	92.70
Square age	2669.83	2962.42	-292.60	2773.98	2754.56	19.43	93.36
Hispanic (1/0)	0.31	0.16	0.15	0.25	0.26	-0.01	93.13
African-American (1/0)	0.04	0.02	0.02	0.04	0.04	0.00	90.81
Valid driver license (1/0)	0.89	0.98	-0.08	0.95	0.93	0.02	81.52
Employed (1/0)	0.60	0.63	-0.04	0.62	0.61	0.00	90.93
Sample size		Control			Treated		Total
All		829			2,190		3,019
Matched		668			1,890		2,558
Unmatched		161			300		461
Discarded		0			0		0

Table A-14 PSM result for household residing in the block group with more than 50% Of single-family residential use: Households with no artificial zero gaps in automobile travel

Treatment 2: <i>Household's residence was located in the block group with more than 50% of single-family residential use</i>	Summary of balance for all data			Summary of balance for matched data			Percent balance improvement
	Means Treated	Means Control	Mean Difference	Means Treated	Means Control	Mean Difference	Mean Difference
Propensity score	0.47	0.38	0.09	0.47	0.47	0.00	99.95
HH characteristics							
The number of children	0.59	0.74	-0.14	0.60	0.61	-0.01	94.43
HH income: \$0-\$49,999 (1/0)	0.15	0.31	-0.16	0.15	0.16	-0.01	95.43
HH income: \$50,000-\$99,999 (1/0)	0.58	0.52	0.06	0.59	0.60	-0.01	77.81
Number of vehicles	2.32	2.04	0.28	2.29	2.28	0.00	99.14
Male head's characteristics							
Age	56.10	51.98	4.12	56.02	55.98	0.04	99.05
Square age	3285.42	2871.74	413.67	3276.40	3268.72	7.67	98.14
Hispanic (1/0)	0.17	0.31	-0.14	0.18	0.18	0.00	96.56
African-American (1/0)	0.04	0.05	-0.01	0.04	0.04	0.00	74.03
Valid driver license (1/0)	0.99	0.97	0.02	0.99	0.98	0.00	69.93
Employed (1/0)	0.73	0.78	-0.05	0.73	0.72	0.02	67.73
Female head's characteristics							
Age	53.50	49.25	4.25	53.39	53.48	-0.10	97.68
Square age	2987.54	2578.05	409.50	2974.36	2980.37	-6.01	98.53
Hispanic (1/0)	0.20	0.32	-0.13	0.20	0.21	-0.01	91.76
African-American (1/0)	0.03	0.04	-0.01	0.03	0.03	0.00	86.56
Valid driver license (1/0)	0.97	0.88	0.08	0.97	0.97	-0.01	93.30
Employed (1/0)	0.61	0.61	0.00	0.61	0.60	0.01	-1146.74
Sample size		Control			Treated		Total
All		1,750			1,269		3,019
Matched		812			1,250		2,062
Unmatched		938			19		957
Discarded		0			0		0

Table A-15 PSM result for household residing in a walkable neighborhood: Households with no artificial zero gaps in automobile travel

Treatment 3:	Summary of balance for all data			Summary of balance for matched data			Percent balance improvement
<i>Household's residence was located in a walkable neighborhood</i>	Means Treated	Means Control	Mean Difference	Means Treated	Means Control	Mean Difference	Mean Difference
Propensity score	0.34	0.26	0.08	0.32	0.32	0.00	99.96
HH characteristics							
The number of children	0.81	0.63	0.18	0.77	0.77	0.00	98.60
HH income: \$0-\$49,999 (1/0)	0.35	0.20	0.15	0.31	0.32	-0.01	95.04
HH income: \$50,000-\$99,999 (1/0)	0.47	0.58	-0.11	0.50	0.51	-0.01	90.49
Number of vehicles	1.91	2.26	-0.35	1.98	2.00	-0.02	93.25
Male head's characteristics							
Age	50.54	54.96	-4.43	51.14	51.24	-0.10	97.77
Square age	2722.76	3173.19	-450.43	2780.08	2803.27	-23.19	94.85
Hispanic (1/0)	0.34	0.22	0.12	0.31	0.29	0.02	84.73
African-American (1/0)	0.05	0.04	0.00	0.04	0.06	-0.01	-138.05
Valid driver license (1/0)	0.96	0.98	-0.02	0.98	0.97	0.00	87.54
Employed (1/0)	0.80	0.74	0.07	0.80	0.78	0.02	74.99
Female head's characteristics							
Age	47.97	52.25	-4.27	48.58	48.47	0.12	97.22
Square age	2450.01	2868.77	-418.76	2505.74	2511.28	-5.54	98.68
Hispanic (1/0)	0.36	0.24	0.12	0.33	0.31	0.02	81.43
African-American (1/0)	0.04	0.04	0.00	0.04	0.04	-0.01	-65.67
Valid driver license (1/0)	0.85	0.94	-0.10	0.89	0.87	0.02	83.36
Employed (1/0)	0.60	0.61	-0.01	0.61	0.60	0.01	8.43
Sample size		Control			Treated		Total
All		2,164			855		3,019
Matched		614			799		1,413
Unmatched		1,550			56		1,606
Discarded		0			0		0

Appendix B: Estimations Results of Individual Travel Patterns and Within-Household Gendered Inequality in Travel Behaviors Based on the Full Datasets

This appendix documents the estimation results based on the full datasets. It is anticipated to compare the influences of built environments before and after self-selection problem is remedied by propensity score matching. To understand the effect of different built environment measures, Model 1 incorporated street connectivity, regional accessibility, and local accessibility; Model 2 considered regional accessibility and walk score. Note that walk score is regarded as an integrated measure of street connectivity and local accessibility.

Tables B-1 to B-4 show the estimations based on negative binomial regressions for male and female heads' daily trip frequencies by all modes, walking, driving, and automobile, respectively. Tables B-5 to B-9 provide the results based on Tobit models that estimated male and female heads' daily travel distances by all modes, walking, driving, automobile, and VMT, respectively. For the estimations on gendered inequality, Tables B-10 and B-11 describe the negative binomial regression results for inequalities in daily trips by all modes, walking, driving, and automobile. Tables B-12, B-13a, and B-13b display the results based on Tobit models for investigating the gendered inequalities in daily travel distances by all modes, walking, driving, automobile, and VMT.

Table B-1 Negative binomial model for estimating individual daily trip frequency of all modes

Dependent variable: Trip frequency of all modes of ground transportation	Model I-1				Model I-2			
	Male heads		Female heads		Male heads		Female heads	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	0.5786	**	0.1338		0.4959	**	0.0964	
Household characteristics								
The number of children	0.0638	***	0.1359	***	0.0645	***	0.1346	***
HH income: \$0-\$49,999	-0.1445	***	-0.0440		-0.1581	***	-0.0508	
HH income: \$50,000-\$99,999	-0.0340		-0.0685	*	-0.0431		-0.0705	*
Number of vehicles	-0.0508	***	-0.0436	**	-0.0490	***	-0.0414	**
Head's characteristics								
Age	0.0267	***	0.0433	***	0.0264	***	0.0437	***
Square age	-0.0003	***	-0.0005	***	-0.0003	***	-0.0005	***
Hispanic	-0.0270		-0.0454		-0.0224		-0.0458	
African-American	-0.0883		-0.1088		-0.0822		-0.1123	
Valid driver license	0.0687		0.2148	***	0.0744		0.2135	***
Employed	0.0836	**	0.0676	**	0.0815	**	0.0642	*
Street connectivity								
Low-medium	-0.0326		0.0652					
Medium-high	-0.0110		0.0533					
High	0.0464		0.0417					
Regional accessibility								
Low-medium	0.1076	**	0.0143		0.0607		-0.0051	
Medium-high	0.0510		0.0378		-0.0040		0.0099	
High	0.1179	**	0.1001	*	0.0592		0.0670	
Local accessibility								
Low-medium	-0.0694		-0.0593					
Medium-high	0.0213		-0.0392					
High	0.0242		-0.0128					
Walkable neighborhood								
Walk Score					0.0021	**	0.0011	
Sample size	3,588		3,588		3,588		3,588	
P-value of χ^2(goodness of fit)	6.66E-16		0.00E+00		0.00E+00		0.00E+00	
Street connectivity	0.3959		0.4787					
Regional accessibility	0.0451**		0.2890		0.2888		0.5326	
Local accessibility	0.1478		0.5413					
Walk score					0.0105**		0.1824	
Log-likelihood	-8,266.88		-8,451.15		-8,268.39		-8,452.34	
McFadden adjusted R²	0.0047		0.0091		0.0051		0.0096	

Significance: * p < .1, ** p < .05, *** p < .01.

Table B-2 Negative binomial model for estimating individual daily walking trip frequency

Dependent variable: Walking trip frequency	Model I-3				Model I-4			
	Male heads		Female heads		Male heads		Female heads	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	-0.3248		-1.0649		-0.7191		-1.3088	
Household characteristics								
The number of children	0.0855		0.0278		0.0847		0.0264	
HH income: \$0-\$49,999	-0.2705		-0.1091		-0.2956		-0.1324	
HH income: \$50,000-\$99,999	-0.1861		-0.3926	***	-0.2251		-0.4131	***
Number of vehicles	-0.3071	***	-0.3310	***	-0.2885	***	-0.3124	***
Head's characteristics								
Age	0.0191		0.0644	*	0.0183		0.0649	*
Square age	-0.0002		-0.0008	**	-0.0002		-0.0008	**
Hispanic	-0.2573		-0.0102		-0.2229		0.0028	
African-American	-0.4651		-0.0007		-0.4113		0.0514	
Valid driver license	-1.2738	***	-0.7352	***	-1.2783	***	-0.7418	***
Employed	0.0154		-0.1270		0.0343		-0.1360	
Street connectivity								
Low-medium	0.0932		0.2491		0.2113		0.0386	
Medium-high	0.0551		0.1297		0.0967		0.1043	
High	0.2078		0.2049		0.3711		0.4090	*
Regional accessibility								
Low-medium	0.2919		0.1311					
Medium-high	0.2269		0.2522					
High	0.5865	**	0.5902	***				
Local accessibility								
Low-medium	0.3145		0.0271					
Medium-high	0.4563	**	0.2153					
High	0.5089	**	0.3543	*				
Walkable neighborhood								
Walk Score					0.0144	***	0.0106	***
Sample size	3,588		3,588		3,588		3,588	
P-value of χ^2(goodness of fit)	1.11E-16		0.00E+00		0.00E+00		0.00E+00	
Street connectivity	0.7845		0.4630					
Regional accessibility	0.0868*		0.0209**		0.3912		0.1534	
Local accessibility	0.0974*		0.2388					
Walk score					2.37E-05***		0.0006***	
Log-likelihood	-2,020.87		-2,477.61		-2,016.87		-2,475.88	
McFadden adjusted R²	0.0199		0.0335		0.0242		0.0361	

Significance: * p < .1, ** p < .05, *** p < .01.

Table B-3 Negative binomial model for estimating individual daily driving trip frequency

Dependent variable: Driving trip frequency	Model I-5				Model I-6			
	Male heads		Female heads		Male heads		Female heads	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	0.2238		-0.5988	*	0.1537		-0.5950	*
Household characteristics								
The number of children	0.0766	***	0.2204	***	0.0782	***	0.2180	***
HH income: \$0-\$49,999	-0.1960	***	-0.0005		-0.2121	***	-0.0035	
HH income: \$50,000-\$99,999	-0.0651		-0.0192		-0.0744		-0.0177	
Number of vehicles	-0.0101		0.0421		-0.0096		0.0424	
Head's characteristics								
Age	0.0330	***	0.0530	***	0.0338	***	0.0540	***
Square age	-0.0003	***	-0.0005	***	-0.0003	***	-0.0006	***
Hispanic	0.0235		-0.0942		0.0269		-0.0911	
African-American	-0.0576		-0.1376		-0.0538		-0.1398	
Valid driver license								
Employed	0.1189	**	0.1185	**	0.1154		0.1154	**
Street connectivity								
Low-medium	-0.0505		0.0769					
Medium-high	-0.0182		0.0852					
High	0.0571		0.0455					
Regional accessibility								
Low-medium	0.1053	**	0.0037		0.0702		0.0183	
Medium-high	0.0131		0.0579		-0.0185		0.0730	
High	0.0173		-0.0267		-0.0183		-0.0160	
Local accessibility								
Low-medium	-0.1223	**	-0.0382					
Medium-high	-0.0492		-0.0664					
High	-0.0987		-0.0914					
Walkable neighborhood								
Walk Score					0.0002		-0.0006	
Sample size	3,431		3,194		3,431		3,194	
P-value of χ^2(goodness of fit)	2.07E-14		0.00E+00		1.11E-14		0.00E+00	
Street connectivity	0.2971		0.5208					
Regional accessibility	0.1421		0.6443		0.2716		0.5593	
Local accessibility	0.1068		0.6414					
Walk score					0.8167		0.6334	
Log-likelihood	-7,276.75		-6,607.97		-7,281.68		-6,609.52	
McFadden adjusted R²	0.0047		0.0088		0.0048		0.0093	

Significance: * p < .1, ** p < .05, *** p < .01.

Table B-4 Negative binomial model for estimating individual daily automobile trip frequency

Dependent variable: Automobile trip frequency	Model I-7				Model I-8			
	Male heads		Female heads		Male heads		Female heads	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	-0.9510	***	-0.9264	***	-0.9987	***	-0.9346	***
Household characteristics								
The number of children	0.0610	***	0.1597	***	0.0625	***	0.1595	***
HH income: \$0-\$49,999	-0.1613	***	-0.0898		-0.1711	***	-0.0921	
HH income: \$50,000-\$99,999	-0.0298		-0.0301		-0.0364		-0.0295	
Number of vehicles	0.0059		0.0309		0.0058		0.0317	
Head's characteristics								
Age	0.0211	**	0.0391	***	0.0210	**	0.0400	***
Square age	-0.0002	***	-0.0004	***	-0.0002	***	-0.0004	***
Hispanic	0.0134		-0.0657		0.0166		-0.0643	
African-American	-0.0881		-0.1821	**	-0.0852		-0.1849	**
Valid driver license	1.5680	***	1.0240	***	1.5700	***	1.0230	***
Employed	0.0767	*	0.0895	**	0.0752	*	0.0870	**
Street connectivity								
Low-medium	-0.0653		0.0312					
Medium-high	-0.0423		0.0398					
High	0.0198		0.0328					
Regional accessibility								
Low-medium	0.0975	**	-0.0023		0.0671		0.0030	
Medium-high	0.0241		0.0537		-0.0060		0.0609	
High	-0.0010		-0.0180		-0.0282		-0.0112	
Local accessibility								
Low-medium	-0.0988	**	-0.0625					
Medium-high	0.0024		-0.0639					
High	-0.0390		-0.0969	*				
Walkable neighborhood								
Walk Score					0.0003		-0.0008	
Sample size	3,588		3,588		3,588		3,588	
P-value of χ^2(goodness of fit)	0.00E+00		0.00E+00		0.00E+00		0.00E+00	
Street connectivity	0.2530		0.8576					
Regional accessibility	0.0940*		0.4810		0.1962		0.4374	
Local accessibility	0.0940*		0.3315					
Walk score					0.6943		0.3656	
Log-likelihood	-7,733.91		-7,812.20		-7,739.41		-7,813.62	
McFadden adjusted R²	0.0173		0.0254		0.0172		0.0258	

Significance: * p < .1, ** p < .05, *** p < .01.

Table B-5 Tobit model for estimating individual daily travel distance of all modes

Dependent variable: Travel distance of all modes of ground transportation (mile)	Model I-9				Model I-10			
	Male heads		Female heads		Male heads		Female heads	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	-5.9376		-0.0364		-6.5286		1.0235	
Household characteristics								
The number of children	0.9458		1.1708		1.0180		1.2252	
HH income: \$0-\$49,999	-9.7491	***	-9.0426	***	-10.2348	***	-9.1954	***
HH income: \$50,000-\$99,999	-1.5219		-5.3522	**	-1.6443		-5.3414	**
Number of vehicles	-0.1051		-1.2070		-0.2052		-1.3033	
Head's characteristics								
Age	0.9102	*	0.9086	*	0.8802	*	0.9052	*
Square age	-0.0104	**	-0.0107	**	-0.0101	**	-0.0107	**
Hispanic	3.0699		-1.5553		2.9139		-1.6799	
African-American	-9.5494	**	-8.1539	*	-9.9096	**	-8.5012	*
Valid driver license	18.8446	***	13.4940	***	19.0670	***	13.3154	***
Employed	10.4437	***	9.3030	***	10.4715	***	9.3885	***
Street connectivity								
Low-medium	-5.6844	**	-2.4520					
Medium-high	-7.9973	***	-4.4321					
High	-4.7473		-1.4922					
Regional accessibility								
Low-medium	-4.6035	*	-6.5421	***	-5.9072	**	-6.3294	**
Medium-high	-8.7704	***	-6.5249	**	-10.4615	***	-6.1611	**
High	-9.4938	***	-10.0117	***	-10.3563	***	-9.0068	***
Local accessibility								
Low-medium	-7.2732	***	-3.4060					
Medium-high	-1.7051		-1.5421					
High	-2.9121		-2.3750					
Walkable neighborhood								
Walk Score					-0.0820	*	-0.0827	*
Sample size	3588		3588		3588		3588	
P-value of χ^2(goodness of fit)	1.22E-31		2.18E-25		6.30E-31		1.88E-27	
Street connectivity	0.0313**		0.4149					
Regional accessibility	0.0086***		0.0098***		0.0035***		0.0379**	
Local accessibility	0.0371**		0.6039					
Walk score					0.0967*		0.0851*	
Log-likelihood	-15,887.63		-15,573.34		-15,896.21		-15,574.64	
McFadden adjusted R²	0.0050		0.0041		0.0048		0.0043	

Significance: * p < .1, ** p < .05, *** p < .01.

Table B-6 Tobit model for estimating individual daily walking distance

Dependent variable: Walking distance (mile)	Model I-11				Model I-12			
	Male heads		Female heads		Male heads		Female heads	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	-1.0953		-2.5869	*	-1.7346		-2.9414	**
Household characteristics								
The number of children	0.0220		0.0654		0.0242		0.0591	
HH income: \$0-\$49,999	-0.5290	*	-0.2944		-0.5967	**	-0.3419	
HH income: \$50,000-\$99,999	-0.3206		-0.5850	**	-0.3768	*	-0.6174	***
Number of vehicles	-0.5333	***	-0.5668	***	-0.5009	***	-0.5400	***
Head's characteristics								
Age	0.0264		0.0827		0.0267		0.0815	
Square age	-0.0003		-0.0011	**	-0.0003		-0.0011	**
Hispanic	-0.3532	*	0.0208		-0.3303		0.0254	
African-American	-0.7405	*	0.1661		-0.6853	*	0.2105	
Valid driver license	-1.8919	***	-1.6318	***	-1.8785	***	-1.6292	***
Employed	0.0156		-0.1316		0.0049		-0.1428	
Street connectivity								
Low-medium	-0.0333		0.3459					
Medium-high	0.0015		-0.0228					
High	0.2726		0.1657					
Regional accessibility								
Low-medium	0.2025		0.3091		-0.0881		0.1131	
Medium-high	0.2875		0.3797		-0.0608		0.0950	
High	0.6707	**	1.0006	***	0.1938		0.6268	*
Local accessibility								
Low-medium	0.2942		0.0476					
Medium-high	0.3668		0.1845					
High	0.5745	**	0.4053					
Walkable neighborhood								
Walk Score					0.0209	***	0.0145	***
Sample size	3,588		3,588		3,588		3,588	
P-value of χ^2(goodness of fit)	1.20E-26		7.65E-46		2.29E-32		1.27E-49	
Street connectivity	0.5362		0.4051					
Regional accessibility	0.0811*		0.0066**		0.6137		0.1223	
Local accessibility	0.1863		0.5221					
Walk score					7.27E-07***		0.0026***	
Log-likelihood	-1,698.57		-2141.74		-1,690.95		-2,140.11	
McFadden adjusted R²	0.0375		0.0505		0.0446		0.0534	

Significance: * p < .1, ** p < .05, *** p < .01.

Table B-7 Tobit model for estimating individual daily driving distance

Dependent variable: Driving distance (mile)	Model I-13				Model I-14			
	Male heads		Female heads		Male heads		Female heads	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	-18.0243		-14.5657		-18.7408		-12.3164	
Household characteristics								
The number of children	1.6054		1.8315	*	1.6855		1.8605	*
HH income: \$0-\$49,999	-10.1872	***	-2.2212		-10.8447	***	-2.1598	
HH income: \$50,000-\$99,999	-2.2712		-2.7561		-2.3806		-2.7138	
Number of vehicles	0.7677		1.3077		0.7505		1.1902	
Head's characteristics								
Age	1.5000	***	1.0192	**	1.5259	***	1.0192	**
Square age	-0.0159	***	-0.0129	***	-0.0160	***	-0.0129	***
Hispanic	5.1737	*	-1.8328		4.9662	*	-1.9478	
African-American	-6.7043		-5.1596		-7.1904		-5.5254	
Valid driver license								
Employed	14.1886	***	12.0238	***	14.1164	***	12.0727	***
Street connectivity								
Low-medium	-3.3152		-0.5329					
Medium-high	-6.1739	**	-0.2225					
High	-2.5658		1.6705					
Regional accessibility								
Low-medium	-1.5830		-7.8827	***	-2.4776		-6.6461	***
Medium-high	-9.0748	***	-3.9413	*	-10.1594	***	-2.0275	
High	-9.6372	***	-10.2816	***	-10.2263	***	-7.5737	**
Local accessibility								
Low-medium	-8.0713	***	-0.8107					
Medium-high	-6.3578	**	-2.6162					
High	-7.9168	**	-1.9712					
Walkable neighborhood								
Walk Score					-0.1268	**	-0.0794	*
Sample size	3,431		3,194		3,431		3,194	
P-value of χ^2 (goodness of fit)	2.11E-30		3.58E-24		9.07E-31		4.20E-27	
Street connectivity	0.2362		0.8426					
Regional accessibility	0.0043***		0.0003***		0.0036***		0.0068***	
Local accessibility	0.0214**		0.7399					
Walk score					0.0165**		0.0596*	
Log-likelihood	-13,602.54		-11,051.33		-13,608.50		-11,050.53	
McFadden adjusted R²	0.0056		0.0054		0.0055		0.0059	

Significance: * p < .1, ** p < .05, *** p < .01.

Table B-8 Tobit model for estimating individual daily travel distance of automobile trip

Dependent variable: Automobile travel distance (mile)	Model I-15				Model I-16			
	Male heads		Female heads		Male heads		Female heads	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	-48.6233	***	-21.2844		-48.1848	***	-19.8865	
Household characteristics								
The number of children	1.1665		1.5511		1.2553		1.6520	
HH income: \$0-\$49,999	-10.8188	***	-10.1260	***	-11.2116	***	-10.2090	***
HH income: \$50,000-\$99,999	-1.5548		-5.0697	**	-1.6014		-5.0491	**
Number of vehicles	1.4673		0.5229		1.3144		0.3802	
Head's characteristics								
Age	0.9957	*	0.7936		0.9751	*	0.8054	
Square age	-0.0116	**	-0.0092	*	-0.0114	**	-0.0093	*
Hispanic	4.6250	*	-1.5885		4.4060	*	-1.6766	
African-American	-9.0152	*	-9.1087	*	-9.4769	**	-9.3800	*
Valid driver license	54.9050	***	30.6406	***	55.0772	***	30.4384	***
Employed	10.7533	***	10.4569	***	10.7587	***	10.5057	***
Street connectivity								
Low-medium	-6.0049	**	-4.0479					
Medium-high	-8.6970	***	-4.1261					
High	-4.6143		-0.3349					
Regional accessibility								
Low-medium	-4.6361	*	-7.3915	***	-5.3172	*	-6.7143	**
Medium-high	-9.6784	***	-6.8685	**	-10.4559	***	-5.5592	*
High	-13.0499	***	-13.8793	***	-12.7660	***	-11.7021	***
Local accessibility								
Low-medium	-7.3102	***	-3.4721					
Medium-high	-2.5033		-1.9124					
High	-4.2275		-3.9276					
Walkable neighborhood								
Walk Score					-0.1263	**	-0.1142	**
Sample size	3,588		3,588		3,588		3,588	
P-value of χ^2(goodness of fit)	3.79E-59		5.74E-53		1.76E-59		9.31E-56	
Street connectivity	0.0221**		0.2429					
Regional accessibility	0.0007***		0.0005***		0.0017***		0.0092***	
Local accessibility	0.0560*		0.5225					
Walk score					0.0139**		0.0229**	
Log-likelihood	-15,005.16		-14,598.23		-15,012.35		-14,599.31	
McFadden adjusted R²	0.0097		0.0090		0.0096		0.0092	

Significance: * p < .1, ** p < .05, *** p < .01.

Table B-9 Tobit model for estimating individual daily VMT per capita

Dependent variable: VMT (mile)	Model I-17				Model I-18			
	Male heads		Female heads		Male heads		Female heads	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	-31.2611	***	-13.2926		-31.4219	***	-12.2201	
Household characteristics								
The number of children	-0.5435		-1.1766	*	-0.4990		-1.1179	*
HH income: \$0-\$49,999	-6.4753	***	-4.7975	**	-6.8294	***	-4.8522	***
HH income: \$50,000-\$99,999	-0.4861		-2.1791		-0.5259		-2.1742	
Number of vehicles	1.6672	**	0.6311		1.6217	**	0.5354	
Head's characteristics								
Age	0.5315		0.4688		0.5255		0.4771	
Square age	-0.0069	**	-0.0059	*	-0.0068	**	-0.0060	*
Hispanic	4.2053	**	-1.3775		4.0991	**	-1.4523	
African-American	-4.1820		-4.8266	*	-4.4824		-5.0580	*
Valid driver license	37.8734	***	19.5746	***	38.0950	***	19.5468	***
Employed	10.3964	***	9.2355	***	10.3774	***	9.2658	***
Street connectivity								
Low-medium	-2.6527		-2.2472					
Medium-high	-5.4788	***	-2.1017					
High	-2.6114		0.1953					
Regional accessibility								
Low-medium	-2.9668	*	-4.5198	***	-3.5853	**	-3.9531	**
Medium-high	-6.9751	***	-3.9687	**	-7.8059	***	-2.9426	*
High	-9.2161	***	-8.4346	***	-9.7066	***	-6.8699	***
Local accessibility								
Low-medium	-4.8240	***	-1.4232					
Medium-high	-2.3695		-1.8765					
High	-4.0518	*	-2.3970					
Walkable neighborhood								
Walk Score					-0.0774	**	-0.0736	**
Sample size	3,588		3,588		3,588		3,588	
P-value of χ^2(goodness of fit)	5.15E-74		2.53E-76		1.55E-74		8.34E-80	
Street connectivity	0.0449**		0.2402					
Regional accessibility	0.0001***		0.0002***		0.0001***		0.0063***	
Local accessibility	0.0458**		0.5752					
Walk score					0.0210**		0.0106**	
Log-likelihood	-13,894.59		-13,176.65		-13,901.78		-13,176.88	
McFadden adjusted R²	0.0130		0.0141		0.0128		0.0145	

Significance: * p < .1, ** p < .05, *** p < .01.

Table B-10 Negative binomial model for estimating gendered inequality in daily trip frequencies for all modes and walking

Dependent variable: Gendered inequality	All modes				Walking			
	Model II-1		Model II-2		Model II-3		Model II-4	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	0.2921		0.2898		0.7769	*	0.8721	*
Household characteristics								
The number of children	0.0971	***	0.0967	***	0.0200		0.0174	
HH income: \$0-\$49,999	-0.0308		-0.0263		0.3014	***	0.3196	***
HH income: \$50,000-\$99,999	-0.0094		-0.0085		0.0638		0.0806	
Number of vehicles	-0.0192		-0.0196		0.0454		0.0374	
Male head's characteristics								
Age	-0.0012		-0.0009		-0.0127		-0.0135	
Square age	0.0000		0.0000		0.0001		0.0002	
Hispanic	0.0651		0.0690		0.1662		0.1801	*
African-American	0.0976		0.0941		0.0769		0.0528	
Valid driver license	-0.2462	**	-0.2489	**	0.1814	*	0.1843	*
Employed	-0.0269		-0.0277		0.0600		0.0676	
Female head's characteristics								
Age	0.0373	**	0.0374	**	-0.0025		-0.0034	
Square age	-0.0004	**	-0.0004	**	0.0000		0.0000	
Hispanic	-0.0926		-0.0931		-0.1119		-0.1211	
African-American	0.1959		0.2063		0.0786		0.0953	
Valid driver license	0.0065		0.0021		-0.1669	*	-0.1755	*
Employed	-0.1469	***	-0.1481	***	-0.0355		-0.0385	
Street connectivity								
Low-medium	0.0136				0.1189			
Medium-high	0.0569				0.0977			
High	0.0568				0.0625			
Regional accessibility								
Low-medium	0.0662		0.0763		-0.0525		0.0067	
Medium-high	-0.0127		0.0045		-0.0387		0.0143	
High	0.0498		0.0718		-0.0433		0.0384	
Local accessibility								
Low-medium	0.0092				0.0240			
Medium-high	0.0573				0.1532			
High	0.0417				0.1826	*		
Walkable neighborhood								
Walk Score			0.0008				0.0012	
Sample size	3,174		3,174		711		711	
P-value of χ^2(goodness of fit)	5.68E-10		4.49E-11		2.75E-06		1.72E-06	
Street connectivity	0.7081				0.5692		0.9809	
Regional accessibility	0.3722		0.3464		0.9621			
Local accessibility	0.7430				0.1925			
Walk score			0.4337				0.4681	
Log-likelihood	-6,501.81		-6,503.33		-1,324.00		-1,327.52	
McFadden adjusted R²	0.0034		0.0039		0.0077		0.0088	

Significance: * p < .1, ** p < .05, *** p < .01.

Table B-11 Negative binomial model for estimating gendered inequality in daily driving trip frequency and in daily automobile trip frequency

Dependent variable: Gendered inequality	Driving				Automobile			
	Model II-5		Model II-6		Model II-7		Model II-8	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	0.9723	***	1.0378	***	-0.0709		-0.0636	
Household characteristics								
The number of children	0.0624	***	0.0634	***	0.1025	***	0.1039	***
HH income: \$0-\$49,999	-0.0258		-0.0183		0.0216		0.0310	
HH income: \$50,000-\$99,999	-0.0281		-0.0249		0.0133		0.0175	
Number of vehicles	-0.0610	***	-0.0643	***	-0.0159		-0.0175	
Male head's characteristics								
Age	0.0135		0.0120		-0.0038		-0.0046	
Square age	-0.0001		-0.0001		0.0000		0.0000	
Hispanic	-0.0507		-0.0512		0.0062		0.0082	
African-American	0.0089		0.0102		0.0530		0.0592	
Valid driver license	-0.1327		-0.1401		-0.1025		-0.1091	
Employed	-0.0905	**	-0.0894	**	-0.0286		-0.0282	
Female head's characteristics								
Age	0.0149		0.0153		0.0442	**	0.0453	**
Square age	-0.0001		-0.0001		-0.0005	**	-0.0005	***
Hispanic	0.0077		0.0081		-0.0785		-0.0751	
African-American	0.0752		0.0779		0.1099		0.1204	
Valid driver license	-0.1057	*	-0.1139	*	0.1219		0.1173	
Employed	-0.1368	***	-0.1331	***	-0.1521	***	-0.1519	***
Street connectivity								
Low-medium	-0.0575		0.0599		-0.0413			
Medium-high	-0.0485		0.0284		0.0202			
High	-0.0508		0.0616		-0.0207			
Regional accessibility								
Low-medium	0.0420				0.0976	*	0.1084	**
Medium-high	0.0047				-0.0204		-0.0047	
High	0.0190				0.0317		0.0485	
Local accessibility								
Low-medium	-0.0305				0.0164			
Medium-high	0.0667				0.0864			
High	0.0329				0.0116			
Walkable neighborhood								
Walk Score			-0.0010				2.12E-05	
Sample size	2,966		2,966		3019		3019	
P-value of χ^2 (goodness of fit)	1.01E-09		2.43E-10		6.07E-08		1.16E-08	
Street connectivity	0.4690		0.4629		0.7020			
Regional accessibility	0.6920				0.1023		0.0948*	
Local accessibility	0.1232				0.3803			
Walk score			0.1664				0.9832	
Log-likelihood	-6,403.42		-6,406.28		-5986.63		-5988.8870	
McFadden adjusted R²	0.0033		0.0036		0.0026		0.0031	

Significance: * p < .1, ** p < .05, *** p < .01.

Table B-12 Tobit model for estimating gendered inequality in daily travel distances for all modes and walking

Dependent variable: Gendered inequality in travel distance (mile)	All modes				Walking			
	Model II-9		Model II-10		Model II-11		Model II-12	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	4.0039		7.3739		2.1455	*	2.3099	**
Household characteristics								
The number of children	-1.6270	**	-1.6445	**	0.0223		0.0172	
HH income: \$0-\$49,999	-2.9323		-2.6006		0.0984		0.1159	
HH income: \$50,000-\$99,999	-0.1648		-0.0044		0.1311		0.1441	
Number of vehicles	0.9698		0.8105		0.1459		0.1591	
Male head's characteristics								
Age	-0.5241		-0.5311		-0.0701		-0.0756	
Square age	0.0056		0.0055		0.0007		0.0007	
Hispanic	4.6301	**	4.5210	**	-0.1341		-0.0808	
African-American	1.4473		1.3503		0.4004		0.4340	
Valid driver license	2.4143		2.2110		0.0994		0.1193	
Employed	4.9600	***	4.9482	***	0.0970		0.0873	
Female head's characteristics								
Age	1.3222	**	1.3234	**	0.0121		0.0160	
Square age	-0.0159	***	-0.0160	***	-0.0001		-0.0001	
Hispanic	-0.5526		-0.6639		0.3063		0.2887	
African-American	5.3469		4.9982		0.1721		0.1206	
Valid driver license	2.4287		2.3642		-0.4105	*	-0.4101	*
Employed	0.1466		0.2993		-0.1079		-0.1014	
Street connectivity								
Low-medium	0.2917				0.3409			
Medium-high	-1.3238				-0.0225			
High	0.0327				0.0576			
Regional accessibility								
Low-medium	-6.2030	***	-4.5710	**	-0.1923		-0.0917	
Medium-high	-9.1063	***	-6.9593	***	0.0234		0.1056	
High	-11.4965	***	-8.5707	***	-0.0831		-0.0476	
Local accessibility								
Low-medium	0.1663				0.0681			
Medium-high	-0.8683				0.0281			
High	-0.0522				-0.1755			
Walkable neighborhood								
Walk Score			-0.0822	**			-0.0026	
Sample size	3,174		3,174		711		711	
P-value of χ^2(goodness of fit)	2.29E-15		3.71E-18		0.5493		0.5788	
Street connectivity	0.8390				0.2618			
Regional accessibility	9.58E-07***		0.0017***		0.7265		0.7774	
Local accessibility	0.9469				0.6698			
Walk score			0.0157***				0.5364	
Log-likelihood	-14,583.27		-14,580.99		-1,336.2840		-1,338.9610	
McFadden adjusted R²	0.0026		0.0031		-0.0098		-0.0081	

Significance: * p < .1, ** p < .05, *** p < .01.

Table B-13a Tobit model for estimating gendered inequality in daily driving and automobile travel distance

Dependent variable: Gendered inequality in travel distance (mile)	Driving				Automobile			
	Model II-13		Model II-14		Model II-15		Model II-16	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	28.0000	*	31.7700	**	4.1864		7.3193	
Household characteristics								
The number of children	-2.0770	**	-2.0090	**	-2.0733	***	-2.1009	***
HH income: \$0-\$49,999	-6.8530	**	-6.7100	**	-2.9316		-2.6713	
HH income: \$50,000-\$99,999	-2.0340		-1.8690		-0.0693		0.0911	
Number of vehicles	-0.1650		-0.3747		0.9563		0.8233	
Male head's characteristics								
Age	0.9666		0.9231		-0.3463		-0.3497	
Square age	-0.0108		-0.0105		0.0034		0.0033	
Hispanic	4.1990		3.9670		5.5952	**	5.4794	**
African-American	0.6867		0.6718		4.2902		4.0949	
Valid driver license	2.7420		2.8040		1.0229		0.8804	
Employed	1.2190		1.1680		5.6036	***	5.5896	***
Female head's characteristics								
Age	-0.0571		-0.0449		1.2360	*	1.2369	*
Square age	0.0009		0.0007		-0.0150	**	-0.0150	**
Hispanic	-0.8933		-0.9847		-1.2451		-1.3274	
African-American	-1.1510		-1.7680		-0.8349		-1.1653	
Valid driver license	-0.7134		-0.9241		2.3595		2.2923	
Employed	-3.9490	**	-3.6990	**	-0.2096		-0.0494	
Street connectivity								
Low-medium	-3.2390				0.9589			
Medium-high	-5.6270	**			-1.3670			
High	-3.2670				-0.3725			
Regional accessibility								
Low-medium	-6.5070	***	-5.2050	**	-5.1510	***	-3.6393	*
Medium-high	-9.3060	***	-7.5800	***	-8.2749	***	-6.3745	***
High	-14.1500	***	-10.9800	***	-10.9605	***	-8.2821	***
Local accessibility								
Low-medium	-3.1570				-0.5643			
Medium-high	-1.9980				-1.5088			
High	-1.5330				-0.3857			
Walkable neighborhood								
Walk Score			-0.1485	***			-0.0851	**
Sample size	2,966		2,966		3,019		3,019	
P-value of χ^2(goodness of fit)	4.25E-09		3.92E-11		9.06E-15		2.28E-17	
Street connectivity	0.1874				0.7097			
Regional accessibility	3.55E-05***		0.0059***		1.42E-05***		0.0050***	
Local accessibility	0.6202				0.8850			
Walk score			0.0010***				0.0153**	
Log-likelihood	-15467.7200		-15466.4000		-13,852.74		-13,850.89	
McFadden adjusted R²	0.0013		0.0017		0.0026		0.0031	

Significance: * p < .1, ** p < .05, *** p < .01.

Table B-13a Tobit model for estimating gendered inequality in daily VMT

Dependent variable: Gendered inequality in travel distance (mile)	VMT			
	Model II-17		Model II-18	
	Coefficient	Sig.	Coefficient	Sig.
Intercept	2.0371		3.5731	
Household characteristics				
The number of children	-2.2673	***	-2.2678	***
HH income: \$0-\$49,999	-1.8783		-1.8381	
HH income: \$50,000-\$99,999	0.2356		0.3099	
Number of vehicles	0.9771		0.9144	
Male head's characteristics				
Age	-0.4745		-0.4814	
Square age	0.0042		0.0042	
Hispanic	4.4292	**	4.3367	**
African-American	4.3481		4.2708	
Valid driver license	4.6699		4.6452	
Employed	5.5934	***	5.5760	***
Female head's characteristics				
Age	1.1737	**	1.1829	**
Square age	-0.0138	***	-0.0139	***
Hispanic	-0.4115		-0.4463	
African-American	-0.5560		-0.8462	
Valid driver license	1.9160		1.8804	
Employed	-0.1975		-0.1037	
Street connectivity				
Low-medium	0.3057			
Medium-high	-1.5031			
High	-0.6378			
Regional accessibility				
Low-medium	-3.1133	**	-2.4219	
Medium-high	-6.0432	***	-5.2066	***
High	-9.2415	***	-7.9840	***
Local accessibility				
Low-medium	-1.1988			
Medium-high	-1.8028			
High	-1.3948			
Walkable neighborhood				
Walk Score			-0.0626	**
Sample size	3,019		3,019	
P-value of χ^2(goodness of fit)	2.43E-19		9.67E-22	
Street connectivity	0.7214			
Regional accessibility	1.53E-05***		0.0008***	
Local accessibility	0.7295			
Walk score			0.0300**	
Log-likelihood	-13,337.80		-13,337.04	
McFadden adjusted R²	0.0036		0.0041	

Significance: * p < .1, ** p < .05, *** p < .01.

Appendix C: Estimation Results for Male and Female Heads' Travel Behaviors based on the PSM Data for Households with No Artificial Zero Gaps

In order to understand whether gendered inequality could be attributed to any particular subgroups and the influences of built environments on subgroups, I analyzed male and female heads' daily travel behaviors based on the PSM data for households with no artificial zero gaps. Tables C-1 to C-4 document the estimations of male and female head's daily trip frequency by all modes, walking, driving, and automobile travel. The goodness-of-fit tests suggest the estimations are favorable except for the models that estimated male head's driving trip frequency. The most significant socio-demographic variable is the number of children, which suggests 10-24% of increase in female head's trip frequency as the number of children increases one unit. The effects of the built environments are very limited. Only the estimation of male head's daily trip frequency of all modes show moderate significance of walk score.

Tables C-5 to C-9 provide the analyses of male and female head's daily travel distance by all modes, walking, driving, and automobile travel based on the PSM data. The goodness-of-fit tests and McFadden R^2 identify that the estimation models fit the data except the models that estimated female head's walking distance. In general, the possession of driver license and being employed positively influence on travel distance by all modes, driving, and automobile to various extents, but the covariates show negative impacts on walk distance. Regional accessibility and walk score consistently show significances to travel distance by all modes, driving, automobile and VMT. The magnitudes of the estimated coefficients suggest that regional accessibility has slightly greater impacts on male head's overall travel distance than on female head; however, the significant levels of the estimated coefficients show built environment

may more influential to female head's driving and automobile travel distance. Overall, it is difficult to assert that gendered inequality is attributed to male or female heads.

Table C-1 Negative binomial model for estimating individual daily trip frequency of all modes based on the PSM data for households with no artificial zero gaps

Dependent variable: Trip frequency of all modes of ground transportation	Model I-1				Model I-2			
	Male heads		Female heads		Male heads		Female heads	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	0.8531	***	0.1647		0.7899	***	0.1669	
Household characteristics								
The number of children	0.0344	*	0.1254	***	0.0348	*	0.1252	***
HH income: \$0-\$49,999	-0.0760		0.0336		-0.0822		0.0328	
HH income: \$50,000-\$99,999	-0.0178		-0.0032		-0.0213		-0.0028	
Number of vehicles	-0.0597	**	-0.0212		-0.0564	**	-0.0217	
Head's characteristics								
Age	0.0275	***	0.0410	***	0.0267	**	0.0410	***
Square age	-0.0003	***	-0.0004	***	-0.0003	***	-0.0004	***
Hispanic	-0.0851	*	-0.0142		-0.0757		-0.0194	
African-American	-0.0415		-0.2038	*	-0.0250		-0.2120	**
Valid driver license	-0.0717		0.2022	***	-0.0595		0.2047	***
Employed	0.0458		-0.0010		0.0391		-0.0001	
Street connectivity								
Low-medium	0.0353		0.0677					
Medium-high	-0.0429		0.0535					
High	0.0481		0.0496					
Regional accessibility								
Low-medium	0.0083		-0.0052		-0.0278		0.0016	
Medium-high	-0.0377		0.0312		-0.0759		0.0384	
High	0.0159		0.0704		-0.0362		0.0859	
Local accessibility								
Low-medium	-0.0614		-0.0330					
Medium-high	0.0849		-0.0502					
High	0.0578		0.0099					
Walkable neighborhood								
Walk Score					0.0023	**	0.0002	
Sample size	1,537		1,537		1,537		1,537	
Treated units	860		860		860		860	
Control units	677		677		677		677	
P-value of χ^2(goodness of fit)	0.0043		1.76E-10		0.0046		8.18E-12	
Street connectivity	0.3068		0.7193					
Regional accessibility	0.7206		0.5676		0.6427		0.4882	
Local accessibility	0.0635*		0.6146					
Walk score					0.0308**		0.8392	
Log-likelihood	-3,603.75		-3,659.67		-3,607.53		-3,661.16	
McFadden adjusted R²	0.0002		0.0065		0.0005		0.0074	

Significance: * p < .1, ** p < .05, *** p < .01.

Table C-2 Negative binomial model for estimating individual daily walking trip frequency based on the PSM data for households with no artificial zero gaps

Dependent variable: Walking trip frequency	Model I-3				Model I-4			
	Male heads		Female heads		Male heads		Female heads	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	2.3400	**	1.8140	***	2.1070	**	1.8109	***
Household characteristics								
The number of children	-0.0233		0.0399		-0.0209		0.0354	
HH income: \$0-\$49,999	-0.0925		0.3540	**	-0.1031		0.3611	**
HH income: \$50,000-\$99,999	-0.0066		0.0437		-0.0253		0.0643	
Number of vehicles	-0.1627	*	0.0368		-0.1695	*	0.0295	
Head's characteristics								
Age	-0.0066		-0.0449	*	0.0011		-0.0452	*
Square age	2.74E-05		0.0004		0.0000		0.0004	
Hispanic	-0.7020	***	0.0251		-0.6903	***	0.0373	
African-American	-0.2855		0.1493		-0.2539		0.1290	
Valid driver license	-1.0300	***	-0.2793	**	-1.0190	***	-0.2651	**
Employed	-0.2382		0.0227		-0.2605		0.0097	
Street connectivity								
Low-medium	0.1153		0.2514	*				
Medium-high	0.0756		0.2270					
High	0.2776		0.2036					
Regional accessibility								
Low-medium	-0.0526		0.0095		-0.0541		-0.0301	
Medium-high	-0.3377		0.1688		-0.3340		0.1172	
High	-0.0983		0.1718		-0.1267		0.1154	
Local accessibility								
Low-medium	0.0391		-0.2382					
Medium-high	0.0454		-0.2127					
High	0.0314		-0.1966					
Walkable neighborhood								
Walk Score					0.0036		0.0011	
Sample size	388		388		388		388	
Treated units	244		244		244		244	
Control units	144		144		144		144	
P-value of χ^2(goodness of fit)	1.77E-05		5.06E-05		1.46E-06		1.04E-05	
Street connectivity	0.4691		0.3828					
Regional accessibility	0.3049		0.4463		0.3284		0.6050	
Local accessibility	0.9977		0.5538					
Walk score					0.3642		0.7114	
Log-likelihood	-656.58		-773.69		-657.62		-775.77	
McFadden adjusted R²	0.0130		0.0092		0.0188		0.0129	

Significance: * p < .1, ** p < .05, *** p < .01.

Table C-3 Negative binomial model for estimating individual daily driving trip frequency based on the PSM data for households with no artificial zero gaps

Dependent variable: Driving trip frequency	Model I-5				Model I-6			
	Male heads		Female heads		Male heads		Female heads	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	0.9600	***	-0.0369		0.9316	***	0.0412	
Household characteristics								
The number of children	0.0238		0.2369	***	0.0243		0.2335	***
HH income: \$0-\$49,999	-0.1205		0.0990		-0.1414	*	0.1012	
HH income: \$50,000-\$99,999	-0.0860		0.0057		-0.1015	*	0.0219	
Number of vehicles	-0.0046		0.0927	**	-0.0098		0.0888	**
Head's characteristics								
Age	0.0164		0.0275		0.0166		0.0281	
Square age	-0.0002		-0.0003		-0.0002		-0.0003	
Hispanic	0.0051		-0.0579		0.0033		-0.0590	
African-American	-0.1184		0.0526		-0.1305		0.0498	
Valid driver license								
Employed	0.0167		0.0659		0.0098		0.0665	
Street connectivity								
Low-medium	-0.1013		0.0869					
Medium-high	-0.1154		0.1326					
High	-0.0152		0.0287					
Regional accessibility								
Low-medium	-0.0037		-0.0320		-0.0279		0.0270	
Medium-high	-0.0107		-0.0242		-0.0311		0.0393	
High	0.0158		-0.0869		-0.0129		0.0039	
Local accessibility								
Low-medium	-0.1060		-0.0225					
Medium-high	-0.0099		-0.1541					
High	-0.0762		-0.0631					
Walkable neighborhood								
Walk Score					-0.0006		-0.0024	
Sample size	1,330		1,170		1,330		1,170	
Treated units	751		645		751		645	
Control units	579		525		579		525	
P-value of χ^2 (goodness of fit)	0.2656		2.30E-08		0.4373		1.80E-09	
Street connectivity	0.2095		0.4392					
Regional accessibility	0.9792		0.8367		0.9712		0.9614	
Local accessibility	0.3587		0.3504					
Walk score					0.6666		0.1526	
Log-likelihood	-29,49.16		-2,559.85		-2,953.23		-2,561.68	
McFadden adjusted R²	-0.0025		0.0069		-0.0022		0.0081	

Significance: * p < .1, ** p < .05, *** p < .01.

Table C-4 Negative binomial model for estimating individual daily automobile trip frequency based on the PSM data for households with no artificial zero gaps

Dependent variable: Automobile trip frequency	Model I-7				Model I-8			
	Male heads		Female heads		Male heads		Female heads	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	-0.0777		-0.5199		-0.1395		-0.5155	
Household characteristics								
The number of children	0.0325		0.1093	***	0.0349	*	0.1092	***
HH income: \$0-\$49,999	-0.0453		-0.0528		-0.0552		-0.0525	
HH income: \$50,000-\$99,999	-0.0009		-0.0233		-0.0058		-0.0201	
Number of vehicles	0.0268		0.0245		0.0251		0.0233	
Head's characteristics								
Age	0.0137		0.0360	***	0.0141		0.0360	***
Square age	-0.0001		-0.0004	***	-0.0001		-0.0004	***
Hispanic	0.0014		-0.0067		-0.0034		-0.0066	
African-American	-0.0706		-0.1935	*	-0.0718		-0.1962	*
Valid driver license	0.9438	***	0.8856	***	0.9493	***	0.8881	***
Employed	0.0397		-0.0088		0.0346		-0.0076	
Street connectivity								
Low-medium	-0.0339		-0.0207					
Medium-high	-0.0710		0.0215					
High	0.0310		-0.0453					
Regional accessibility								
Low-medium	0.0647		0.0016		0.0431		0.0013	
Medium-high	0.0180		0.0956		-0.0014		0.0941	
High	0.0266		0.0307		0.0014		0.0392	
Local accessibility								
Low-medium	-0.0897		-0.0360					
Medium-high	-0.0282		-0.0571					
High	-0.0313		-0.0327					
Walkable neighborhood								
Walk Score					0.0003		-0.0009	
Sample size	1,413		1,413		1,413		1,413	
Treated units	799		799		799		799	
Control units	614		614		614		614	
P-value of χ^2 (goodness of fit)	7.60E-06		0.00E+00		3.43E-06		0.00E+00	
Street connectivity	0.2637		0.6796					
Regional accessibility	0.7378		0.3264		0.8298		0.3612	
Local accessibility	0.5626		0.8697					
Walk score					0.7726		0.4409	
Log-likelihood	-3,137.31		-3,148.40		-3,140.64		-3,149.34	
McFadden adjusted R²	0.0032		0.0209		0.0037		0.0221	

Significance: * p < .1, ** p < .05, *** p < .01.

Table C-5 Tobit model for estimating individual daily travel distance of all modes based on the PSM data for households with no artificial zero gaps

Dependent variable: Travel distance (mile) of all modes of ground transportation	Model I-9				Model I-10			
	Male heads		Female heads		Male heads		Female heads	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	22.2374		53.7249	***	25.8726		57.5257	***
Household characteristics								
The number of children	1.5751		1.5659		1.6057		1.6476	
HH income: \$0-\$49,999	-6.6494		-5.1809		-6.9737		-5.7745	
HH income: \$50,000-\$99,999	0.3907		-1.2907		0.2935		-1.6551	
Number of vehicles	0.9644		0.9973		0.7309		0.7412	
Head's characteristics								
Age	-0.0413		-1.1996		-0.1224		-1.1948	*
Square age	0.0018		0.0142	*	0.0026		0.0142	*
Hispanic	2.4906		1.9192		2.3793		1.4582	
African-American	-13.4869	**	-11.6004	*	-14.0277	**	-12.8148	**
Valid driver license	17.3157	***	7.3817	*	18.5235	***	7.3826	*
Employed	9.9873	***	9.8227	***	9.8776	***	10.0582	***
Street connectivity								
Low-medium	-5.8129		-7.4333	**				
Medium-high	-7.7435	*	-5.9663					
High	-5.8301		-3.6784					
Regional accessibility								
Low-medium	-14.4934	***	-13.6007	***	-13.2683	***	-11.3759	***
Medium-high	-17.2078	***	-11.9457	***	-15.3078	***	-8.5704	**
High	-16.2712	***	-15.5883	***	-12.6400	***	-10.0552	**
Local accessibility								
Low-medium	-9.9701	**	-8.2736	**				
Medium-high	-2.6809		-6.3569					
High	-4.2137		-5.7512					
Walkable neighborhood								
Walk Score					-0.2018	***	-0.2476	***
Sample size	1,537		1,537		1,537		1,537	
Treated units	860		860		860		860	
Control units	677		677		677		677	
P-value of χ^2(goodness of fit)	1.09E-13		1.96E-11		4.02E-15		8.04E-14	
Street connectivity	0.2863		0.2187					
Regional accessibility	0.0002***		0.0015***		0.0032***		0.0459**	
Local accessibility	0.0864*		0.2420					
Walk score					0.0046***		0.0004***	
Log-likelihood	-7,414.84		-7,235.61		-7,416.56		-7,234.48	
McFadden adjusted R²	0.0044		0.0037		0.0048		0.0045	

Significance: * p < .1, ** p < .05, *** p < .01.

Table C-6 Tobit model for estimating individual daily walking distance based on the PSM data for households with no artificial zero gaps

Dependent variable: Walking distance (mile)	Model I-11				Model I-12			
	Male heads		Female heads		Male heads		Female heads	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	2.9733	**	3.3784	*	2.3283		3.5826	*
Household characteristics								
The number of children	-0.1168		0.0985		-0.1165		0.0898	
HH income: \$0-\$49,999	-0.5466		0.2617		-0.5638	*	0.2216	
HH income: \$50,000-\$99,999	-0.1576		0.0178		-0.1717		-0.0226	
Number of vehicles	-0.2787	*	0.0550		-0.3094	**	0.0105	
Head's characteristics								
Age	0.0267		-0.1100		0.0398		-0.1093	
Square age	-0.0003		0.0012		-0.0004		0.0011	
Hispanic	-0.8212	***	0.1896		-0.7929	***	0.2164	
African-American	-0.2170		0.9441		-0.2715		0.9381	
Valid driver license	-1.6235	***	-0.5350		-1.5689	***	-0.4401	
Employed	-0.4197		-0.1530		-0.4432	*	-0.1534	
Street connectivity								
Low-medium	0.0997		0.5598					
Medium-high	0.2316		0.3278					
High	0.5462	*	0.5056					
Regional accessibility								
Low-medium	-0.3442		0.3094		-0.5033		0.2304	
Medium-high	-0.6157	*	0.4653		-0.7489	**	0.3642	
High	-0.4013		0.3814		-0.6231	*	0.2509	
Local accessibility								
Low-medium	-0.5368		-0.4745					
Medium-high	-0.3892		-0.8736	**				
High	-0.4837		-0.9370	**				
Walkable neighborhood								
Walk Score					0.0053		-0.0053	
Sample size	388		388		388		388	
Treated units	244		244		244		244	
Control units	144		144		144		144	
P-value of χ^2 (goodness of fit)	2.51E-07		0.1075		5.77E-08		0.1248	
Street connectivity	0.2359		0.4689					
Regional accessibility	0.3512		0.7509		0.2004		0.8651	
Local accessibility	0.5009		0.1326					
Walk score					0.3984		0.4970	
Log-likelihood	-521.33		-721.10		-524.13		-724.46	
McFadden adjusted R²	0.0264		-0.0076		0.0304		-0.0053	

Significance: * p < .1, ** p < .05, *** p < .01.

Table C-7 Tobit model for estimating individual daily driving distance based on the PSM data for households with no artificial zero gaps

Dependent variable: Driving distance (mile)	Model I-13				Model I-14			
	Male heads		Female heads		Male heads		Female heads	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	-5.6474		17.2300		-4.7383		20.3694	
Household characteristics								
The number of children	-0.6775		1.5500		-0.5513		1.6135	
HH income: \$0-\$49,999	-2.9250		2.5800		-3.5854		2.2084	
HH income: \$50,000-\$99,999	1.0308		-0.9223		0.9219		-1.0215	
Number of vehicles	3.4688	*	3.3140	**	3.3853	*	3.3011	**
Head's characteristics								
Age	1.1676		-0.1687		1.1783		-0.2220	
Square age	-0.0125	*	-0.0002		-0.0124	*	0.0004	
Hispanic	4.1471		0.0826		3.7903		-0.4469	
African-American	-8.1640		6.2920		-8.7880		5.2626	
Valid driver license								
Employed	9.7757	***	11.5900	***	9.7379	**	11.7349	***
Street connectivity								
Low-medium	-5.4644		-2.7050					
Medium-high	-5.5999		-1.4170					
High	-3.8438		-0.1279					
Regional accessibility								
Low-medium	-2.1037		-10.0600	***	-2.0472		-8.6593	**
Medium-high	-1.9884		-5.6940		-1.6762		-3.6817	
High	-4.3169		-11.5200	***	-3.3122		-7.9279	*
Local accessibility								
Low-medium	-7.6148	*	-4.9920					
Medium-high	-7.3665	*	-6.9410	*				
High	-9.1073	**	-2.8640					
Walkable neighborhood								
Walk Score					-0.1828	**	-0.1335	**
Sample size	1,330		1,170		1,330		1,170	
Treated units	751		645		751		645	
Control units	579		525		579		525	
P-value of χ^2(goodness of fit)	5.51E-05		3.50E-07		6.01E-06		1.18E-08	
Street connectivity	0.5273		0.8262					
Regional accessibility	0.8125		0.0105*		0.9227		0.0763*	
Local accessibility	0.2194		0.2359					
Walk score					0.0121**		0.0307**	
Log-likelihood	-5,898.40		-4,488.68		-5,899.74		-4,489.23	
McFadden adjusted R²	0.0013		0.0032		0.0019		0.0042	

Significance: * p < .1, ** p < .05, *** p < .01.

Table C-8 Tobit model for estimating individual daily automobile travel distance based on the PSM data for households with no artificial zero gaps

Dependent variable: Automobile travel distance (mile)	Model I-15				Model I-16			
	Male heads		Female heads		Male heads		Female heads	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	-19.6498		0.6809		-18.5927		2.4124	
Household characteristics								
The number of children	1.4515		-0.2997		1.5312		-0.2203	
HH income: \$0-\$49,999	-3.0079		-3.4443		-3.2615		-3.5251	
HH income: \$50,000-\$99,999	-0.6379		-1.8397		-0.6339		-1.9685	
Number of vehicles	3.8028	**	0.2846		3.6488	**	0.1124	
Head's characteristics	0.5394		0.3520					
Age					0.5406		0.3948	
Square age	-0.0062		-0.0050		-0.0062		-0.0054	
Hispanic	2.3420		0.3950		2.0325		-0.1829	
African-American	-8.9013	*	-7.4942		-9.3796	*	-8.5526	
Valid driver license	26.8702	***	26.0791	***	26.9599	***	26.2278	***
Employed	10.9741	***	4.5729	*	10.8933	***	4.6946	*
Street connectivity								
Low-medium	-1.0988		-0.6822					
Medium-high	-3.9825		-1.4460					
High	-0.7475		1.9782					
Regional accessibility								
Low-medium	-1.7445		-8.6985	**	-0.7985		-6.3795	*
Medium-high	-5.6022		-6.2881	*	-4.4255		-3.1916	
High	-8.0719	**	-11.5167	***	-6.3877		-7.4058	*
Local accessibility								
Low-medium	-3.5120		-2.2423					
Medium-high	-1.7723		-3.1691					
High	-1.8554		-1.6540					
Walkable neighborhood								
Walk Score					-0.0789		-0.1070	*
Sample size	1,413		1,413		1,413		1,413	
Treated units	799		799		799		799	
Control units	614		614		614		614	
P-value of χ^2(goodness of fit)	2.45E-10		7.53E-12		5.65E-12		6.25E-14	
Street connectivity	0.6366		0.7173					
Regional accessibility	0.1286		0.0276*		0.3009		0.2408	
Local accessibility	0.8290		0.8570					
Walk score					0.2077		0.0984*	
Log-likelihood	-6,484.57		-6,276.25		-6,485.22		-6,276.00	
McFadden adjusted R²	0.0036		0.0044		0.0043		0.0052	

Significance: * p < .1, ** p < .05, *** p < .01.

Table C-9 Tobit model for estimating individual daily automobile travel distance based on the PSM data for households with no artificial zero gaps

Dependent variable: Automobile travel distance (mile)	Model I-17				Model I-18			
	Male heads		Female heads		Male heads		Female heads	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	-16.7774		5.8321		-15.7075		6.8879	
Household characteristics								
The number of children	-0.7271		-2.5451	***	-0.7077		-2.4859	***
HH income: \$0-\$49,999	-2.1804		-1.2007		-2.1520		-1.2199	
HH income: \$50,000-\$99,999	-0.9971		-0.6852		-0.8039		-0.7844	
Number of vehicles	3.3013	***	0.6961		3.2063	***	0.5803	
Head's characteristics								
Age	0.3549		-0.0139		0.3553		0.0223	
Square age	-0.0042		-0.0013		-0.0042		-0.0016	
Hispanic	3.2218		-0.0108		3.1058		-0.4222	
African-American	-3.5571		-3.0944		-3.7989		-3.8361	
Valid driver license	20.5386	***	16.2432	***	20.7144	***	16.3895	***
Employed	10.9678	***	6.6169	***	10.9579	***	6.6927	***
Street connectivity								
Low-medium	1.1558		-0.8712					
Medium-high	-2.3006		0.4441					
High	-0.8600		1.3997					
Regional accessibility								
Low-medium	-0.2430		-5.5601	***	0.4062		-3.9141	*
Medium-high	-3.3640		-3.6559	.	-2.7511		-1.3986	
High	-5.1998	*	-7.5249	***	-4.4467		-4.3085	*
Local accessibility								
Low-medium	-3.0147		-2.0142					
Medium-high	-1.7117		-3.1656					
High	-3.2945		-1.4112					
Walkable neighborhood								
Walk Score					-0.0689		-0.0801	**
Sample size	1,413		1,413		1,413		1,413	
Treated units	799		799		799		799	
Control units	614		614		614		614	
P-value of χ^2(goodness of fit)	4.34E-15		3.03E-26		8.08E-17		5.02E-29	
Street connectivity	0.4943		0.6847					
Regional accessibility	0.1079		0.0055***		0.1681		0.1388	
Local accessibility	0.5605		0.4725					
Walk score					0.1116		0.0286**	
Log-likelihood	-6,027.96		-5,600.60		-6,029.0890		-5,600.1920	
McFadden adjusted R²	0.0060		0.0116		0.0067		0.0125	

Significance: * p < .1, ** p < .05, *** p < .01.

Appendix D: Regression Results Based on the Matched Data of Treatments 1 and 2

This appendix aims at the comparative analyses for the matched data of Treatment 3, which assigns the households living in walkable neighborhoods to the treated group. For comparative purpose, the appendix summarizes the regression results of the individual travel behaviors and gendered inequality in paired heads' travel patterns based on the matched data of Treatments 1 and 2. Recall that Treatment 1 represents the households living within 0.25 miles of any transit stop, and Treatment 2 is designated to the households that resided in the block groups with more than 50% of single-family residential use.

The subsections below will focus on whether built environments still explain for individual travel behaviors and gendered inequality when residential selection is taken into account; the discussion subsection will compare the estimation results based on the matched samples of the three treatments. Data and the PSM technique used for generating the matched treated and control units are documented in Appendix A of the chapter. Methodologies in the analysis sections of the chapter describe the regression models for analyzing the travel patterns in detail.

Individual Travel Behaviors for Paired Household Heads in Los Angeles

The subsection briefly depicts how built environments affect the male and female heads' daily travel behaviors. Negative binomial and Tobit models were adopted to analyze individual trip frequency and travel distance, respectively. Tables D-1 to D-4 present the estimated coefficients of the socio-demographic and built environment variables on heads' daily trip frequencies by all

modes of ground transportation, walking, driving, and automobile travel. The results suggest that walk score is significantly associated with individual trip frequencies by all modes and walking whereas other built environment measures do not show any noticeable and clear relationships with trip frequencies.

For the matched data of Treatment 1, the increasing walking score is positively associated with male head's daily trip frequency; one unit increase in walk score leads to 1.7% and 1.1% of increases in male and female heads' walking frequencies, respectively. The estimation based on the matched data of Treatment 2 reveals that one unit increase in walk score rises male and female heads' walking frequencies by 1.1% and 0.9%, respectively. It is further implied that the surrounding walking environment has greater influences on male head than on female head.

The increasing built environment measures discourage the travel distance of all modes, driving, automobile, and VMT, but encourage individual's daily walking distance (Tables D-5 to D-9). However, there is no particular trend that illustrates how travel distance vary along with built environments; for example, high street connectivity does not guarantee the greatest reduction on individual daily travel distance. The estimation results also identify that built environments have greater impacts on male heads' travel distance than female. Street connectivity, regional accessibility, and local accessibility on average present greater significances and estimated coefficients on reducing male head's travel distances of all modes, automobile, and VMT. One unit increase in walk score leads male head to have 0.02 mile greater walking distance but increases female head's walking distance by 0.01 mile.

Gendered Inequality for Paired Household Heads' Travel Behaviors in Los Angeles

Gendered inequalities in terms of trip frequency and travel distance were analyzed based on negative binomial and Tobit models. For households with no artificial zeros, Tables D-10 to D-13 present the estimations on the gendered inequality of trip frequencies by all modes, walking, driving, and automobile, respectively. Built environments are not very significant to account for gendered inequality. Walk score is only found to be negatively associated with the gendered inequality in driving frequency and regional accessibility has positive association with the gendered inequality in automobile trip frequency; the influences are moderate. Note that the model for estimating gendered inequality in walking trips does not show good fit according to the negative values of McFadden R^2 .

The estimations on gendered inequality in travel distance are exhibited in Tables D-14 to D-18. The p-values of χ^2 and McFadden R^2 suggest that the models perform good fits except the models for walking distance. Street connectivity and local accessibility have no significant influences. Regional accessibility and walk score have significantly positive associations with the equalities in travel distances of all modes, driving, automobile travel, and VMT. In particular, it is observed that the gendered inequality decreases along with increasing regional accessibility.

Discussion

The appendix is expected to concisely provide comparisons among the matched samples based on Treatments 1, 2, and 3. Several comparable facts are identified. First, results exhibit that built environments remain significant impacts when self-selection is taken into account. Especially, regional accessibility and walk score are regarded as the most significant factors that explain for

individual travel behaviors and gendered inequality among the four built environment variables of interests in the chapter. Second, it is implied that male and female heads are likely respond to the built environment differently. For example, walk score consistently show greater impacts on male's travel behavior than on female. Different from Treatment 3, street connectivity and local accessibility are found to be significant to various extents based on the matched samples of Treatment 1 and 2. In short, analyses in the appendix provide the evidences to support the conclusions that are drawn in the chapter; however, influences of street connectivity and local accessibility may not be able to universally account for travel behavior and gendered inequality.

Table D-1a Negative binomial model for estimating individual daily trip frequency of all modes based on the Treatment 1 PSM data

Dependent variable: Trip frequency of all modes of ground transportation	Treatment 1 matched data							
	Model I-1				Model I-2			
	Male heads		Female heads		Male heads		Female heads	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	0.1865		0.0946		0.1119		0.0675	
Household characteristics								
The number of children	0.0698	***	0.1490	***	0.0698	***	0.1472	***
HH income: \$0-\$49,999	-0.1355	**	-0.0656		-0.1434	**	-0.0720	
HH income: \$50,000-\$99,999	-0.0558		-0.0828	*	-0.0612		-0.0844	**
Number of vehicles	-0.0595	***	-0.0364	*	-0.0580	***	-0.0350	
Head's characteristics								
Age	0.0342	***	0.0434	***	0.0342	***	0.0439	***
Square age	-0.0004	***	-0.0005	***	-0.0004	***	-0.0005	***
Hispanic	-0.0295		-0.0487		-0.0245		-0.0492	
African-American	-0.0584		-0.0595		-0.0532		-0.0649	
Valid driver license	0.3147	***	0.2020	***	0.3198	***	0.2006	***
Employed	0.0709		0.0817	**	0.0696		0.0784	**
Street connectivity								
Low-medium	-0.0177		0.0680					
Medium-high	-0.0090		0.0509					
High	0.0342		0.0609					
Regional accessibility								
Low-medium	0.1081	**	0.0018		0.0724		-0.0073	
Medium-high	0.0461		0.0461		0.0029		0.0334	
High	0.0810		0.0833		0.0376		0.0704	
Local accessibility								
Low-medium	-0.0664		-0.0633					
Medium-high	0.0402		-0.0504					
High	0.0365		-0.0228					
Walkable neighborhood								
Walk Score					0.0018	**	0.0006	
Sample size	3073		3073		3073		3073	
Treated units	2283		2283		2283		2283	
Control units	790		790		790		790	
P-value of χ^2 (goodness of fit)	1.22E-15		0.00E+00		0.00E+00		0.00E+00	
Street connectivity	0.7620		0.4809					
Regional accessibility	0.1055		0.4329		0.3171		0.5474	
Local accessibility	0.1107		0.5353					
Walk score					0.0360**		0.4685	
Log-likelihood	-7067.97		-7230.04		-7069.84		-7231.84	
McFadden adjusted R²	0.0054		0.0091		0.0058		0.0096	

Significance: * p < .1, ** p < .05, *** p < .01.

Table D-1b Negative binomial model for estimating individual daily trip frequency of all modes based on the Treatment 2 PSM data

Dependent variable: Trip frequency of all modes of ground transportation	Treatment 2 matched data							
	Model I-1				Model I-2			
	Male heads		Female heads		Male heads		Female heads	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-0.0007		-0.5361		-0.0796		-0.5665	
Household characteristics								
The number of children	0.0732	***	0.1756	***	0.0742	***	0.1751	***
HH income: \$0-\$49,999	-0.1167	*	-0.0694		-0.1281	*	-0.0818	
HH income: \$50,000-\$99,999	-0.0265		-0.0839	*	-0.0316		-0.0873	*
Number of vehicles	-0.0413	*	-0.0193		-0.0385	*	-0.0180	
Head's characteristics								
Age	0.0424	***	0.0621	***	0.0421	***	0.0624	***
Square age	-0.0004	***	-0.0006	***	-0.0004	***	-0.0006	***
Hispanic	-0.0110		-0.0226		-0.0057		-0.0219	
African-American	0.0295		-0.0925		0.0257		-0.1097	
Valid driver license	0.2419		0.2789	***	0.2445		0.2818	***
Employed	0.0311		0.0387		0.0332		0.0385	
Street connectivity								
Low-medium	-0.0338		0.0608					
Medium-high	0.0060		0.0155					
High	0.0247		0.0428					
Regional accessibility								
Low-medium	0.1134	**	0.0174		0.0719		0.0010	
Medium-high	0.0643		0.0471		0.0140		0.0229	
High	0.0817		0.0955		0.0338		0.0777	
Local accessibility								
Low-medium	-0.1109	**	-0.0861	*				
Medium-high	-0.0064		-0.0707					
High	-0.0012		-0.0118					
Walkable neighborhood								
Walk Score					0.0014		0.0004	
Sample size	2383		2383		2383		2383	
Treated units	1437		1437		1437		1437	
Control units	946		946		946		946	
P-value of χ^2(goodness of fit)	8.61E-09		0.00E+00		1.67E-09		0.00E+00	
Street connectivity	0.7807		0.6371					
Regional accessibility	0.1402		0.5770		0.4707		0.7044	
Local accessibility	0.0910*		0.2774					
Walk score					0.1535		0.6830	
Log-likelihood	-5461.66		-5573.40		-5464.54		-5575.90	
McFadden adjusted R²	0.0035		0.0106		0.0039		0.0110	

Significance: * p < .1, ** p < .05, *** p < .01.

Table D-2a Negative binomial model for estimating individual daily walking trip frequency based on the Treatment 1 PSM data

Dependent variable: Walking trip frequency	Treatment 1 matched data							
	Model I-3				Model I-4			
	Male heads		Female heads		Male heads		Female heads	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-1.0765		-0.7159		-1.6611		-0.9990	
Household characteristics								
The number of children	0.1167		0.0218		0.1222		0.0137	
HH income: \$0-\$49,999	-0.2574		-0.1561		-0.2868		-0.1730	
HH income: \$50,000-\$99,999	-0.2270		-0.4119	**	-0.2572		-0.4173	**
Number of vehicles	-0.2986	***	-0.3401	***	-0.2817	***	-0.3235	***
Head's characteristics								
Age	0.0261		0.0503		0.0280		0.0515	
Square age	-0.0002		-0.0006	*	-0.0002		-0.0007	*
Hispanic	-0.2396		-0.0625		-0.1973		-0.0361	
African-American	-0.5865		0.0716		-0.5130		0.1273	
Valid driver license	-0.8894	**	-0.7455	***	-0.9052	**	-0.7557	***
Employed	0.0690		-0.1148		0.1005		-0.1339	
Street connectivity								
Low-medium	0.1120		0.2496					
Medium-high	0.0593		0.2112					
High	0.2345		0.2826					
Regional accessibility								
Low-medium	0.3553	*	0.1058		0.2639		-0.0039	
Medium-high	0.2862		0.2960		0.1320		0.1329	
High	0.6031	**	0.6485	***	0.3465		0.4560	*
Local accessibility								
Low-medium	0.2738		-0.0806					
Medium-high	0.5166	**	0.2071					
High	0.5206	**	0.3080					
Walkable neighborhood								
Walk Score					0.0165	***	0.0113	***
Sample size	3073		3073		3073		3073	
Treated units	2283		2283		2283		2283	
Control units	790		790		790		790	
P-value of χ^2(goodness of fit)	2.94E-07		4.44E-16		1.35E-10		0.00E+00	
Street connectivity	0.7746		0.4840					
Regional accessibility	0.1385		0.0301**		0.5097		0.1717	
Local accessibility	0.1072		0.2740					
Walk score					1.09E-05***		0.0014***	
Log-likelihood	-1650.57		-1920.79		-1645.88		-1919.87	
McFadden adjusted R²	0.0086		0.0200		0.0144		0.0229	

Significance: * p < .1, ** p < .05, *** p < .01.

Table D-2b Negative binomial model for estimating individual daily walking trip frequency based on the Treatment 2 PSM data

Dependent variable: Walking trip frequency	Treatment 2 matched data (estimations for male heads were not converged)							
	Model I-3				Model I-4			
	Male heads		Female heads		Male heads		Female heads	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-1.7489		-1.4498		-1.9884		-1.7990	
Household characteristics								
The number of children	0.1029		0.0328		0.0944		0.0440	
HH income: \$0-\$49,999	0.0085		-0.1436		0.0116		-0.2034	
HH income: \$50,000-\$99,999	-0.1545		-0.4385	**	-0.1944		-0.4639	**
Number of vehicles	-0.2119	*	-0.2579	**	-0.2015	*	-0.2466	**
Head's characteristics								
Age	0.0476		0.0741		0.0427		0.0775	
Square age	-0.0005		-0.0008		-0.0004		-0.0009	*
Hispanic	-0.1910		-0.0315		-0.1931		-0.0337	
African-American	-0.2974		-0.0963		-0.3029		-0.1175	
Valid driver license	-0.9814		-0.7785	**	-0.9736		-0.7673	**
Employed	0.2458		-0.1417		0.2677		-0.1646	
Street connectivity								
Low-medium	0.0129		0.0811					
Medium-high	0.0255		-0.0728					
High	0.0129		0.0623					
Regional accessibility								
Low-medium	0.3779		0.1780		0.3319		0.0755	
Medium-high	0.3256		0.3343		0.2098		0.1592	
High	0.7556	**	0.6483	**	0.6108	*	0.5164	
Local accessibility								
Low-medium	0.2039		-0.0402					
Medium-high	0.3059		0.0778					
High	0.5533	*	0.4585					
Walkable neighborhood								
Walk Score					0.0113	**	0.0085	*
Sample size	2383		2383		2383		2383	
Treated units	1437		1437		1437		1437	
Control units	946		946		946		946	
P-value of χ^2(goodness of fit)	0.0029		9.22E-06		7.91E-05		3.66E-07	
Street connectivity	0.9998		0.9265					
Regional accessibility	0.1536		0.2228		0.2871		0.4183	
Local accessibility	0.3651		0.3313					
Walk score					0.0115**		0.0618*	
Log-likelihood	-1161.66		-1293.93		-1160.26		-1294.15	
McFadden adjusted R²	0.0010		0.0074		0.0064		0.0110	

Significance: * p < .1, ** p < .05, *** p < .01.

Table D-3a Negative binomial model for estimating individual daily driving trip frequency based on the Treatment 1 PSM data

Dependent variable: Driving trip frequency	Treatment 1 matched data							
	Model I-5				Model I-6			
	Male heads		Female heads		Male heads		Female heads	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	0.1819		-0.8585	**	0.1329		-0.8142	**
Household characteristics								
The number of children	0.0868	***	0.2338	***	0.0878	***	0.2309	***
HH income: \$0-\$49,999	-0.1982	***	-0.0309		-0.2083	***	-0.0359	
HH income: \$50,000-\$99,999	-0.0771		-0.0318		-0.0820		-0.0295	
Number of vehicles	-0.0224		0.0463		-0.0231		0.0453	
Head's characteristics								
Age	0.0361	***	0.0618	***	0.0374	***	0.0623	***
Square age	-0.0004	***	-0.0006	***	-0.0004	***	-0.0006	***
Hispanic	0.0004		-0.0921		0.0012		-0.0916	
African-American	-0.0960		-0.0402		-0.1037		-0.0478	
Valid driver license								
Employed	0.1057	*	0.1268	**	0.1041	*	0.1243	**
Street connectivity								
Low-medium	-0.0273		0.0935					
Medium-high	-0.0229		0.0514					
High	0.0266		0.0622					
Regional accessibility								
Low-medium	0.1124	**	-0.0232		0.0978	*	0.0034	
Medium-high	0.0247		0.0297		0.0142		0.0587	
High	0.0260		-0.0044		0.0236		0.0264	
Local accessibility								
Low-medium	-0.1227	**	-0.0287					
Medium-high	-0.0676		-0.0949					
High	-0.0768		-0.0984					
Walkable neighborhood								
Walk Score					-0.0007		-0.0013	
Sample size	2933		2781		2933		2781	
Treated units	2160		2023		2160		2023	
Control units	773		758		773		758	
P-value of χ^2(goodness of fit)	2.97E-12		0.00E+00		3.07E-13		0.00E+00	
Street connectivity	0.8181		0.5495					
Regional accessibility	0.1746		0.8847		0.2707		0.8341	
Local accessibility	0.1877		0.5028					
Walk score					0.5072		0.3178	
Log-likelihood	-6202.06		-5742.27		-6204.86		-5743.68	
McFadden adjusted R²	0.0046		0.0088		0.0050		0.0095	

Significance: * p < .1, ** p < .05, *** p < .01.

Table D-3b Negative binomial model for estimating individual daily driving trip frequency based on the Treatment 2 PSM data

Dependent variable: Driving trip frequency	Treatment 2 matched data							
	Model I-5				Model I-6			
	Male heads		Female heads		Male heads		Female heads	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	0.0146		-1.7168	***	-0.0943		-1.7230	***
Household characteristics								
The number of children	0.0938	***	0.2621	***	0.0963	***	0.2598	***
HH income: \$0-\$49,999	-0.1929	**	-0.0585		-0.2078	**	-0.0633	
HH income: \$50,000-\$99,999	-0.0733		-0.0461		-0.0770		-0.0433	
Number of vehicles	-0.0328		0.0353		-0.0295		0.0330	
Head's characteristics								
Age	0.0435	***	0.0951	***	0.0449	***	0.0972	***
Square age	-0.0004	***	-0.0009	***	-0.0004	***	-0.0009	***
Hispanic	-0.0048		0.0034		0.0027		0.0047	
African-American	0.1237		-0.1021		0.1175		-0.1073	
Valid driver license								
Employed	0.0524		0.0729		0.0545		0.0740	
Street connectivity								
Low-medium	-0.0338		0.1125					
Medium-high	-0.0061		0.1395	*				
High	0.0281		0.0621					
Regional accessibility								
Low-medium	0.1037	*	-0.0302		0.0638		-0.0033	
Medium-high	-0.0010		0.0037		-0.0454		0.0342	
High	-0.1089		0.0087		-0.1563	*	0.0442	
Local accessibility								
Low-medium	-0.1654	***	-0.0606					
Medium-high	-0.0559		-0.1101					
High	-0.1083		-0.0823					
Walkable neighborhood								
Walk Score					0.0002		-0.0009	
Sample size	2304		2206		2304		2206	
Treated units	1393		1339		1393		1339	
Control units	911		867		911		867	
P-value of χ^2(goodness of fit)	1.45E-08		0.00E+00		9.63E-09		0.00E+00	
Street connectivity	0.8574		0.2468					
Regional accessibility	0.0443**		0.9533		0.0494**		0.9396	
Local accessibility	0.0474**		0.5504					
Walk score					0.8742		0.5062	
Log-likelihood	-4870.40		-4581.63		-4874.81		-4584.08	
McFadden adjusted R²	0.0038		0.0108		0.0039		0.0114	

Significance: * p < .1, ** p < .05, *** p < .01.

Table D-4a Negative binomial model for estimating individual daily automobile trip frequency based on the Treatment 1 PSM data

Dependent variable: Automobile trip frequency	Treatment 1 matched data							
	Model I-7				Model I-8			
	Male heads		Female heads		Male heads		Female heads	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-1.0599	***	-0.6718	**	-1.0890	***	-0.6615	**
Household characteristics								
The number of children	0.0657	***	0.1642	***	0.0657	***	0.1629	***
HH income: \$0-\$49,999	-0.1413	**	-0.1009	*	-0.1463	**	-0.1033	*
HH income: \$50,000-\$99,999	-0.0509		-0.0553		-0.0536		-0.0533	
Number of vehicles	-0.0085		0.0207		-0.0095		0.0205	
Head's characteristics								
Age	0.0256	**	0.0373	***	0.0256	**	0.0379	***
Square age	-0.0003	***	-0.0004	***	-0.0003	***	-0.0004	***
Hispanic	-0.0037		-0.0720		-0.0027		-0.0720	
African-American	-0.0789		-0.1178		-0.0816		-0.1284	
Valid driver license	1.6188	***	0.8330	***	1.6220	***	0.8338	***
Employed	0.0758		0.0982	**	0.0754		0.0966	**
Street connectivity								
Low-medium	-0.0349		0.0460					
Medium-high	-0.0445		0.0355					
High	-0.0085		0.0160					
Regional accessibility								
Low-medium	0.0874	*	-0.0022		0.0702		0.0086	
Medium-high	0.0113		0.0535		-0.0077		0.0646	
High	-0.0381		-0.0182		-0.0449		-0.0024	
Local accessibility								
Low-medium	-0.0981	**	-0.0602					
Medium-high	0.0041		-0.0857					
High	0.0018		-0.0766					
Walkable neighborhood								
Walk Score					-7.85E-06		-0.0011	
Sample size	3073		3073		3073		3073	
Treated units	2283		2283		2283		2283	
Control units	790		790		790		790	
P-value of χ^2(goodness of fit)	0.00E+00		0.00E+00		0.00E+00		0.00E+00	
Street connectivity	0.7838		0.7893					
Regional accessibility	0.0890*		0.5410		0.1462		0.5168	
Local accessibility	0.1070		0.3876					
Walk score					0.9931		0.2510	
Log-likelihood	-6697.56		-6833.94		-6701.31		-6835.16	
McFadden adjusted R²	0.0117		0.0154		0.0119		0.0160	

Significance: * p < .1, ** p < .05, *** p < .01.

Table D-4b Negative binomial model for estimating individual daily automobile trip frequency based on the Treatment 2 PSM data

Dependent variable: Automobile trip frequency	Treatment 2 matched data							
	Model I-7				Model I-8			
	Male heads		Female heads		Male heads		Female heads	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-1.0842	***	-1.3690	***	-1.1482	***	-1.3918	***
Household characteristics								
The number of children	0.0760	***	0.1909	***	0.0777	***	0.1909	***
HH income: \$0-\$49,999	-0.1401	**	-0.1051		-0.1497	**	-0.1125	
HH income: \$50,000-\$99,999	-0.0343		-0.0469		-0.0371		-0.0469	
Number of vehicles	-0.0133		0.0232		-0.0112		0.0236	
Head's characteristics								
Age	0.0412	***	0.0609	***	0.0415	***	0.0621	***
Square age	-0.0004	***	-0.0006	***	-0.0004	***	-0.0006	***
Hispanic	0.0080		-0.0277		0.0132		-0.0257	
African-American	0.0268		-0.0991		0.0173		-0.1115	
Valid driver license	1.2175	***	0.8912	***	1.2146	***	0.8921	***
Employed	0.0227		0.0446		0.0257		0.0445	
Street connectivity								
Low-medium	-0.0403		0.0465					
Medium-high	-0.0278		0.0316					
High	0.0043		0.0378					
Regional accessibility								
Low-medium	0.1127	**	0.0000		0.0812		-0.0002	
Medium-high	0.0391		0.0353		0.0030		0.0339	
High	-0.0661		0.0127		-0.0969		0.0166	
Local accessibility								
Low-medium	-0.1413	***	-0.0867	*				
Medium-high	-0.0195		-0.0910					
High	-0.0463		-0.0810					
Walkable neighborhood								
Walk Score					0.0001		-0.0008	
Sample size	2383		2383		2383		2383	
Treated units	1437		1437		1437		1437	
Control units	946		946		946		946	
P-value of χ^2(goodness of fit)	2.44E-15		0.00E+00		1.22E-15		0.00E+00	
Street connectivity	0.8236		0.8276					
Regional accessibility	0.0278**		0.9180		0.0531*		0.9284	
Local accessibility	0.0383**		0.2889					
Walk score					0.8964		0.4507	
Log-likelihood	-5213.88		-5330.83		-5218.70		-5332.62	
McFadden adjusted R²	0.0071		0.0159		0.0071		0.0165	

Significance: * p < .1, ** p < .05, *** p < .01.

Table D-5a Tobit model for estimating individual daily travel distance of all modes based on the Treatment 1 PSM data

Dependent variable: Travel distance of all modes of ground transportation (mile)	Treatment 1 matched data							
	Model I-9				Model I-10			
	Male heads		Female heads		Male heads		Female heads	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-18.8509		-1.3438		-18.8152		0.0551	
Household characteristics								
The number of children	1.2613		0.9252		1.3275		1.0004	
HH income: \$0-\$49,999	-9.7005	***	-10.0031	***	-9.9358	***	-10.3748	***
HH income: \$50,000-\$99,999	-2.5168		-5.2806	**	-2.5171		-5.3948	**
Number of vehicles	-0.1685		-0.6162		-0.3268		-0.7778	
Head's characteristics								
Age	1.1583	**	0.8936		1.1467	**	0.8949	
Square age	-0.0125	**	-0.0102	*	-0.0124	**	-0.0103	*
Hispanic	1.3871		-2.5790		1.2481		-2.7357	
African-American	-9.2311	*	-8.3717		-9.6947	*	-8.9214	
Valid driver license	25.1651	***	11.6652	**	25.6326	***	11.6558	**
Employed	10.4341	***	10.1594	***	10.4187	***	10.2753	***
Street connectivity								
Low-medium	-5.6089	**	-2.6220					
Medium-high	-8.6236	***	-4.8898					
High	-5.9460	*	-0.3725					
Regional accessibility								
Low-medium	-4.3181		-5.6290	**	-4.7866	*	-5.1987	*
Medium-high	-7.2409	**	-4.7873		-7.9197	**	-3.9628	
High	-9.8036	***	-9.5320	***	-9.3618	**	-7.6222	**
Local accessibility								
Low-medium	-7.2434	***	-3.5320					
Medium-high	-1.1927		-3.3593					
High	-2.9699		-2.3389					
Walkable neighborhood								
Walk Score					-0.1227	**	-0.1024	*
Sample size	3073		3073		3073		3073	
Treated units	2283		2283		2283		2283	
Control units	790		790		790		790	
P-value of χ^2(goodness of fit)	4.96E-25		1.33E-16		6.84E-25		2.48E-18	
Street connectivity	0.0328**		0.3228					
Regional accessibility	0.0311**		0.0470**		0.0494**		0.1817	
Local accessibility	0.0479**		0.5779					
Walk score					0.0194**		0.0510*	
Log-likelihood	-13640.49		-13396.11		-13647.26		-13397.42	
McFadden adjusted R²	0.0046		0.0030		0.0044		0.0033	

Significance: * p < .1, ** p < .05, *** p < .01.

Table D-5b Tobit model for estimating individual daily travel distance of all modes based on the Treatment 2 PSM data

Dependent variable: Travel distance of all modes of ground transportation (mile)	Treatment 2 matched data							
	Model I-9				Model I-10			
	Male heads		Female heads		Male heads		Female heads	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-22.1249		-38.1480	*	-25.3079		-37.7110	*
Household characteristics								
The number of children	1.7857		3.1619	**	1.9474		3.2248	**
HH income: \$0-\$49,999	-7.6554	*	-9.6139	**	-8.1558	*	-9.6475	**
HH income: \$50,000-\$99,999	-1.1051		-5.9506	**	-1.1535		-5.9302	**
Number of vehicles	0.4411		-0.7873		0.4070		-0.9032	
Head's characteristics								
Age	1.3384	*	1.9070	**	1.3775	*	1.9086	**
Square age	-0.0146	**	-0.0186	**	-0.0148	**	-0.0186	**
Hispanic	1.9165		-2.9921		1.9900		-2.9879	
African-American	-5.3811		-8.5294		-6.6196		-9.2414	
Valid driver license	24.9297	**	20.1580	***	25.7098	**	20.6783	***
Employed	7.4516	**	8.1054	***	7.5853	**	8.1978	***
Street connectivity								
Low-medium	-7.4550	**	-4.2461					
Medium-high	-10.1112	***	-7.4015	**				
High	-4.7714		-3.2728					
Regional accessibility								
Low-medium	-3.1708		-4.9523		-4.2225		-4.7987	
Medium-high	-6.7183	*	-4.3074		-7.7890	**	-3.9445	
High	-7.7780	*	-7.9755	*	-7.7649		-6.9594	
Local accessibility								
Low-medium	-8.8310	***	-2.4331					
Medium-high	-1.7152		-0.5385					
High	-3.6236		-1.6392					
Walkable neighborhood								
Walk Score					-0.1253	*	-0.1035	*
Sample size	2383		2383		2383		2383	
Treated units	1437		1437		1437		1437	
Control units	946		946		946		946	
P-value of χ^2(goodness of fit)	1.07E-13		1.70E-11		7.46E-13		7.25E-13	
Street connectivity	0.0270**		0.2096					
Regional accessibility	0.2437		0.2751		0.2113		0.4049	
Local accessibility	0.0465**		0.8823					
Walk score					0.0517*		0.0991*	
Log-likelihood	-10718.78		-10507.47		-10726.49		-10509.03	
McFadden adjusted R²	0.0031		0.0025		0.0028		0.0029	

Significance: * p < .1, ** p < .05, *** p < .01.

Table D-6a Tobit model for estimating individual daily walking distance based on the Treatment 1 PSM data

Dependent variable: Walking distance (mile)	Treatment 1 matched data							
	Model I-11				Model I-12			
	Male heads		Female heads		Male heads		Female heads	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-1.8551		-2.0432		-2.5898	*	-2.4221	
Household characteristics								
The number of children	0.0755		0.0526		0.0803		0.0430	
HH income: \$0-\$49,999	-0.5292	*	-0.4301		-0.5819	**	-0.4613	
HH income: \$50,000-\$99,999	-0.3848	*	-0.6122	**	-0.4296	**	-0.6308	***
Number of vehicles	-0.5227	***	-0.5645	***	-0.4895	***	-0.5367	***
Head's characteristics								
Age	0.0302		0.0637		0.0302		0.0639	
Square age	-0.0004		-0.0009		-0.0003		-0.0009	
Hispanic	-0.3096		-0.0225		-0.2704		-0.0097	
African-American	-0.6835		0.2128		-0.5965		0.2784	
Valid driver license	-1.4393	***	-1.6777	***	-1.4330	***	-1.6942	***
Employed	-0.0280		-0.1117		-0.0277		-0.1326	
Street connectivity								
Low-medium	-0.0333		0.3435					
Medium-high	0.0476		0.1730					
High	0.2230		0.3070					
Regional accessibility								
Low-medium	0.3347		0.1756		0.0248		-0.0160	
Medium-high	0.4409	*	0.4372		0.0622		0.1829	
High	0.8146	***	1.1395	***	0.2782		0.8123	**
Local accessibility								
Low-medium	0.2545		-0.1386					
Medium-high	0.4624	*	0.1917					
High	0.5975	**	0.3040					
Walkable neighborhood								
Walk Score					0.0228	***	0.0145	***
Sample size	3073		3073		3073		3073	
Treated units	2283		2283		2283		2283	
Control units	790		790		790		790	
P-value of χ^2(goodness of fit)	1.78E-12		1.03E-23		1.32E-17		9.98E-27	
Street connectivity	0.7829		0.6023					
Regional accessibility	0.0585*		0.0024***		0.7745		0.0320**	
Local accessibility	0.1848		0.4825					
Walk score					9.32E-07***		0.0053***	
Log-likelihood	-1410.07		-1684.93		-1402.01		-1683.74	
McFadden adjusted R²	0.0203		0.0337		0.0292		0.0372	

Significance: * p < .1, ** p < .05, *** p < .01.

Table D-6b Tobit model for estimating individual daily walking distance based on the Treatment 2 PSM data

Dependent variable: Walking distance (mile)	Treatment 2 matched data							
	Model I-11				Model I-12			
	Male heads		Female heads		Male heads		Female heads	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-4.2213	**	-3.3035		-4.6899	**	-3.5787	
Household characteristics								
The number of children	0.1079		0.0714		0.1065		0.0601	
HH income: \$0-\$49,999	-0.1685		-0.2321		-0.2221		-0.3280	
HH income: \$50,000-\$99,999	-0.3533		-0.7063	**	-0.4079		-0.7581	**
Number of vehicles	-0.3906	***	-0.4123	**	-0.3698	***	-0.4013	**
Head's characteristics								
Age	0.0909		0.0961		0.0862		0.0902	
Square age	-0.0009		-0.0012		-0.0009		-0.0012	
Hispanic	-0.5234	*	-0.2318		-0.5163	*	-0.2380	
African-American	-0.7482		0.3050		-0.6929		0.2595	
Valid driver license	-1.2975	**	-1.9909	***	-1.2635	*	-1.9381	***
Employed	0.2173		-0.1712		0.2230		-0.1782	
Street connectivity								
Low-medium	-0.1603		0.0773					
Medium-high	0.1003		-0.2952					
High	0.0810		-0.1072					
Regional accessibility								
Low-medium	0.2672		0.3333		0.0184		0.1072	
Medium-high	0.4500		0.6015		0.1132		0.2491	
High	0.9791	**	1.2637	***	0.5665		0.9409	*
Local accessibility								
Low-medium	0.1942		-0.1320					
Medium-high	0.1539		0.0012					
High	0.5056		0.6361					
Walkable neighborhood								
Walk Score					0.0174	***	0.0117	*
Sample size	2383		2383		2383		2383	
Treated units	1437		1437		1437		1437	
Control units	946		946		946		946	
P-value of χ^2(goodness of fit)	2.78E-05		2.53E-09		7.74E-08		7.73E-11	
Street connectivity	0.8465		0.8059					
Regional accessibility	0.0799*		0.0525*		0.4176		0.1962	
Local accessibility	0.5605		0.3071					
Walk score					0.0018***		0.0905*	
Log-likelihood	-1004.56		-1174.42		-1001.29		-1175.21	
McFadden adjusted R²	0.0080		0.0170		0.0160		0.0204	

Significance: * p < .1, ** p < .05, *** p < .01.

Table D-7a Tobit model for estimating individual daily driving distance based on the Treatment 1 PSM data

Dependent variable: Driving distance (mile)	Treatment 1 matched data							
	Model I-13				Model I-14			
	Male heads		Female heads		Male heads		Female heads	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-22.1923		-20.5250		-20.8307		-17.1119	
Household characteristics								
The number of children	1.6837		1.9203	*	1.8066		1.9224	*
HH income: \$0-\$49,999	-11.6413	***	-2.6263		-12.0698	***	-2.7651	
HH income: \$50,000-\$99,999	-2.6791		-2.4463		-2.6127		-2.4904	
Number of vehicles	0.4639		2.1349	*	0.3264		1.9424	*
Head's characteristics								
Age	1.6937	***	1.1073	**	1.7211	***	1.0960	**
Square age	-0.0174	***	-0.0133	**	-0.0176	***	-0.0132	**
Hispanic	3.0163		-2.5657		2.7259		-2.7265	
African-American	-8.1041		-6.3013		-9.1250		-6.8086	
Valid driver license								
Employed	13.7481	***	12.6497	***	13.6549	***	12.7633	***
Street connectivity								
Low-medium	-4.3777		0.5456					
Medium-high	-7.0415	**	-1.7752					
High	-4.9487		2.6235					
Regional accessibility								
Low-medium	-0.9328		-8.8337	***	-0.7212		-7.3799	***
Medium-high	-6.8664	**	-4.7481	*	-6.6011	*	-2.5873	
High	-8.5976	**	-9.0681	***	-7.1000	*	-6.0305	*
Local accessibility								
Low-medium	-8.6371	***	0.2805					
Medium-high	-7.6741	**	-3.5746					
High	-8.2918	**	-1.5289					
Walkable neighborhood								
Walk Score					-0.2061	***	-0.0884	**
Sample size	2933		2781		2933		2781	
Treated units	2160		2023		2160		2023	
Control units	773		758		773		758	
P-value of χ^2 (goodness of fit)	1.44E-24		1.81E-22		8.15E-26		9.21E-25	
Street connectivity	0.1891		0.4648					
Regional accessibility	0.0516**		0.0008***		0.1160		0.0129**	
Local accessibility	0.0193*		0.4337					
Walk score					0.0003***		0.0472*	
Log-likelihood	-11585.30		-9576.00		-11588.69		-9576.62	
McFadden adjusted R²	0.0053		0.0058		0.0054		0.0063	

Significance: * p < .1, ** p < .05, *** p < .01.

Table D-7b Tobit model for estimating individual daily driving distance based on the Treatment 2 PSM data

Dependent variable: Driving distance (mile)	Treatment 2 matched data							
	Model I-13				Model I-14			
	Male heads		Female heads		Male heads		Female heads	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-32.5307		-63.9307	***	-35.9324		-61.3137	***
Household characteristics								
The number of children	2.9563	*	3.6939	***	3.0751	*	3.7177	***
HH income: \$0-\$49,999	-9.2537	**	-3.8530		-10.2514	**	-3.7263	
HH income: \$50,000-\$99,999	-2.1121		-4.4116	*	-2.3076		-4.3033	*
Number of vehicles	0.2890		1.7425		0.3445		1.5787	
Head's characteristics								
Age	2.1258	**	2.7743	***	2.2142	**	2.7987	***
Square age	-0.0212	***	-0.0282	***	-0.0218	***	-0.0285	***
Hispanic	1.3439		1.4594		1.5059		1.4537	
African-American	0.7551		-3.4906		-0.7226		-3.6089	
Valid driver license								
Employed	10.5141	***	10.3881	***	10.5869	***	10.4945	***
Street connectivity								
Low-medium	-4.3802		0.5390					
Medium-high	-8.4527	**	0.8093					
High	-2.7210		1.9277					
Regional accessibility								
Low-medium	-0.4349		-8.4271	***	-1.7989		-6.8231	**
Medium-high	-8.2011	**	-5.9745	**	-9.8547	**	-3.6037	
High	-12.2556	**	-7.7626	**	-12.9389	**	-4.7629	
Local accessibility								
Low-medium	-10.1343	***	1.5791					
Medium-high	-7.2845	*	-3.2255					
High	-6.8121		-1.8996					
Walkable neighborhood								
Walk Score					-0.1359	**	-0.0841	
Sample size	1581		1361		2304		2206	
Treated units	886		749		1393		1339	
Control units	695		612		911		867	
P-value of χ^2(goodness of fit)	2.63E-15		1.69E-16		5.15E-15		9.34E-19	
Street connectivity	0.1759		0.9574					
Regional accessibility	0.0233**		0.0135**		0.0196**		0.0951*	
Local accessibility	0.0289**		0.4539					
Walk score					0.0453**		0.1112	
Log-likelihood	-9241.01		-7735.37		-9247.49		-7735.45	
McFadden adjusted R²	0.0040		0.0052		0.0038		0.0058	

Significance: * p < .1, ** p < .05, *** p < .01.

Table D-8a Tobit model for estimating individual daily automobile travel distance based on the Treatment 1 PSM data

Dependent variable: Automobile travel distance (mile)	Treatment 1 matched data							
	Model I-15				Model I-16			
	Male heads		Female heads		Male heads		Female heads	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-50.9736	***	-16.0476		-49.4929	***	-14.2045	
Household characteristics								
The number of children	1.3096		1.2831		1.3822		1.3853	
HH income: \$0-\$49,999	-10.6978	***	-10.7399	***	-10.9036	***	-11.0911	***
HH income: \$50,000-\$99,999	-2.5284		-5.1633	**	-2.4799		-5.2857	**
Number of vehicles	1.2064		0.8046		0.9739		0.5926	
Head's characteristics								
Age	1.1375	*	0.7066		1.1270	*	0.7139	
Square age	-0.0128	**	-0.0082		-0.0127	**	-0.0083	
Hispanic	2.1115		-2.8871		1.8472		-3.0562	
African-American	-9.0160	*	-9.7050	*	-9.6461	*	-10.3083	*
Valid driver license	54.4555	***	25.3466	***	54.7993	***	25.3682	***
Employed	10.7848	***	10.9798	***	10.7470	***	11.1015	***
Street connectivity								
Low-medium	-5.7740	**	-3.8905					
Medium-high	-9.2886	***	-4.5331					
High	-6.0630	*	0.1431					
Regional accessibility								
Low-medium	-4.6260		-5.9786	**	-4.4909		-5.2034	*
Medium-high	-8.1686	***	-5.1777	*	-7.9971	**	-3.6761	
High	-13.5820	***	-12.7526	***	-11.8943	***	-9.8410	**
Local accessibility								
Low-medium	-7.4780	***	-3.6371					
Medium-high	-2.3630		-4.2299					
High	-3.6669		-3.0434					
Walkable neighborhood								
Walk Score					-0.1667	***	-0.1292	**
Sample size	3073		3073		3073		3073	
Treated units	2283		2283		2283		2283	
Control units	790		790		790		790	
P-value of χ^2(goodness of fit)	3.83E-39		5.95E-28		5.16E-40		3.10E-30	
Street connectivity	0.0252**		0.2434					
Regional accessibility	0.0023***		0.0058***		0.0181**		0.0724*	
Local accessibility	0.0643**		0.4948					
Walk score					0.0021***		0.0165**	
Log-likelihood	-13010.98		-12799.08		-13016.07		-12800.03	
McFadden adjusted R²	0.0075		0.0055		0.0075		0.0058	

Significance: * p < .1, ** p < .05, *** p < .01.

Table D-8b Tobit model for estimating individual daily automobile travel distance based on the Treatment 2 PSM data

Dependent variable: Automobile travel distance (mile)	Treatment 2 matched data							
	Model I-15				Model I-16			
	Male heads		Female heads		Male heads		Female heads	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-55.6469	**	-53.0552	**	-58.3036	**	-52.7477	**
Household characteristics								
The number of children	2.1625		3.2310	**	2.3322		3.3505	**
HH income: \$0-\$49,999	-9.0023	**	-10.9383	**	-9.5618	**	-10.8993	**
HH income: \$50,000-\$99,999	-1.5386		-5.7616	**	-1.5918		-5.7517	**
Number of vehicles	1.2950		0.4518		1.2190		0.3174	
Head's characteristics								
Age	1.5760	*	1.9149	**	1.6324	**	1.9314	**
Square age	-0.0171	**	-0.0184	**	-0.0175	**	-0.0186	**
Hispanic	3.3461		-2.7512		3.3655		-2.7226	
African-American	-4.6774		-8.6671		-6.1543		-9.2532	
Valid driver license	49.7451	***	29.8510	***	50.4993	***	30.4676	***
Employed	7.2080	**	8.6833	***	7.3244	**	8.7602	***
Street connectivity								
Low-medium	-7.3756	**	-5.1156					
Medium-high	-10.7757	***	-6.4201	*				
High	-4.3386		-1.9459					
Regional accessibility								
Low-medium	-2.7797		-5.6684	*	-3.4693		-5.2239	
Medium-high	-7.8984	**	-5.2750		-8.3992	**	-4.2540	
High	-13.1044	***	-11.5388	**	-12.1662	**	-9.6834	**
Local accessibility								
Low-medium	-9.1827	***	-2.0564					
Medium-high	-3.2474		-1.2766					
High	-4.0332		-2.4598					
Walkable neighborhood								
Walk Score					-0.1589	**	-0.1167	*
Sample size	2383		2383		2383		2383	
Treated units	1437		1437		1437		1437	
Control units	946		946		946		946	
P-value of χ^2(goodness of fit)	6.19E-21		5.15E-17		1.38E-20		7.58E-19	
Street connectivity	0.0223**		0.2241					
Regional accessibility	0.0320**		0.0787*		0.0639*		0.2077	
Local accessibility	0.0533*		0.9120					
Walk score					0.0161**		0.0658*	
Log-likelihood	-10298.52		-10163.02		-10305.53		-10164.11	
McFadden adjusted R²	0.0050		0.0041		0.0048		0.0045	

Significance: * p < .1, ** p < .05, *** p < .01.

Table D-9a Tobit model for estimating individual daily VMT based on the Treatment 1 PSM data

Dependent variable: VMT (mile)	Treatment 1 matched data							
	Model I-17				Model I-18			
	Male heads		Female heads		Male heads		Female heads	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-32.7479	***	-10.8072		-31.7508	***	-9.3326	
Household characteristics								
The number of children	-0.3332		-1.5250	**	-0.3047		-1.4707	**
HH income: \$0-\$49,999	-5.6055	**	-4.6602	**	-5.7705	**	-4.8714	**
HH income: \$50,000-\$99,999	-0.5726		-1.9306		-0.5066		-2.0058	
Number of vehicles	1.3765		0.9409		1.2582		0.8034	
Head's characteristics								
Age	0.6266		0.4122		0.6187		0.4147	
Square age	-0.0077	**	-0.0053		-0.0077	**	-0.0053	
Hispanic	3.0575	*	-1.8380		2.8976		-1.9612	
African-American	-4.7554		-5.8929	*	-5.1396		-6.2643	**
Valid driver license	37.2977	***	17.0978	***	37.5785	***	17.2205	***
Employed	10.6983	***	9.3034	***	10.6704	***	9.3839	***
Street connectivity								
Low-medium	-2.7418		-1.8758					
Medium-high	-6.5508	***	-2.4027					
High	-4.3258	*	0.4731					
Regional accessibility								
Low-medium	-3.6244	*	-4.1897	***	-3.6118	*	-3.5430	**
Medium-high	-6.4220	***	-3.3949	*	-6.5623	***	-2.2642	
High	-9.6250	***	-8.0444	***	-9.1128	***	-6.1354	***
Local accessibility								
Low-medium	-4.3928	**	-1.0778					
Medium-high	-1.5998		-2.9893	*				
High	-3.1109		-1.7190					
Walkable neighborhood								
Walk Score					-0.1077	***	-0.0788	**
Sample size	3073		3073		3073		3073	
Treated units	2283		2283		2283		2283	
Control units	790		790		790		790	
P-value of χ^2(goodness of fit)	5.06E-50		1.18E-43		4.99E-51		1.76E-46	
Street connectivity	0.0167**		0.2673					
Regional accessibility	0.0005***		0.0012***		0.0025***		0.0313**	
Local accessibility	0.1133		0.3956					
Walk score					0.0024***		0.0101**	
Log-likelihood	-12056.57		-11537.44		-12061.81		-11538.01	
McFadden adjusted R²	0.0103		0.0094		0.0102		0.0098	

Significance: * p < .1, ** p < .05, *** p < .01.

Table D-9a Tobit model for estimating individual daily VMT based on the Treatment 2 PSM data

Dependent variable: VMT (mile)	Treatment 2 matched data							
	Model 1				Model 2			
	Male heads		Female heads		Male heads		Female heads	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-32.1360	*	-37.7423	***	-34.1842	**	-36.8721	***
Household characteristics								
The number of children	0.0103		-0.3223		0.0680		-0.2784	
HH income: \$0-\$49,999	-4.2726		-4.8232	**	-4.7296	*	-4.8047	**
HH income: \$50,000-\$99,999	-0.8958		-2.8725	*	-0.9219		-2.8369	*
Number of vehicles	1.6796	*	0.9619		1.6809	*	0.8762	
Head's characteristics								
Age	0.8209		1.2863	***	0.8587	*	1.2930	***
Square age	-0.0098	**	-0.0126	***	-0.0101	**	-0.0127	***
Hispanic	3.3385		-1.4646		3.3961		-1.4401	
African-American	-0.8629		-4.5041		-1.8079		-4.7586	
Valid driver license	33.4286	***	19.4425	***	34.1613	***	19.7446	***
Employed	8.4198	***	8.1641	***	8.4714	***	8.2161	***
Street connectivity								
Low-medium	-2.6523		-2.3958					
Medium-high	-6.3647	***	-2.9083					
High	-2.6155		-1.1715					
Regional accessibility								
Low-medium	-2.2219		-3.5855	**	-2.8975		-3.0989	*
Medium-high	-6.5137	***	-3.6567	*	-7.3969	***	-2.8448	
High	-9.7423	***	-6.8932	***	-10.1553	***	-5.7109	**
Local accessibility								
Low-medium	-5.9571	***	0.0751					
Medium-high	-3.0254		-1.6409					
High	-3.9860		-1.7145					
Walkable neighborhood								
Walk Score					-0.0909	**	-0.0734	**
Sample size	2383		2383		2383		2383	
Treated units	1437		1437		1437		1437	
Control units	946		946		946		946	
P-value of χ^2(goodness of fit)	7.39E-29		5.90E-26		6.47E-29		1.81E-28	
Street connectivity	0.0726		0.4275					
Regional accessibility	0.0049***		0.0475**		0.0042***		0.1746	
Local accessibility	0.0474**		0.7735					
Walk score					0.0301**		0.0402**	
Log-likelihood	-9498.78		-9152.40		-9505.30		-9152.64	
McFadden adjusted R²	0.0076		0.0071		0.0074		0.0076	

Significance: * p < .1, ** p < .05, *** p < .01.

Table D-10 Negative binomial model for estimating gendered inequality in daily trip frequency for all modes based on the PSM data

Dependent variable: Gendered inequality in trip frequency for all modes	Treatment 1 matched data				Treatment 2 matched data			
	Model II-1		Model II-2		Model II-1		Model II-2	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-0.0510		-0.0726		0.1844		0.1988	
Household characteristics								
The number of children	0.1099	***	0.1098	***	0.1226	***	0.1220	***
HH income: \$0-\$49,999	0.0088		0.0102		-0.0600		-0.0546	
HH income: \$50,000-\$99,999	0.0173		0.0161		-0.0221		-0.0204	
Number of vehicles	-0.0010		-0.0010		-0.0259		-0.0266	
Male head's characteristics								
Age	-0.0063		-0.0061		0.0001		-3.99E-05	
Square age	0.0001		0.0001		0.0000		4.27E-05	
Hispanic	0.0790		0.0813		0.1002		0.1032	
African-American	0.0016		-0.0018		0.2105		0.2042	
Valid driver license	0.0307		0.0247		-0.0778		-0.0908	
Employed	0.0025		0.0020		-0.0013		0.0002	
Female head's characteristics								
Age	0.0370	*	0.0372	*	0.0363		0.0367	
Square age	-0.0004	**	-0.0004	**	-0.0004	*	-0.0004	*
Hispanic	-0.0859		-0.0850		-0.0756		-0.0756	
African-American	0.3236	**	0.3368	**	0.1210		0.1392	
Valid driver license	0.0647		0.0639		-0.1380		-0.1420	
Employed	-0.1141	***	-0.1160	***	-0.1161	**	-0.1175	**
Street connectivity								
Low-medium	0.0045				0.0001			
Medium-high	0.0407				0.0771			
High	0.0535				0.0562			
Regional accessibility								
Low-medium	0.0648		0.0608		0.0400		0.0511	
Medium-high	-0.0107		-0.0122		0.0065		0.0230	
High	0.0769		0.0761		0.0068		0.0298	
Local accessibility								
Low-medium	0.0118				0.0024			
Medium-high	0.0605				0.0474			
High	0.0461				-0.0048			
Walkable neighborhood								
Walk Score			0.0013				0.0005	
Sample size	2734		2734		2111		2111	
Treated units	2020		2020		1280		1280	
Control units	714		714		831		831	
P-value of χ^2(goodness of fit)	3.73E-06		3.15E-07		3.64E-05		5.81E-06	
Street connectivity	0.8072				0.6207			
Regional accessibility	0.3368		0.3726		0.9025		0.8687	
Local accessibility	0.7470				0.8624			
Walk score			0.2182				0.6587	
Log-likelihood	-5556.64		-5557.42		-4289.05		-4290.41	
McFadden adjusted R²	0.0018		0.0026		0.0015		0.0024	

Significance: * p < .1, ** p < .05, *** p < .01.

Table D-11 Negative binomial model for estimating gendered inequality in daily walking trip frequency based on the PSM data

Dependent variable: Gendered inequality in walking trip frequency	Treatment 1 matched data				Treatment 2 matched data			
	Model II-3		Model II-3		Model II-4		Model II-4	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	0.6452		0.4682		0.6192		0.6012	
Household characteristics								
The number of children	0.0348		0.0311		-0.0446		-0.0433	
HH income: \$0-\$49,999	0.1657		0.1668		0.4630	***	0.4768	***
HH income: \$50,000-\$99,999	0.2097	*	0.1883	*	0.1981	*	0.2054	*
Number of vehicles	0.0843		0.0700		0.0525		0.0534	
Male head's characteristics								
Age	-0.0712	*	-0.0644		-0.0201		-0.0169	
Square age	0.0007	*	0.0006	*	0.0002		0.0001	
Hispanic	0.1585		0.1535		0.2284		0.2171	
African-American	0.3417		0.2951		0.1391		0.1238	
Valid driver license	0.1746		0.2296		-0.1659		-0.1757	
Employed	0.1807		0.1692		0.1803		0.1896	
Female head's characteristics								
Age	0.0497		0.0430		0.0075		0.0046	
Square age	-0.0005		-0.0004		-0.0001		-0.0001	
Hispanic	-0.0292		-0.0265		-0.0462		-0.0441	
African-American	-0.1199		-0.0395		0.1197		0.1493	
Valid driver license	-0.1626		-0.1604		0.0788		0.0750	
Employed	-0.0678		-0.0815		-0.1136		-0.1185	
Street connectivity								
Low-medium	0.0223				0.0241			
Medium-high	0.0245				0.0283			
High	0.1414				-0.0238			
Regional accessibility								
Low-medium	-0.0037		-0.0702		0.0742		0.1026	
Medium-high	0.0812		0.0018		0.1185		0.1478	
High	0.0174		-0.0589		0.1925		0.2427	
Local accessibility								
Low-medium	-0.1286				0.0695			
Medium-high	0.0896				0.1008			
High	0.1674				0.2014			
Walkable neighborhood								
Walk Score			0.0053	**			0.0012	
Sample size	344		344		306		306	
Treated units	252		252		176		176	
Control units	92		92		130		130	
P-value of χ^2 (goodness of fit)	0.0932		0.0556		0.0178		0.0046	
Street connectivity	0.6005				0.9746			
Regional accessibility	0.8655		0.8869		0.6859		0.5567	
Local accessibility	0.1203				0.6240			
Walk score			0.0126**				0.6281	
Log-likelihood	-591.90		-593.78		-539.5124		-540.41	
McFadden adjusted R²	-0.0125		-0.0074		-0.0071		0.0002	

Significance: * p < .1, ** p < .05, *** p < .01.

Table D-12 Negative binomial model for estimating gendered inequality in daily driving trip frequency based on the PSM data

Dependent variable: Gendered inequality in driving trip frequency	Treatment 1 matched data				Treatment 2 matched data			
	Model II-5		Model II-6		Model II-5		Model II-6	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	0.9632	***	1.0520	***	0.8117	**	0.8937	**
Household characteristics								
The number of children	0.0682	***	0.0687	***	0.0909	***	0.0922	***
HH income: \$0-\$49,999	-0.0262		-0.0180		-0.0531		-0.0401	
HH income: \$50,000-\$99,999	-0.0325		-0.0291		-0.0054		0.0000	
Number of vehicles	-0.0530	**	-0.0565	***	-0.0710	***	-0.0768	***
Male head's characteristics								
Age	0.0138		0.0115		0.0164		0.0148	
Square age	-0.0001		-0.0001		-0.0001		-0.0001	
Hispanic	-0.0528		-0.0539		0.0071		0.0000	
African-American	-0.1233		-0.1277		0.0435		0.0288	
Valid driver license	-0.1215		-0.1281		-0.1171		-0.1290	
Employed	-0.0881	**	-0.0865	**	-0.0667		-0.0655	
Female head's characteristics								
Age	0.0172		0.0172		0.0171		0.0177	
Square age	-0.0002		-0.0002		-0.0002		-0.0002	
Hispanic	0.0080		0.0074		-0.0032		-0.0008	
African-American	0.1814		0.1818		0.0993		0.0998	
Valid driver license	-0.1981	**	-0.1996	**	-0.2111	**	-0.2117	**
Employed	-0.1585	***	-0.1540	***	-0.1349	***	-0.1301	***
Street connectivity								
Low-medium	-0.0614				-0.0323			
Medium-high	-0.0510		0.0795	*	-0.0568			
High	-0.0500		0.0392		-0.0721			
Regional accessibility			0.0620					
Low-medium	0.0588				0.0534		0.0853	*
Medium-high	0.0107				-0.0071		0.0323	
High	0.0076				0.0308		0.0989	
Local accessibility								
Low-medium	-0.0292				-0.0301			
Medium-high	0.0662				0.0726			
High	0.0592				0.0861			
Walkable neighborhood								
Walk Score			-0.0010				-0.0015	*
Sample size	2549		2549		2020		2020	
Treated units	1867		1867		1239		1239	
Control units	682		682		781		781	
P-value of χ^2(goodness of fit)	3.31E-08		9.36E-09		2.02E-06		3.71E-07	
Street connectivity	0.4966				0.5918			
Regional accessibility	0.4825		0.3387		0.5221		0.2320	
Local accessibility	0.1451				0.1244			
Walk score			0.2157				0.0912*	
Log-likelihood	-5516.58		-5519.40		-4336.0030		-4337.89	
McFadden adjusted R²	0.0030		0.0034		0.0025		0.0032	

Significance: * p < .1, ** p < .05, *** p < .01.

Table D-13 Negative binomial model for estimating gendered inequality in daily automobile trip frequency based on the PSM data

Dependent variable: Gendered inequality in automobile trip frequency	Treatment 1 matched data				Treatment 2 matched data			
	Model II-7		Model II-8		Model II-7		Model II-8	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	-0.0983		-0.0985		-0.1593		-0.1417	
Household characteristics								
The number of children	0.1210	***	0.1236	***	0.1198	***	0.1238	***
HH income: \$0-\$49,999	0.0129		0.0193		0.0076		0.0227	
HH income: \$50,000-\$99,999	0.0095		0.0132		0.0040		0.0120	
Number of vehicles	-0.0078		-0.0092		-0.0312		-0.0347	
Male head's characteristics								
Age	-0.0008		-0.0013		0.0396		0.0384	
Square age	2.26E-06		0.0000		-0.0003		-0.0003	
Hispanic	-0.0104		-0.0091		0.0446		0.0436	
African-American	0.0062		0.0165		0.0640		0.0739	
Valid driver license	-0.2231		-0.2349		-0.1563		-0.1946	
Employed	-0.0159		-0.0156		0.0091		0.0105	
Female head's characteristics								
Age	0.0466	**	0.0473	**	0.0086		0.0111	
Square age	-0.0005	**	-0.0005	**	-0.0002		-0.0002	
Hispanic	-0.0503		-0.0456		-0.0662		-0.0619	
African-American	0.1548		0.1621		0.1550		0.1619	
Valid driver license	0.0626		0.0570		-0.0938		-0.0957	
Employed	-0.1558	***	-0.1562	***	-0.1525	***	-0.1484	***
Street connectivity								
Low-medium	-0.0458				-0.0702			
Medium-high	0.0194				0.0130			
High	-0.0273				-0.0333			
Regional accessibility								
Low-medium	0.0968	*	0.0986	*	0.1372	**	0.1636	***
Medium-high	-0.0025		0.0016		0.0337		0.0699	
High	0.0558		0.0596		0.0660		0.1143	
Local accessibility								
Low-medium	0.0079				-0.0169			
Medium-high	0.0861				0.0974			
High	0.0176				-0.0145			
Walkable neighborhood								
Walk Score			0.0004				-0.0010	
Sample size	2558		2558		2062		2062	
Treated units	1890		1890		1250		1250	
Control units	668		668		812		812	
P-value of χ^2 (goodness of fit)	3.32E-07		5.51E-08		8.47E-06		2.56E-06	
Street connectivity	0.7080				0.5913			
Regional accessibility	0.2213		0.2320		0.1257		0.0696*	
Local accessibility	0.4614				0.3184			
Walk score			0.7320				0.4090	
Log-likelihood	-5076.98		-5078.91		-4087.59		-4090.00	
McFadden adjusted R²	0.0026		0.0032		0.0021		0.0028	

Significance: * p < .1, ** p < .05, *** p < .01.

Table D-14 Tobit model for estimating gendered inequality in daily travel distance for all modes based on the PSM data

Dependent variable: Gendered inequality in travel distance for all modes	Treatment 1 matched data				Treatment 2 matched data			
	Model II-9		Model II-10		Model II-9		Model II-10	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	-1.5152		1.2601		12.9196		14.5204	
Household characteristics								
The number of children	-2.1365	**	-2.1645	***	-2.3420	**	-2.2899	**
HH income: \$0-\$49,999	-1.2207		-1.0026		-1.6646		-1.2051	
HH income: \$50,000-\$99,999	0.9551		1.0495		-0.0724		0.0510	
Number of vehicles	1.3179		1.1650		1.7039		1.5798	
Male head's characteristics								
Age	-0.6070		-0.6141		-0.0294		-0.0166	
Square age	0.0065		0.0065		0.0013		0.0011	
Hispanic	3.9865	*	3.8498	*	6.3608	**	6.2008	**
African-American	0.3519		0.0423		3.6593		3.3389	
Valid driver license	9.9403	*	9.8431	*	1.9994		1.8444	
Employed	5.6020	***	5.5607	***	5.4133	**	5.4431	**
Female head's characteristics								
Age	1.2387	*	1.2617	*	0.5620		0.5788	
Square age	-0.0154	**	-0.0156	**	-0.0098		-0.0100	
Hispanic	0.4936		0.4225		-2.1906		-2.2182	
African-American	7.0527		6.7447		3.5544		3.4438	
Valid driver license	2.4847		2.5024		2.4081		2.5731	
Employed	0.3738		0.4876		-1.3010		-1.1134	
Street connectivity								
Low-medium	1.0497				-0.0998			
Medium-high	-1.0813				-1.8060			
High	0.6013				-0.9657			
Regional accessibility								
Low-medium	-6.6018	***	-5.0022	**	-7.2475	***	-5.6756	***
Medium-high	-9.3331	***	-7.1902	***	-10.8682	***	-8.7239	***
High	-11.4784	***	-8.6913	***	-14.2208	***	-11.2308	***
Local accessibility								
Low-medium	0.2502				0.8010			
Medium-high	-0.7395				0.7893			
High	-0.2662				1.9682			
Walkable neighborhood					12.9196			
Walk Score			-0.0750	**			-0.0722	*
Sample size	2734		2734		2111		2111	
Treated units	2020		2020		1280		1280	
Control units	714		714		831		831	
P-value of χ^2(goodness of fit)	1.40E-12		6.90E-15		1.44E-10		1.36E-12	
Street connectivity	0.7574				0.8862			
Regional accessibility	5.13E-06***		0.0034***		2.48E-06***		0.0010***	
Local accessibility	0.9696				0.9247			
Walk score			0.0396**				0.0854*	
Log-likelihood	-12606.31		-12604.91		-9772.12		-9771.14	
McFadden adjusted R²	0.0024		0.0029		0.0024		0.0030	

Significance: * p < .1, ** p < .05, *** p < .01.

Table D-15 Tobit model for estimating gendered inequality in daily walking distance based on the PSM data

Dependent variable: Gendered inequality in walking distance (mile)	Treatment 1 matched data		Treatment 2 matched data	
	Model II-11	Model II-12	Model II-11	Model II-12
Intercept	Coefficient 0.3918	Coefficient 0.3409	Coefficient 3.7467	Coefficient 4.3684
Household characteristics				
The number of children	0.0588	0.0447	-0.0321	-0.0374
HH income: \$0-\$49,999	-0.4415	-0.5178	0.1402	0.1067
HH income: \$50,000-\$99,999	0.2889	0.2729	-0.1084	-0.0725
Number of vehicles	0.0014	-0.0033	0.0179	0.0394
Male head's characteristics				
Age	0.0717	0.0719	-0.1907	-0.2085 *
Square age	-0.0005	-0.0006	0.0020 *	0.0022 *
Hispanic	-0.0232	0.1042	-0.0742	-0.0023
African-American	1.0501 *	1.0208 *	1.9775 **	1.9397 **
Valid driver license	0.5164	0.6038	-0.2869	-0.2998
Employed	-0.0698	-0.1055	0.5804	0.5665
Female head's characteristics				
Age	-0.0508	-0.0466	0.0816	0.0852
Square age	0.0004	0.0004	-0.0009	-0.0010
Hispanic	-0.0078	-0.0317	-0.4576	-0.5230
African-American	-0.8582	-0.9587 *	-0.2757	-0.2765
Valid driver license	-0.7377 **	-0.6903 **	-0.4929	-0.6188
Employed	-0.0663	-0.0979	-0.3259	-0.3161
Street connectivity				
Low-medium	0.3418		0.6438 *	
Medium-high	-0.1848		0.4725	
High	0.0985		0.3221	
Regional accessibility				
Low-medium	-0.0984	-0.0477	-0.0512	0.0212
Medium-high	0.1012	0.1265	0.4305	0.4774
High	0.3329	0.3519	0.0212	0.0428
Local accessibility				
Low-medium	-0.2301		-0.2290	
Medium-high	-0.1291		-0.2527	
High	-0.3441		-0.3382	
Walkable neighborhood				
Walk Score		-0.0038		-0.0004
Sample size	344	344	306	306
Treated units	252	252	176	176
Control units	92	92	130	130
P-value of χ^2 (goodness of fit)	0.5463	0.5712	0.2510	0.1962
Street connectivity	0.2568		0.3014	
Regional accessibility	0.4111	0.4748	0.4337	0.4320
Local accessibility	0.6303		0.8657	
Walk score		0.3877		0.9547
Log-likelihood	-585.58	-588.22	-595.97	-598.06
McFadden adjusted R²	-0.0222	-0.0182	-0.0169	-0.0122

Significance: * p < .1, ** p < .05, *** p < .01.

Table D-16 Tobit model for estimating gendered inequality in daily driving distance based on the PSM data

Dependent variable: Gendered inequality in driving distance (mile)	Treatment 1 matched data				Treatment 2 matched data			
	Model II-13		Model II-14		Model II-13		Model II-14	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	33.0190	*	37.3150	**	16.4497		19.5095	
Household characteristics								
The number of children	-2.7929	**	-2.7972	**	-2.4424	*	-2.3131	
HH income: \$0-\$49,999	-4.8641		-4.8118		-5.2720		-5.0109	
HH income: \$50,000-\$99,999	-1.0306		-0.8469		-1.6730		-1.4473	
Number of vehicles	-0.7441		-0.9167		0.6968		0.4474	
Male head's characteristics								
Age	0.5148		0.3943		1.7556		1.7414	
Square age	-0.0065		-0.0055		-0.0190	*	-0.0189	*
Hispanic	4.0450		3.8280		4.7204		4.5438	
African-American	2.3404		1.9023		7.3471		6.8512	
Valid driver license	3.2268		3.2818		2.2244		2.3307	
Employed	1.5442		1.4817		1.8842		1.8686	
Female head's characteristics								
Age	0.4639		0.5225		-0.2401		-0.2566	
Square age	-0.0050		-0.0056		0.0038		0.0039	
Hispanic	0.0833		-0.0512		-2.6247		-2.6155	
African-American	-0.4073		-1.1242		-4.5380		-4.9001	
Valid driver license	-4.2010		-4.1263		-5.7148		-5.5514	
Employed	-4.9951	**	-4.7449	**	-5.7243	**	-5.5208	**
Street connectivity								
Low-medium	-2.8917				-3.5491			
Medium-high	-6.7246	**			-5.2766			
High	-2.7888				-4.4675			
Regional accessibility								
Low-medium	-7.6701	***	-6.3246	**	-7.6940	***	-6.3669	**
Medium-high	-9.9015	***	-8.0086	***	-11.8326	***	-10.0689	***
High	-15.7425	***	-12.2146	***	-14.3496	***	-11.2089	**
Local accessibility								
Low-medium	-3.9592				-2.4129			
Medium-high	-1.6071				-0.7901			
High	-1.1223				0.2112			
Walkable neighborhood								
Walk Score			-0.1485	***			-0.1419	**
Sample size	2549		2549		2020		2020	
Treated units	1867		1867		1239		1239	
Control units	682		682		781		781	
P-value of χ^2(goodness of fit)	7.39E-08		3.21E-09		3.85E-05		1.28E-06	
Street connectivity	0.1207				0.3979			
Regional accessibility	2.35E-05***		0.0055***		0.0007***		0.0171**	
Local accessibility	0.4703				0.8391			
Walk score			0.0026***				0.0143**	
Log-likelihood	-13289.37		-13289.71		-10668.39		-10667.57	
McFadden adjusted R²	0.0012		0.0015		0.0006		0.0012	

Significance: * p < .1, ** p < .05, *** p < .01.

Table D-17 Tobit model for estimating gendered inequality in daily automobile travel distance based on the PSM data

Dependent variable: Gendered inequality in automobile travel distance (mile)	Treatment 1 matched data				Treatment 2 matched data			
	Model II-15		Model II-16		Model II-15		Model II-16	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	12.4932		15.0802		3.7482		5.6173	
Household characteristics								
The number of children	-2.6094	***	-2.7000	***	-1.9277	*	-1.9312	*
HH income: \$0-\$49,999	-4.2778	*	-4.0226		-3.7116		-3.4125	
HH income: \$50,000-\$99,999	-0.6654		-0.5023		-0.0900		0.1313	
Number of vehicles	1.4061		1.3254		1.1001		0.9420	
Male head's characteristics								
Age	-0.4589		-0.4790		0.8834		0.8935	
Square age	0.0046		0.0047		-0.0070		-0.0071	
Hispanic	4.9670	**	4.9136	**	5.9779	**	5.8285	**
African-American	3.8789		3.4926		8.3808		8.4878	
Valid driver license	1.6006		1.6833		-0.6294		-0.7472	
Employed	6.2542	***	6.2140	***	6.4394	***	6.5288	***
Female head's characteristics								
Age	1.0302		1.0724		0.1635		0.1793	
Square age	-0.0134	*	-0.0139	**	-0.0054		-0.0056	
Hispanic	-0.3010		-0.3663		-1.8063		-1.7509	
African-American	1.8973		1.6984		-5.1998		-5.9934	
Valid driver license	1.7024		1.6551		-1.8974		-1.6531	
Employed	-1.4199		-1.2937		-0.5426		-0.3547	
Street connectivity								
Low-medium	2.5046				-0.7881			
Medium-high	-0.0702				-2.9188			
High	0.1950				-3.6534			
Regional accessibility								
Low-medium	-5.9947	***	-4.3866	**	-5.4331	**	-4.0059	*
Medium-high	-8.6329	***	-6.6458	***	-7.8076	***	-5.9843	**
High	-11.5808	***	-9.2100	***	-12.3140	***	-9.5915	***
Local accessibility								
Low-medium	-0.2972				-0.2478			
Medium-high	-0.9689				-0.2873			
High	-1.5695				1.1169			
Walkable neighborhood								
Walk Score			-0.0765	**			-0.1045	**
Sample size	2558		2558		2062		2062	
Treated units	1890		1890		1250		1250	
Control units	668		668		812		812	
P-value of χ^2 (goodness of fit)	3.81E-13		3.12E-15		9.05E-09		6.94E-11	
Street connectivity	0.5237				0.5303			
Regional accessibility	2.26E-05***		0.0047***		0.0006***		0.0280**	
Local accessibility	0.9228				0.9661			
Walk score			0.0417**				0.0163**	
Log-likelihood	-11740.63		-11739.91		-9533.38		-9531.75	
McFadden adjusted R²	0.0027		0.0032		0.0019		0.0026	

Significance: * p < .1, ** p < .05, *** p < .01.

Table D-18 Tobit model for estimating gendered inequality in daily VMT based on the PSM data

Dependent variable: Gendered inequality in VMT (mile)	Treatment 1 matched data				Treatment 2 matched data			
	Model II-17		Model II-18		Model II-17		Model II-18	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Intercept	9.0138		10.2714		2.9833		3.5897	
Household characteristics								
The number of children	-2.5882	***	-2.6191	***	-1.7032	**	-1.6918	*
HH income: \$0-\$49,999	-2.5419		-2.5178		-2.1739		-2.2353	
HH income: \$50,000-\$99,999	0.1002		0.1724		-0.0823		-0.0502	
Number of vehicles	1.3793	*	1.3389		1.1440		1.0699	
Male head's characteristics								
Age	-0.6091		-0.6274		0.5448		0.5682	
Square age	0.0055		0.0057		-0.0045		-0.0046	
Hispanic	4.0764	**	4.0106	**	4.7447	**	4.6591	**
African-American	3.7839		3.4501		8.8030		9.1092	*
Valid driver license	5.2524		5.4107		2.2285		2.3247	
Employed	6.4414	***	6.4003	***	6.5855	***	6.6552	***
Female head's characteristics								
Age	1.0136		1.0477		0.1870		0.1629	
Square age	-0.0125	**	-0.0128	**	-0.0047		-0.0045	
Hispanic	0.3853		0.3739		-0.4870		-0.4867	
African-American	1.8828		1.7404		-4.9863		-5.8226	
Valid driver license	1.2868		1.2322		-0.9819		-0.7144	
Employed	-0.6599		-0.5792		0.0448		0.1422	
Street connectivity								
Low-medium	0.8432				-1.3611			
Medium-high	-1.1370				-3.9462	*		
High	-0.7209				-3.1407			
Regional accessibility								
Low-medium	-3.8494	**	-3.1100	*	-2.4088		-2.1219	
Medium-high	-6.1879	***	-5.3030	***	-4.9526	**	-4.6380	**
High	-9.3563	***	-8.2404	***	-9.6758	***	-8.8508	***
Local accessibility								
Low-medium	-1.1892				-0.9212			
Medium-high	-1.4244				-0.8549			
High	-2.0596				0.5515			
Walkable neighborhood								
Walk Score			-0.0630	**			-0.0657	*
Sample size	2558		2558		2062		2062	
Treated units	1890		1890		1250		1250	
Control units	668		668		812		812	
P-value of χ^2(goodness of fit)	6.05E-16		4.17E-18		6.40E-11		2.58E-12	
Street connectivity	0.7292				0.2709			
Regional accessibility	0.0001***		0.0034***		0.0020***		0.0100***	
Local accessibility	0.7729				0.8952			
Walk score			0.0480**				0.0653*	
Log-likelihood	-11378.49		-11377.97		-9180.72		-9181.57	
McFadden adjusted R²	0.0034		0.0039		0.0027		0.0032	

Significance: * p < .1, ** p < .05, *** p < .01.

Appendix E: Conditions that Fail to Delineate Standard Deviation Ellipse (SDE)

The main text of this dissertation has mentioned that SDE is applicable for individual who visited more than 2 unique destinations and the visited places should not be in alignment. This appendix provides the proofs that to support the main text of this dissertation. Recall that weighted SDE is defined as (Buliung & Kanaroglou, 2006; ESRI, 2016a; Levine, 2013; Yuill, 1971):

$$\begin{aligned}\bar{X}_w &= \frac{\sum_{k=1}^K w_k \cdot x_k}{\sum_{k=1}^K w_k}; \bar{Y}_w = \frac{\sum_{k=1}^K w_k \cdot y_k}{\sum_{k=1}^K w_k} \\ \tan \theta &= \frac{A + C}{B} \\ A &= \sum_{k=1}^K w_k (x_k - \bar{X}_w)^2 - \sum_{k=1}^K w_k (y_k - \bar{Y}_w)^2 \\ B &= 2 \cdot \sum_{k=1}^K w_k (x_k - \bar{X}_w) \cdot (y_k - \bar{Y}_w) \\ C &= \sqrt{A^2 + B^2} \\ SD_X &= \sqrt{2} \cdot \sqrt{\frac{\sum_{k=1}^K w_k ((x_k - \bar{X}_w) \cdot \cos \theta - (y_k - \bar{Y}_w) \cdot \sin \theta)^2}{\sum_{k=1}^K w_k}} \\ SD_Y &= \sqrt{2} \cdot \sqrt{\frac{\sum_{k=1}^K w_k ((x_k - \bar{X}_w) \cdot \sin \theta + (y_k - \bar{Y}_w) \cdot \cos \theta)^2}{\sum_{k=1}^K w_k}}\end{aligned}$$

$\bar{X}_w$ and $\bar{Y}_w$, the weighted mean center of SDE

SD_x and SD_y , the weighted standard deviation axes for the SDE

Major axis= max (SD_x , SD_y); minor axis= min (SD_x , SD_y)

Destinations 1 to K visited by the individual

w_k , the total activity duration spending at destination k by the individual

Proof: SDE cannot be generated when the visited places were in alignment

Given that n points $(x_1, y_1), (x_2, y_2) \dots (x_n, y_n)$ are in alignment, these n points can be described by linear equation, $Y=aX+b$. Each point is associated with a weight that represents the attribute of the point.

Point	X	Y	Weight
1	x_1	$y_1=ax_1+b$	w_1
2	x_2	$y_2=ax_2+b$	w_2
$\vdots$	$\vdots$	$\vdots$	$\vdots$
K	x_K	$y_K =ax_K+b$	w_K

The weighted mean center is: $\bar{X}_w = \frac{\sum_{k=1}^K w_k x_k}{\sum_{k=1}^K w_k}$; $\bar{Y}_w = \frac{\sum_{k=1}^K w_k y_k}{\sum_{k=1}^K w_k}$

Based on the definition of SDE, A, B, C can be described as:

$$\begin{aligned}
 A &= \sum_{k=1}^K w_k (x_k - \bar{X}_w)^2 - \sum_{k=1}^K w_k (y_k - \bar{Y}_w)^2 \\
 &= \sum_{k=1}^K w_k (x_k - \bar{X}_w)^2 - \sum_{k=1}^K w_k (ax_k + b - a\bar{X}_w - b)^2 \\
 &= \sum_{k=1}^K w_k (x_k - \bar{X}_w)^2 - a^2 \cdot \left(\sum_{k=1}^K w_k (x_k - \bar{X}_w)^2 \right)
 \end{aligned}$$

Let's substitute $\sum_{k=1}^K w_k (x_k - \bar{X}_w)^2$ by M

$$A = (1 - a^2) M$$

$$\begin{aligned}
 B &= 2 \cdot \sum_{k=1}^K w_k (x_k - \bar{X}_w) \cdot (y_k - \bar{Y}_w) \\
 &= 2 \cdot \sum_{k=1}^K w_k (x_k - \bar{X}_w) \cdot (ax_k + b - a\bar{X}_w - b)
 \end{aligned}$$

$$\begin{aligned}
&= 2a \cdot \left(\sum_{k=1}^K w_k (x_k - \bar{X}_W)^2 \right) \\
&= 2aM
\end{aligned}$$

$$C = \sqrt{A^2 + B^2} = \sqrt{M^2(1 - 2a^2 + a^4) + 4a^2M^2} = (1 + a^2) M$$

$$\tan \theta = \frac{A+C}{B} = \frac{(1-a^2)M + (1+a^2)M}{2aM} = \frac{1}{a} = \frac{\sin \theta}{\cos \theta}$$

Let $\sin \theta = t$ and $\cos \theta = at$

$$\begin{aligned}
SD_X &= \sqrt{2} \cdot \sqrt{\frac{\sum_{k=1}^K w_k ((x_k - \bar{X}_W) \cdot at - (y_k - \bar{Y}_W) \cdot t)^2}{\sum_{k=1}^K w_k}} \\
&= \sqrt{2} \cdot \sqrt{\frac{\sum_{k=1}^K w_k ((x_k - \bar{X}_W) \cdot at - (ax_k + b - a\bar{X}_W - b) \cdot t)^2}{\sum_{k=1}^K w_k}} \\
&= \sqrt{2} \cdot \sqrt{\frac{\sum_{k=1}^K w_k \cdot (at)^2 \cdot ((x_k - \bar{X}_W) - (x_k - \bar{X}_W))^2}{\sum_{k=1}^K w_k}} \\
&= 0
\end{aligned}$$

$$\begin{aligned}
SD_Y &= \sqrt{2} \cdot \sqrt{\frac{\sum_{k=1}^K w_k ((x_k - \bar{X}_W) \cdot t + (y_k - \bar{Y}_W) \cdot at)^2}{\sum_{k=1}^K w_k}} \\
&= \sqrt{2} \cdot \sqrt{\frac{\sum_{k=1}^K w_k ((x_k - \bar{X}_W) \cdot t + (ax_k + b - a\bar{X}_W - b) \cdot at)^2}{\sum_{k=1}^K w_k}} \\
&= \sqrt{2} \cdot \sqrt{\frac{\sum_{k=1}^K w_k ((x_k - \bar{X}_W) \cdot t + (x_k - \bar{X}_W) \cdot a^2 t)^2}{\sum_{k=1}^K w_k}} \\
&= \sqrt{2} \cdot \sqrt{\frac{\sum_{k=1}^K w_k [(x_k - \bar{X}_W)^2 (t + a^2 t)]}{\sum_{k=1}^K w_k}} = \sqrt{2} \cdot (t + a^2 t) \sqrt{\frac{\sum_{k=1}^K w_k [(x_k - \bar{X}_W)^2]}{\sum_{k=1}^K w_k}} \\
&= \sqrt{2} \cdot (t + a^2 t) \sqrt{\frac{\sum_{k=1}^K w_k (x_k^2 + \bar{X}_W^2 - 2x_k \cdot \bar{X}_W)}{\sum_{k=1}^K w_k}} = \sqrt{2} \cdot (t + a^2 t) \sqrt{\frac{(\sum_{k=1}^K w_k x_k^2) - \bar{X}_W^2 \sum_{k=1}^K w_k}{\sum_{k=1}^K w_k}}
\end{aligned}$$

The derivations above prove that SDE cannot be delineated when all the visited points are situated along the same line because SD_X is zero.

When K is 2, SD_X remains 0, indicating that two points cannot form a SDE as well.

Appendix F: Validation of the Proportional Odds Assumption for the Data Used in Chapter 3

The proportional odds assumption for ordinal logit regression assumes that the effects of a predictor on the odds at different response levels remain a linear relationship (Harrell, 2015; Liu & Koirala, 2012). In other words, each of the independent variables in the model has constant effect across all the ordinal responses (Ari & Zeki, 2014; Greene & Hensher, 2010; Liu & Koirala, 2012). Harrell (2015) suggested plotting how ordinal responses vary with each predictor in order to validate the assumption.

To understand whether ordinality holds for the data used in Chapter 3 (the 1,316 households with paired heads), this appendix uses Harrell's graphical methods to examine the relationships between the ordinal responses of gendered differences in spatial behaviors with respect to the independent variables controlled in the models. The proportional assumption holds if the relationship between the ordinal response and the mean independent variable follow a monotonic trend.

The gendered difference in spatial behaviors has three levels, "female head's spatial behavior is smaller than her husband's", "the paired heads have same spatial behaviors", and "female head's spatial behavior is greater than her husband's", coded 1, 2, and 3, respectively. Eight spatial behaviors are included: "SDE area", "MCP area", "distance between home and SDE centroid", "distance between home and MCP centroid", "SDE eccentricity", "SDE elongation", "MCP spatial concentration", "SDE activity density weighted by eccentricity", and

“MCP activity concentration”. See Chapter 3 for the definitions of these spatial behaviors in detail.

Figure F-1 to Figure F-12 provide the graphical results of how the ordinal responses vary with the mean of each predictor. In each subfigure, the x-axis represents the ordinal responses at levels 1, 2, and 3, and the y-axis is the stratified mean predictor, including the presence of children, household income level, number of household vehicle, head’s age, ethnicity, possession of driver license, being employed, regional accessibility, and walk score.

The dash line represents the predicted value of the independent variable given the ordinal response when proportional odds assumption holds, and the solid line shows the mean of the independent variable stratified by the ordinal responses based on Chapter 3’s data. Overall, the relationships between the ordinal responses and the mean independent variables do not suggest any monotonic trends; therefore, it is concluded that the dataset of Chapter 3 fail to support for the ordinality assumption and it is suggested to seek for other regression methods instead of using ordinal logit model.

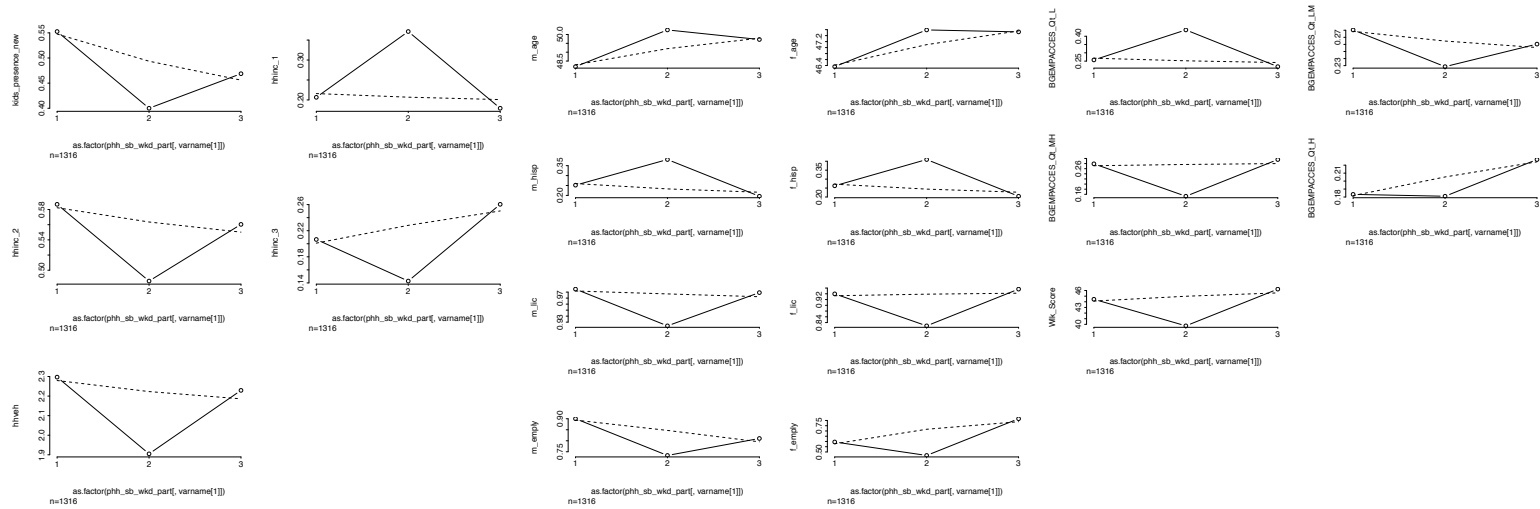


Figure F-1 Ordinality of SDE area by the stratified mean predictor

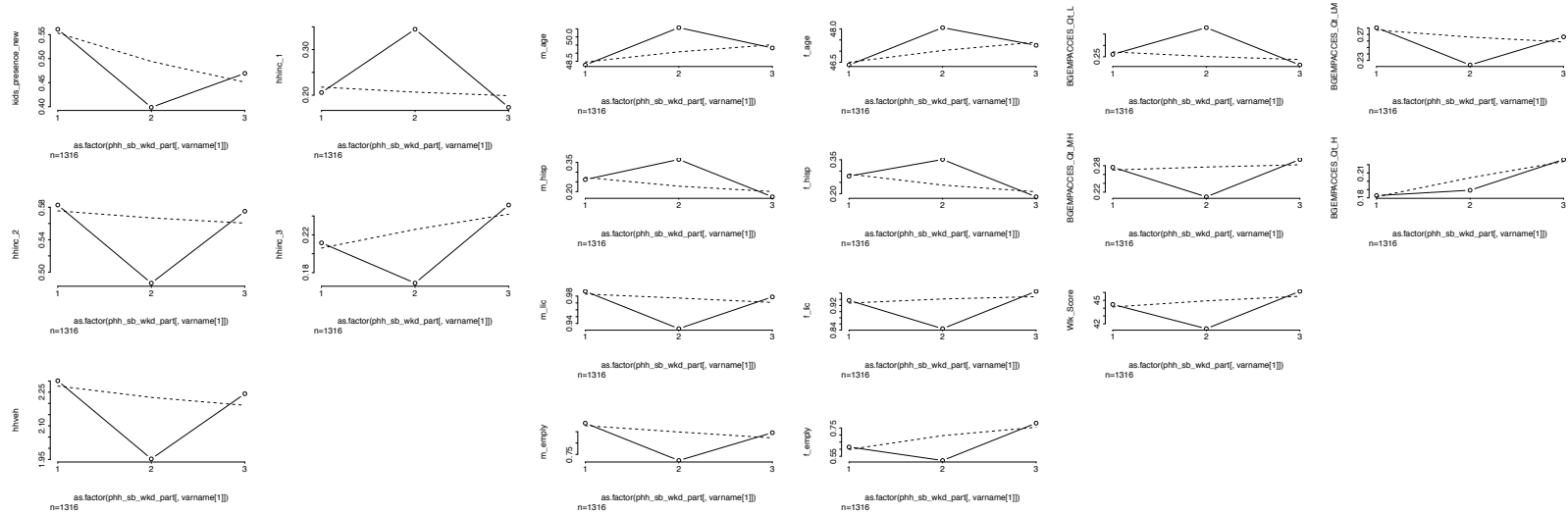


Figure F-2 Ordinality of MCP area by the stratified mean predictor

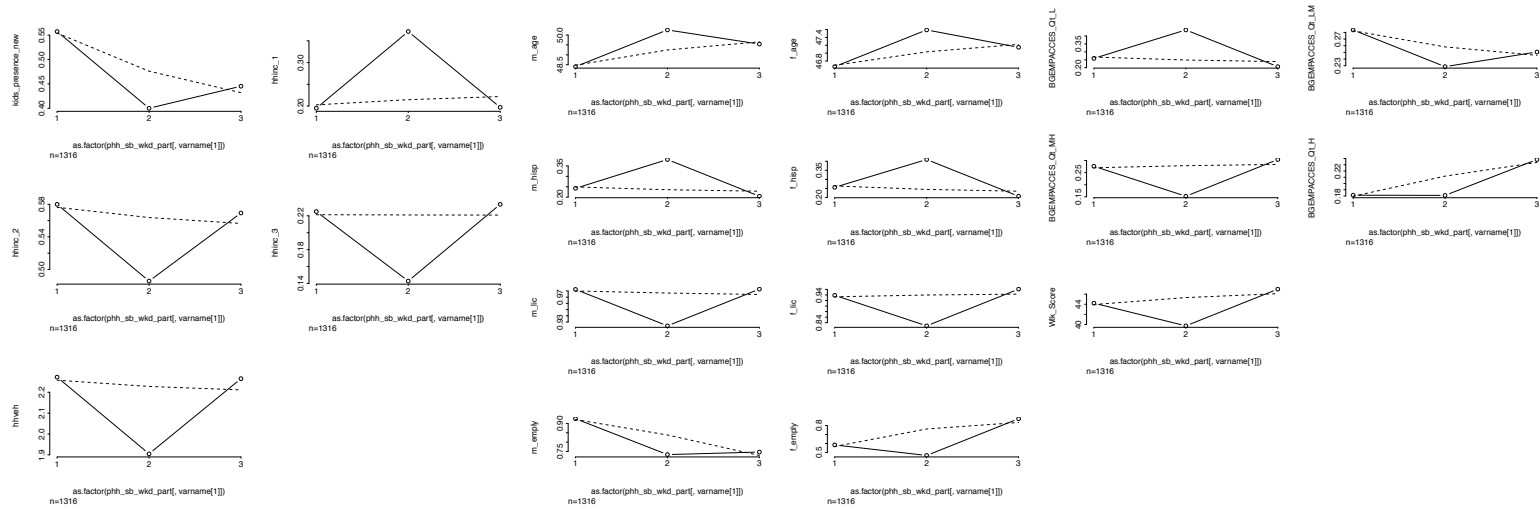


Figure F-3 Ordinality of the distance between home and SDE centroid by the stratified mean predictor

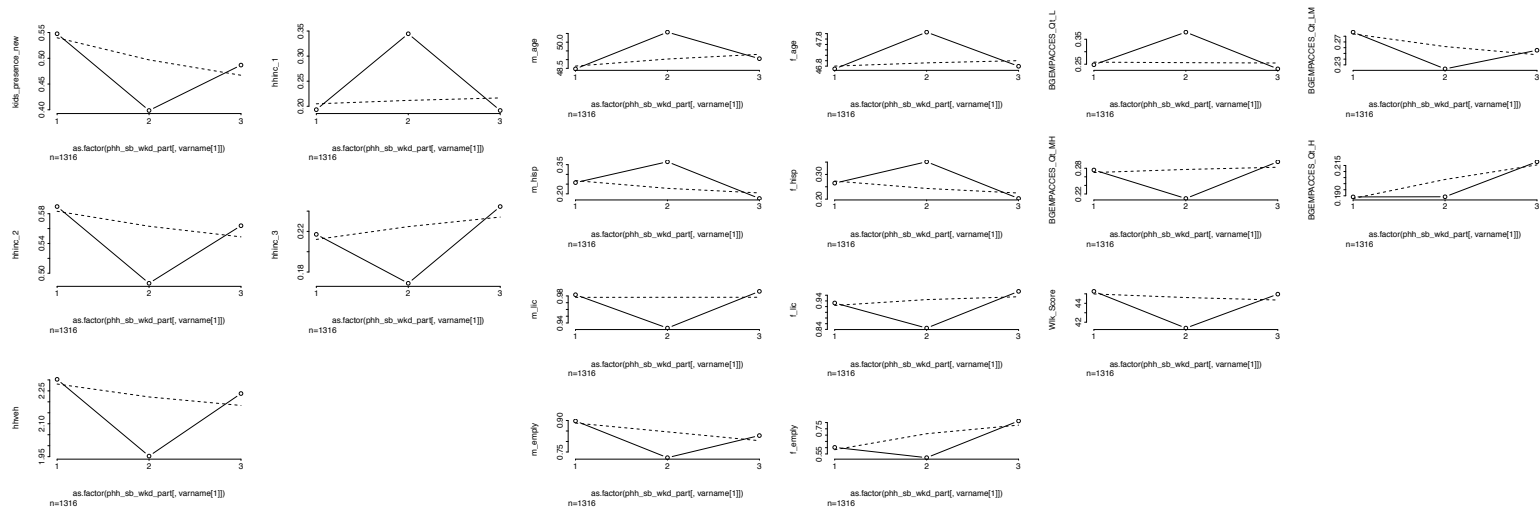


Figure F-4 Ordinality of the distance between home and MCP centroid by the stratified mean predictor

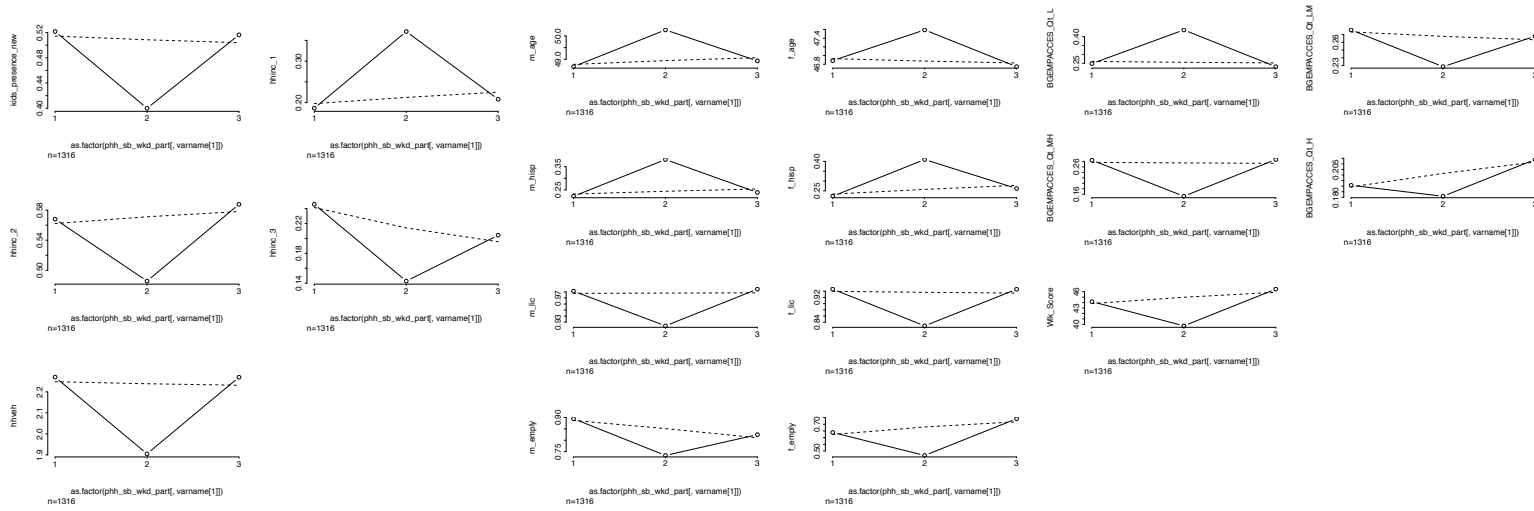


Figure F-5 Ordinality of SDE elongation by the stratified mean predictor

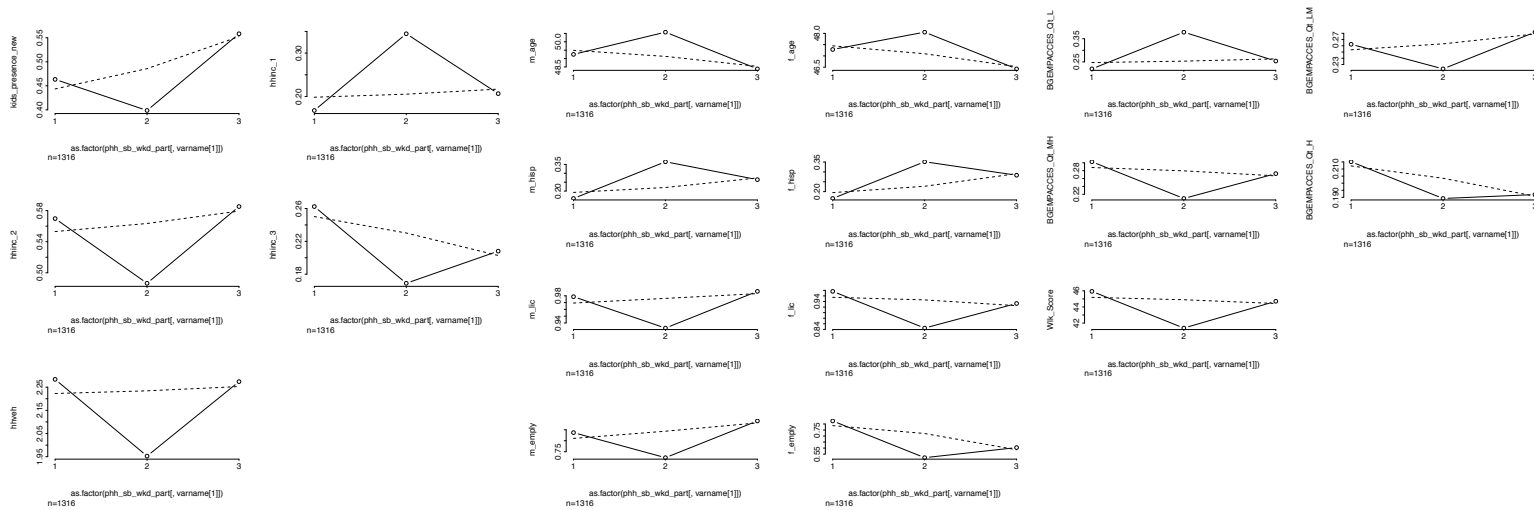


Figure F-6 Ordinality of MCP spatial concentration by the stratified mean predictor

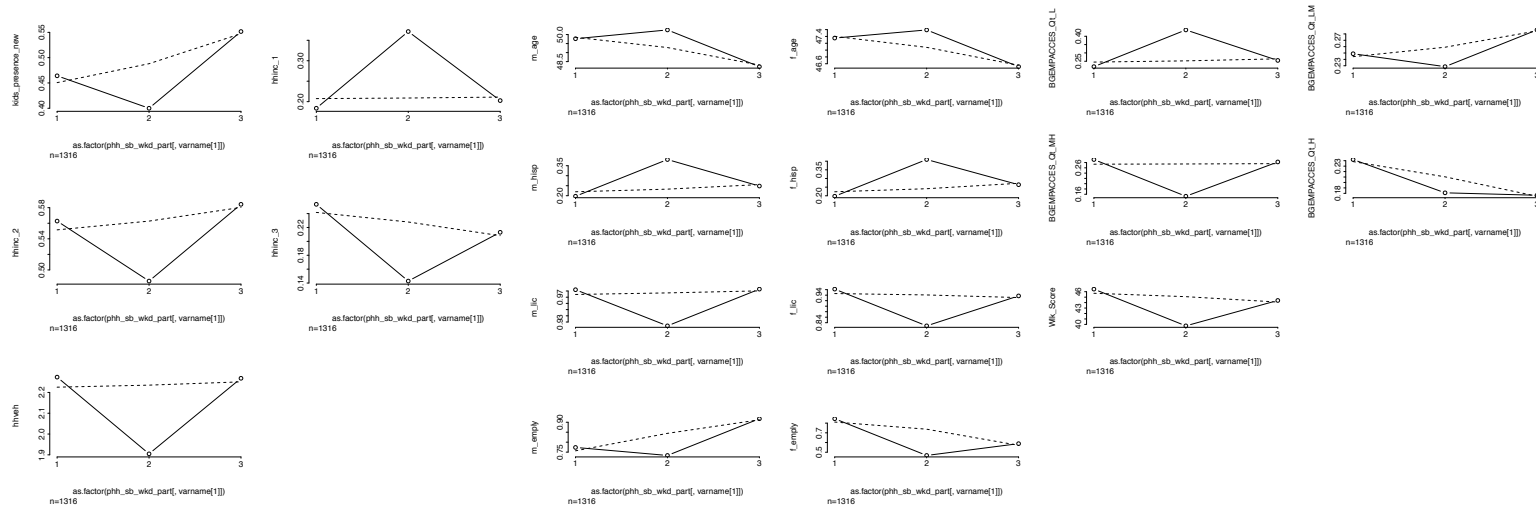


Figure F-7 Ordinality of weighted SDE activity density by the stratified mean predictor

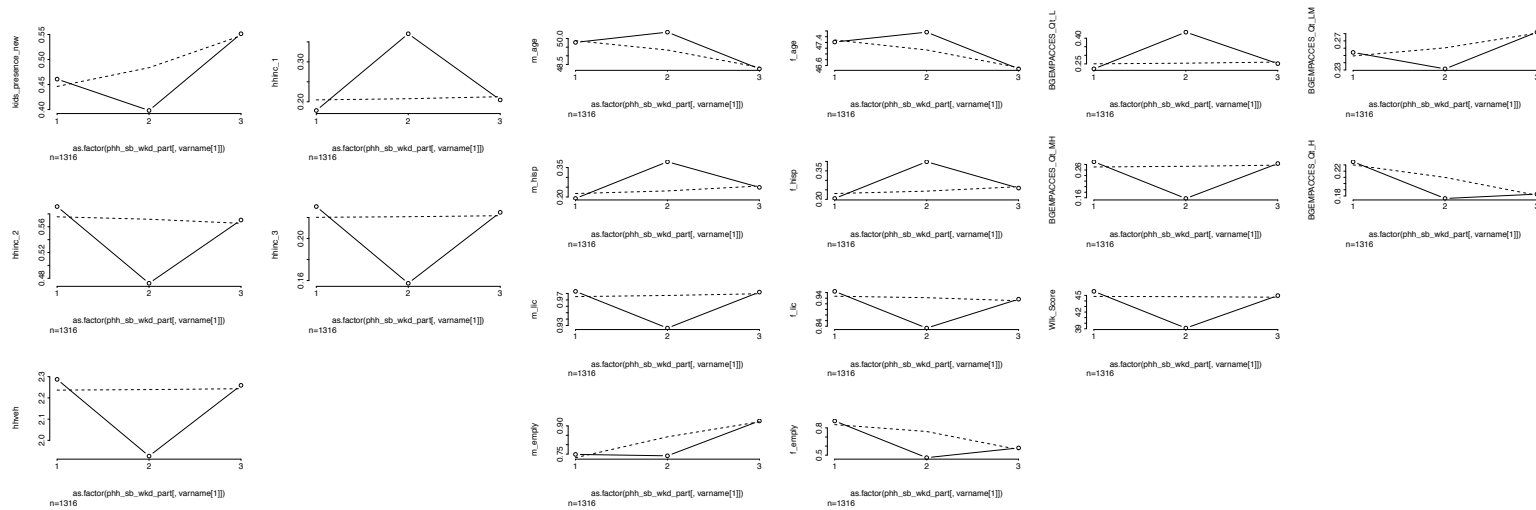


Figure F-8 Ordinality of MCP activity concentration by the stratified mean predictor

Appendix G: Propensity Score Matching Result for the 1316 Households with Paired Heads in Chapter 3

Chapter 3 argued the problem of residential selection bias could be arisen for research on spatial behaviors because people who like to accomplish tasks within the neighborhood proximities may choose to live in an area with compact design elements. Some previous research on activity space behaviors have also accounted for people's travel and movement preferences to avoid selection bias (Fan & Khattak, 2008; Harding et al., 2014; Perchoux et al., 2014). Similar to what has been done in Chapter 2, Chapter 3 also adopted the propensity score matching (PSM) method to remedy the selection bias problem caused by the correlation of the unobserved attitudes toward preferable spatial behavior and built environments. The PSM technique provides a quasi-experimental environment for non-randomized observations and equally compares the outcomes of treated and control units (d'Agostino, 1998; Rosenbaum & Rubin, 1983). The following paragraphs briefly introduce the mechanism of PSM and the results of the PSM estimations for matching treated and control units for regression samples in Chapter 3.

Mechanism of Propensity Score Matching (PSM)

Propensity score is the conditional probability of a unit that is assigned to the treated group given a set of covariates (Cao et al., 2009; Rosenbaum & Rubin, 1983). The treatment considered in Chapter 3 was whether a household lived in a walkable neighborhood. For a household residing in a walkable neighborhood, the household's Walk Score should be equal to or greater than 70. The propensity score model is shown as below (Rosenbaum & Rubin, 1983):

$$\text{Prob}(y_i = 1|x_i) = F(x_i\beta)$$

where it is assumed that $Prob(y_1, \dots, y_n | x_1, \dots, x_n) = \prod_{i=1}^N F(x_i \beta)^{y_i} (1 - F(x_i \beta))^{(1-y_i)}$

$y_i=1$ when household i received the treatment, 0, otherwise

$F(\cdot)$ denotes the cumulative distribution function

x_i and β represent the observed covariates for household i and the coefficients, respectively

The covariates for calculating the propensity score included the presence of household children under 15 years old, household's income level, the number of household's vehicles, head's age and square age, ethnicity groups, the possession of driver license, and the status of being employed. The PSM estimation was conducted by the MatchIt package in R based on probit link function (Ho et al., 2011, 2013; Randolph et al., 2014). The matching technique used "the nearest neighbor" to match a household in the treatment group with a household in the control group when the control household had the closet propensity score to the treated household. As suggested by Cao and Fan (2012), the estimation used 0.01 as the caliper for pairing the treated and control units.

The PSM Estimation Results for the 1316 Households with Paired Heads Living in Southern California

Tables G1 provides the result based on the PSM estimation. The matching technique paired the 217 treated households with 198 households from the control group. The estimation results show that the mean differences between the treated and control groups were improved, namely the characteristics of the treated and control households became similar after PSM was implemented. The new dataset based on the PSM technique could be used to address the selectivity concern for the activity space study in Chapter 3.

Table G-1 PSM estimation results for the 1,316 households with paired heads in Chapter 3

Treatment:	Summary of balance for all data			Summary of balance for matched data			Percent balance improvement
<i>Household's residence was located in a walkable neighborhood</i>	Means Treated	Means Control	Mean Diff.	Means Treated	Means Control	Mean Diff.	
Propensity score	0.28	0.18	0.10	0.22	0.22	0.00	99.90
HH characteristics							
The presence of children	0.56	0.50	0.06	0.54	0.50	0.04	33.33
HH income: \$0-\$49,999	0.34	0.18	0.16	0.24	0.23	0.01	94.13
HH income: \$50,000-\$99,999	0.49	0.59	-0.10	0.56	0.57	0.00	95.30
Number of vehicles	1.83	2.34	-0.51	2.04	2.03	0.01	98.18
Male head's characteristics							
Age	46.53	49.49	-2.97	47.32	47.43	-0.11	96.27
Square age	2259.61	2538.84	-279.22	2332.89	2346.34	-13.45	95.18
Hispanic	0.36	0.21	0.15	0.29	0.26	0.02	84.74
Valid driver license	0.95	0.99	-0.04	1.00	0.98	0.01	65.32
Employed	0.88	0.85	0.03	0.87	0.87	0.00	100.00
Female head's characteristics							
Age	44.55	47.46	-2.91	45.61	45.61	0.00	100.00
Square age	2079.27	2340.62	-261.34	2171.48	2167.63	3.85	98.53
Hispanic	0.34	0.23	0.10	0.26	0.27	-0.01	91.07
Valid driver license	0.83	0.96	-0.13	0.94	0.94	0.00	96.40
Employed	0.70	0.66	0.05	0.74	0.75	-0.01	80.02
Sample size	Control			Treated			Total
All	1,057			259			1,316
Matched	198			217			415
Unmatched	859			42			901
Discarded	0			0			0

Appendix H: Descriptive Statistics for the Weekend Sample Set for Chapter 3

This appendix provides the descriptive statistics of the spatial behaviors for the 745 households undertaking their travel activities over weekend days based on the 2010-2012 California Household Travel Survey (CHTS). The descriptive statistics provide the mean and median values of the spatial behaviors of male and female heads and the differences between male and female heads. The summaries were stratified by the presence of children, employment status, regional accessibility, and walk score. Tables H-1 to H-5 documents the sizes of activity spaces; Tables H-6 to H-10 summarize the degree of centering activity space on residence; Tables H-11 to H-15 shows the degrees of compactness; Table H-16 to Table H-20 provides the degrees of bounding non-home activities.

Size of Activity Space

Table H-1 Mean and median sizes of activity space

Size of activity space (km ²)	SDE area		MCP area	
	Mean	Median	Mean	Median
All heads	67.89	6.42	79.30	13.15
Male heads	72.68	7.38	84.33	14.99
Female heads	63.11	5.85	74.26	11.79
% Difference	-13.17%	-20.82%	-11.93%	-21.32%
Difference	-9.57	0.00	-10.06	0.00
Sig. ¹	*	***	***	***

Significance: * p < .1, ** p < .05, *** p < .01.

Table H-2 Mean and median sizes of activity space by the presence of household children

Size of activity space by the presence of household children (km ²)		SDE area		MCP area	
		Mean	Median	Mean	Median
Paired heads with children (n=333)	Male heads	85.38	7.99	95.38	15.11
	Female heads	67.77	5.32	80.06	9.39
	% Difference	-20.62%	-33.36%	-16.06%	-37.84%
	Difference	-17.60	0.00	-15.32	0.00
	Sig. ¹	**	***	***	***
Paired heads without children (n=412)	Male heads	62.41	7.27	75.40	14.29
	Female heads	59.33	6.86	69.58	15.69
	% Difference	-4.93%	-5.62%	-7.71%	9.80%
	Difference	-3.08	0.00	-5.81	0.00
	Sig. ¹				*
<i>Hypothesis test for the presence of household children</i>	<i>Male heads²</i>				
	<i>Female heads²</i>				**
	<i>Gendered differences²</i>		*		*

Significance: * p < .1, ** p < .05, *** p < .01.

Table H-3 Mean and median sizes of activity space by employment status

Size of activity space by employment status (km ²)		SDE area		MCP area	
		Mean	Median	Mean	Median
Employed male and female heads (n=438)	Male heads	89.16	8.71	101.66	16.94
	Female heads	78.09	7.65	89.46	15.42
	% Difference	-12.41%	-12.22%	-12.00%	-8.96%
	Difference	-11.06	0.00	-12.19	0.00
	Sig. ¹			**	**
Employed male and unemployed female heads (n=220)	Male heads	52.08	5.53	64.06	11.30
	Female heads	38.05	4.23	52.17	8.12
	% Difference	-26.94%	-23.44%	-18.56%	-28.16%
	Difference	-14.03	0.00	-11.89	0.00
	Sig. ¹	*	***	**	***
Unemployed male and employed female heads (n=47)	Male heads	38.23	4.94	44.83	10.93
	Female heads	57.27	5.63	55.41	15.58
	% Difference	49.81%	14.07%	23.61%	42.56%
	Difference	19.04	0.00	10.58	0.00
	Sig. ¹				
Unemployed male and female heads (n=40)	Male heads	45.98	7.42	52.42	16.37
	Female heads	43.68	1.44	51.51	5.41
	% Difference	-5.01%	-80.61%	-1.72%	-66.99%
	Difference	-2.30	0.00	-0.90	0.00
	Sig. ¹		**		**
<i>Hypothesis test for employment status</i>	<i>Male heads²</i>				
	<i>Female heads²</i>		**		**
	<i>Gendered differences²</i>				

Significance: * p < .1, ** p < .05, *** p < .01.

Table H-4 Mean and median sizes of activity space by regional accessibility

Size of activity space by regional accessibility (km ²)		SDE area		MCP area	
		Mean	Median	Mean	Median
Low regional accessibility (n=178)	Male heads	134.70	9.14	164.62	17.20
	Female heads	126.54	6.25	149.63	12.76
	% Difference	-6.05%	-31.64%	-9.10%	-25.80%
	Difference	-8.15	0.00	-14.99	0.00
	Sig. ¹		***	**	***
Low-medium regional accessibility (n=215)	Male heads	74.79	8.35	76.36	18.25
	Female heads	62.91	8.35	68.80	17.87
	% Difference	-15.89%	0.00%	-9.89%	-2.09%
	Difference	-11.88	0.00	-7.56	0.00
	Sig. ¹				
Medium-high regional accessibility (n=180)	Male heads	53.46	6.83	61.03	13.38
	Female heads	40.37	4.78	49.70	10.18
	% Difference	-24.49%	-30.07%	-18.57%	-23.89%
	Difference	-13.09	0.00	-11.33	0.00
	Sig. ¹			*	*
High regional accessibility (n=262)	Male heads	25.96	4.23	35.56	9.73
	Female heads	21.51	4.21	28.80	8.01
	% Difference	-17.15%	-0.60%	-19.02%	-17.67%
	Difference	-4.45	0.00	-6.77	0.00
	Sig. ¹			*	*
<i>Hypothesis test for regional accessibility</i>	<i>Male heads²</i>	**	**	***	***
	<i>Female heads²</i>	**	***	***	***
	<i>Gendered differences²</i>				

Significance: * p < .1, ** p < .05, *** p < .01.

Table H-5 Mean and median sizes of activity space by walkability

Size of activity space by walkability (km ²)		SDE area		MCP area	
		Mean	Median	Mean	Median
Car-dependent areas (n=392)	Male heads	90.01	8.89	109.25	17.26
	Female heads	77.83	7.83	97.08	16.28
	% Difference	-13.53%	-11.97%	-11.14%	-5.65%
	Difference	-12.18	0.00	-12.17	0.00
	Sig. ¹	**	*	**	***
Somewhat walkable areas (n=201)	Male heads	46.11	7.57	53.83	12.71
	Female heads	39.51	5.68	47.55	9.47
	% Difference	-14.33%	-24.98%	-11.67%	-25.49%
	Difference	-6.61	0.00	-6.28	0.00
	Sig. ¹		*		**
Very walkable areas or walker's paradise (n=152)	Male heads	63.09	4.22	60.38	8.08
	Female heads	56.34	3.65	50.77	7.22
	% Difference	-10.70%	-13.49%	-15.92%	-10.57%
	Difference	-6.75	0.00	-9.61	0.00
	Sig. ¹				
<i>Hypothesis test for walkability</i>	<i>Male heads²</i>		***		***
	<i>Female heads²</i>		***		***
	<i>Gendered differences²</i>				

Significance: * p < .1, ** p < .05, *** p < .01.

Degree of Centering Activity Space on Residential Location

Table H-6 Means and medians of the degree of centering activity space on residence

Degree of centering activity space on residence	D _{SDE} (km)		D _{MCP} (km)	
	Mean	Median	Mean	Median
All heads	3.43	1.05	8.40	0.39
Male heads	3.75	1.12	8.79	0.40
Female heads	3.11	1.01	8.01	0.38
% Difference	-17.10%	-10.18%	-8.82%	-4.76%
Difference	-0.64	0.00	-0.78	-0.02
Sig. ¹	***	***	***	***

Significance: * p < .1, ** p < .05, *** p < .01.

Table H-7 Means and medians of the degree of centering activity space on residence by the presence of household children

Degree of centering activity space on residence by the presence of household children		D _{SDE} (km)		D _{MCP} (km)	
		Mean	Median	Mean	Median
Paired heads with children (n=333)	Male heads	3.50	1.20	8.08	4.51
	Female heads	2.68	0.99	7.18	3.45
	% Difference	-23.30%	-17.48%	-11.15%	-23.49%
	Difference	-0.82	0.00	-0.90	0.00
	Sig. ¹	***	***	***	***
Paired heads without children (n=412)	Male heads	3.96	1.08	9.36	4.23
	Female heads	3.46	1.04	8.69	3.95
	% Difference	-12.67%	-3.23%	-7.20%	-6.52%
	Difference	-0.50	0.00	-0.67	0.00
	Sig. ¹	***		**	
<i>Hypothesis test for the presence of household children</i>	<i>Male heads²</i>				
	<i>Female heads²</i>	*			*
	<i>Gendered differences²</i>				*

Significance: * p < .1, ** p < .05, *** p < .01.

Table H-8 Means and medians of the degree of centering activity space on residence by employment status

Degree of centering activity space on residence by employment status		D _{SDE} (km)		D _{MCP} (km)	
		Mean	Median	Mean	Median
Employed male and female heads (n=438)	Male heads	4.09	1.08	9.15	4.54
	Female heads	3.34	1.02	8.12	3.83
	% Difference	-18.40%	-5.89%	-11.24%	-15.57%
	Difference	-0.75	0.00	-1.03	0.00
	Sig. ¹	***	*	***	
Employed male and unemployed female heads (n=220)	Male heads	3.08	1.28	7.59	4.06
	Female heads	2.42	1.00	7.16	3.51
	% Difference	-21.43%	-21.46%	-5.63%	-13.65%
	Difference	-0.66	0.00	-0.43	0.00
	Sig. ¹	***	***		
Unemployed male and employed female heads (n=47)	Male heads	3.60	0.84	9.75	3.77
	Female heads	3.86	0.86	9.35	4.73
	% Difference	7.02%	1.99%	-4.15%	25.48%
	Difference	0.25	0.00	-0.40	0.00
	Sig. ¹				
Unemployed male and female heads (n=40)	Male heads	3.91	1.53	10.27	3.11
	Female heads	3.53	0.84	9.92	2.68
	% Difference	-9.58%	-44.84%	-3.40%	-13.92%
	Difference	-0.37	0.00	-0.35	0.00
	Sig. ¹	**	**		
Hypothesis test for employment status	Male heads²				
	Female heads²				
	Gendered differences²				

Significance: * p < .1, ** p < .05, *** p < .01.

Table H-9 Means and medians of the degree of centering activity space on residence by regional accessibility

Degree of centering activity space on residence by regional accessibility		D _{SDE} (km)		D _{MCP} (km)	
		Mean	Median	Mean	Median
Low regional accessibility (n=178)	Male heads	4.79	1.30	12.22	4.97
	Female heads	4.23	1.02	11.33	4.13
	% Difference	-11.57%	-21.98%	-7.25%	-16.96%
	Difference	-0.55	0.00	-0.89	0.00
	Sig. ¹	**	*	*	
Low-medium regional accessibility (n=215)	Male heads	4.37	1.12	10.20	4.97
	Female heads	3.58	1.24	9.37	4.85
	% Difference	-18.10%	10.82%	-8.09%	-2.51%
	Difference	-0.79	0.00	-0.82	0.00
	Sig. ¹	**		*	
Medium-high regional accessibility (n=180)	Male heads	2.90	1.07	6.83	3.80
	Female heads	2.42	1.00	6.14	3.45
	% Difference	-16.54%	-6.43%	-9.98%	-9.11%
	Difference	-0.48	0.00	-0.68	0.00
	Sig. ¹	*		*	
High regional accessibility (n=262)	Male heads	2.81	1.05	5.54	3.53
	Female heads	2.10	0.83	4.84	2.87
	% Difference	-25.48%	-21.49%	-12.61%	-18.82%
	Difference	-0.72	0.00	-0.70	0.00
	Sig. ¹	***	***	**	**
<i>Hypothesis test for regional accessibility</i>	<i>Male heads²</i>	**		***	***
	<i>Female heads²</i>	***	**	***	***
	<i>Gendered differences²</i>				

Significance: * p < .1, ** p < .05, *** p < .01.

Table H-10 Means and medians of the degree of centering activity space on residence by walkability

Degree of centering activity space on residence by walkability		D _{SDE} (km)		D _{MCP} (km)	
		Mean	Median	Mean	Median
Car-dependent areas (n=392)	Male heads	4.13	1.21	10.34	4.85
	Female heads	3.44	1.09	9.42	4.28
	% Difference	-16.76%	-9.39%	-8.84%	-11.69%
	Difference	-0.69	0.00	-0.91	0.00
	Sig. ¹	***		***	
Somewhat walkable areas (n=201)	Male heads	3.22	1.07	7.17	3.69
	Female heads	2.92	0.93	6.72	3.16
	% Difference	-9.39%	-12.77%	-6.28%	-14.34%
	Difference	-0.30	0.00	-0.45	0.00
	Sig. ¹	**			
Very walkable areas or walker's paradise (n=152)	Male heads	3.48	1.05	6.93	3.73
	Female heads	2.52	0.72	6.09	2.85
	% Difference	-27.55%	-31.35%	-12.23%	-23.40%
	Difference	-0.96	0.00	-0.85	0.00
	Sig. ¹	***	***	***	**
<i>Hypothesis test for walkability</i>	<i>Male heads²</i>			***	***
	<i>Female heads²</i>		**	***	***
	<i>Gendered differences²</i>				

Significance: * p < .1, ** p < .05, *** p < .01.

Degree of Compactness

Table H-11 Means and medians of the degree of localizing activity space

Degree of localizing activity space	E _{SDE}		SC _{MCP}	
	Mean	Median	Mean	Median
All heads	561.92	7.55	20.46	5.61
MHH	1041.98	7.87	31.10	5.35
FHH	81.86	7.51	9.83	6.11
% Difference	-92.14%	-4.56%	-68.39%	14.23%
Difference	-960.11	0.00	-21.27	0.00
Sig. ¹			***	**

Significance: * p < .1, ** p < .05, *** p < .01.

Table H-12 Means and medians of the degree of localizing activity space by the presence of household children

Degree of localizing activity space by the presence of household children		E _{SDE}		SC _{MCP}	
		Mean	Median	Mean	Median
Paired heads with children (n=333)	Male heads	78.03	7.51	32.90	5.30
	Female heads	51.05	6.98	10.19	5.56
	% Difference	-34.57%	-7.05%	-69.02%	4.94%
	Difference	-26.98	0.00	-22.71	0.00
	Sig. ¹	*		***	**
Paired heads without children (n=412)	Male heads	1821.09	7.97	29.64	5.38
	Female heads	106.77	7.60	9.53	6.25
	% Difference	-94.14%	-4.58%	-67.83%	16.03%
	Difference	-1714.32	0.00	-20.10	0.00
	Sig. ¹			***	
<i>Hypothesis test for the presence of household children</i>	<i>Male heads²</i>				
	<i>Female heads²</i>				
	<i>Gendered differences²</i>				*

Significance: * p < .1, ** p < .05, *** p < .01.

Table H-13 Means and medians of the degree of localizing activity space by employment status

Degree of localizing activity space by employment status		E _{SDE}		SC _{MCP}	
		Mean	Median	Mean	Median
Employed male and female heads (n=438)	Male heads	1711.73	7.27	29.92	5.60
	Female heads	53.35	6.50	9.20	6.15
	% Difference	-96.88%	-10.60%	-69.24%	9.74%
	Difference	-1658.38	0.00	-20.72	0.00
	Sig. ¹			***	**
Employed male and unemployed female heads (n=220)	Male heads	75.36	7.80	39.00	4.41
	Female heads	143.71	8.26	10.81	6.32
	% Difference	90.70%	5.89%	-72.28%	43.26%
	Difference	68.35	0.00	-28.19	0.00
	Sig. ¹			***	
Unemployed male and employed female heads (n=47)	Male heads	169.57	13.04	13.41	4.69
	Female heads	83.27	11.79	9.09	4.74
	% Difference	-50.89%	-9.55%	-32.22%	1.06%
	Difference	-86.30	0.00	-4.32	0.00
	Sig. ¹				
Unemployed male and female heads (n=40)	Male heads	49.65	7.99	21.25	5.32
	Female heads	52.25	8.59	12.11	6.72
	% Difference	5.22%	7.60%	-43.02%	26.36%
	Difference	2.59	0.00	-9.14	0.00
	Sig. ¹				
<i>Hypothesis test for employment status</i>	<i>Male heads²</i>				
	<i>Female heads²</i>				
	<i>Gendered differences²</i>				

Significance: * p < .1, ** p < .05, *** p < .01.

Table H-14 Means and medians of the degree of localizing activity space by regional accessibility

Degree of localizing activity space by regional accessibility		E _{SDE}		SC _{MCP}	
		Mean	Median	Mean	Median
Low regional accessibility (n=178)	Male heads	4148.49	8.79	21.91	4.94
	Female heads	59.10	8.86	8.60	5.49
	% Difference	-98.58%	0.78%	-60.75%	11.24%
	Difference	-4089.39	0.00	-13.31	0.00
	Sig. ¹			*	
Low-medium regional accessibility (n=215)	Male heads	73.26	7.94	34.36	5.34
	Female heads	151.73	7.05	9.14	5.92
	% Difference	107.10%	-11.24%	-73.39%	10.84%
	Difference	78.47	0.00	-25.21	0.00
	Sig. ¹			***	
Medium-high regional accessibility (n=180)	Male heads	43.27	6.72	25.85	4.48
	Female heads	64.81	6.99	9.01	5.80
	% Difference	49.76%	4.11%	-65.15%	29.49%
	Difference	21.53	0.00	-16.84	0.00
	Sig. ¹			**	
High regional accessibility (n=172)	Male heads	83.14	7.62	42.02	7.28
	Female heads	35.93	7.07	12.81	8.92
	% Difference	-56.79%	-7.26%	-69.50%	22.50%
	Difference	-47.22	0.00	-29.20	0.00
	Sig. ¹	*	**	***	**
Hypothesis test for regional accessibility	Male heads²				**
	Female heads²			***	*
	Gendered differences²				

Significance: * p < .1, ** p < .05, *** p < .01.

Table H-15 Means and medians of the degree of localizing activity space by walkability

Degree of localizing activity space by walkability		E _{SDE}		SC _{MCP}	
		Mean	Median	Mean	Median
Car-dependent areas (n=392)	Male heads	1907.42	8.18	25.53	4.87
	Female heads	109.61	7.51	8.30	5.50
	% Difference	-94.25%	-8.25%	-67.48%	12.85%
	Difference	-1797.80	0.00	-17.23	0.00
	Sig. ¹			***	
Somewhat walkable areas (n=201)	Male heads	78.85	6.64	42.55	6.22
	Female heads	54.66	7.54	10.58	6.79
	% Difference	-30.67%	13.56%	-75.13%	9.28%
	Difference	-24.18	0.00	-31.97	0.00
	Sig. ¹			***	
Very walkable areas or walker's paradise (n=152)	Male heads	83.66	8.67	30.30	6.07
	Female heads	46.25	7.19	12.77	7.79
	% Difference	-44.71%	-17.03%	-57.86%	28.40%
	Difference	-37.41	0.00	-17.53	0.00
	Sig. ¹		*	***	*
Hypothesis test for walkability	Male heads²				
	Female heads²			***	**
	Gendered differences²		*		

Significance: * p < .1, ** p < .05, *** p < .01.

Degree of Bounding Non-Home Activities

Table H-1 Means and medians of the degree of bounding non-home activities

Degree of bounding non-home activities	AD _{SDE}		ADE _{SDE}		AD _{MCP}		AC _{MCP}	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
All heads	20.09	0.52	565.35	2.20	7.58	0.26	459.17	84.35
Male heads	24.95	0.48	728.16	1.96	11.05	0.23	706.45	81.20
Female heads	15.22	0.56	402.54	2.44	4.10	0.30	211.88	88.17
% Difference	-38.98%	16.07%	-44.72%	24.52%	-62.87%	28.15%	-70.01%	8.58%
Difference	-9.73	0.00	-325.61	0.00	-6.95	0.00	-494.57	0.00
Sig. ¹						***	***	

Significance: * p < .1, ** p < .05, *** p < .01.

Table H-2 Means and medians of the degree of bounding non-home activities by the presence of household children

Degree of bounding non-home activities by the presence of household children		AD _{SDE}		ADE _{SDE}		AD _{MCP}		AC _{MCP}	
		Mean	Median	Mean	Median	Mean	Median	Mean	Median
Paired heads with children (n=333)	Male heads	18.25	0.46	83.36	1.86	12.47	0.22	504.29	83.04
	Female heads	12.45	0.69	108.25	2.62	4.30	0.38	198.37	88.17
	% Difference	-31.77%	47.63%	29.86%	40.98%	-65.52%	68.51%	-60.66%	6.17%
	Difference	-5.80	0.00	24.89	0.00	-8.17	0.00	-305.92	0.00
	Sig. ¹		***		***		***	***	
Paired heads without children (n=412)	Male heads	30.37	0.49	1249.32	2.01	9.91	0.23	869.84	79.86
	Female heads	17.47	0.51	640.41	2.37	3.95	0.26	222.80	87.61
	% Difference	-42.48%	5.12%	-48.74%	17.64%	-60.17%	10.62%	-74.39%	9.70%
	Difference	-12.90	0.00	-608.91	0.00	-5.96	0.00	-647.04	0.00
	Sig. ¹							***	
<i>Hypothesis test for the presence of household children</i>	<i>Male heads²</i>								
	<i>Female heads²</i>						**		
	<i>Gendered differences²</i>		*		**		***		

Significance: * p < .1, ** p < .05, *** p < .01.

Table H-3 Means and medians of the degree of bounding non-home activities by employment status

Degree of bounding non-home activities by employment status		AD _{SDE}		ADE _{SDE}		AD _{MCP}		AC _{MCP}	
		Mean	Median	Mean	Median	Mean	Median	Mean	Median
Employed male and female heads (n=438)	Male heads	29.12	0.39	1184.06	1.69	9.69	0.20	789.74	80.43
	Female heads	17.45	0.46	554.68	1.93	3.28	0.25	196.44	87.14
	% Difference	-40.09%	17.54%	-53.15%	13.87%	-66.16%	26.82%	-75.13%	8.34%
	Difference	-11.67	0.00	-629.39	0.00	-6.41	0.00	-593.30	0.60
	Sig. ¹							***	**
Employed male and unemployed female heads (n=220)	Male heads	23.19	0.55	88.29	2.24	17.27	0.31	605.05	76.02
	Female heads	13.66	0.79	240.03	2.98	6.56	0.43	239.25	97.28
	% Difference	-41.08%	44.19%	171.88%	32.87%	-62.00%	37.10%	-60.46%	27.96%
	Difference	-9.53	0.00	151.75	0.00	-10.71	0.00	-365.79	3.49
	Sig. ¹		*		**		**	***	
Unemployed male and employed female heads (n=47)	Male heads	6.82	0.69	44.38	3.02	2.09	0.32	230.74	88.81
	Female heads	5.23	0.60	35.88	2.45	1.38	0.26	173.64	79.14
	% Difference	-23.29%	-12.41%	-19.16%	-18.85%	-33.91%	-18.82%	-24.75%	-10.88%
	Difference	-1.59	0.00	-8.50	0.00	-0.71	0.00	-57.10	-3.02
	Sig. ¹				**				
Unemployed male and female heads (n=40)	Male heads	10.27	0.41	58.73	1.21	2.35	0.23	911.05	89.44
	Female heads	11.22	1.39	61.35	4.96	2.83	0.55	275.34	90.85
	% Difference	9.22%	237.93%	4.48%	310.71%	20.60%	140.48%	-69.78%	1.57%
	Difference	0.95	0.00	2.63	0.00	0.48	0.00	-635.71	2.93
	Sig. ¹		**		*	*	***		
<i>Hypothesis test for employment status</i>	<i>Male heads²</i>								
	<i>Female heads²</i>		**		*		**		
	<i>Gendered differences²</i>				**		*		

Significance: * p < .1, ** p < .05, *** p < .01.

Table H-4 Means and medians of the degree of bounding non-home activities by regional accessibility

Degree of bounding non-home activities by regional accessibility		AD _{SDE}		ADE _{SDE}		AD _{MCP}		AC _{MCP}	
		Mean	Median	Mean	Median	Mean	Median	Mean	Median
Low regional accessibility (n=178)	Male heads	30.00	0.38	117.97	1.77	20.71	0.21	707.79	75.55
	Female heads	10.05	0.46	60.90	2.01	2.64	0.25	189.72	77.98
	% Difference	-66.51%	21.80%	-48.38%	13.49%	-87.26%	18.65%	-73.20%	3.21%
	Difference	-19.95	0.00	-57.07	0.00	-18.07	0.00	-518.07	0.31
	Sig. ¹								
Low-medium regional accessibility (n=215)	Male heads	4.18	0.40	31.59	1.80	1.56	0.17	639.39	86.83
	Female heads	7.73	0.44	182.30	1.64	4.85	0.19	186.76	85.73
	% Difference	84.75%	8.29%	477.12%	-8.83%	210.05%	13.90%	-70.79%	-1.27%
	Difference	3.54	0.00	150.71	0.00	3.29	0.00	-452.63	0.00
	Sig. ¹							**	
Medium-high regional accessibility (n=180)	Male heads	43.26	0.48	1605.08	1.85	20.58	0.24	478.86	64.12
	Female heads	11.52	0.72	67.19	2.89	4.76	0.35	180.73	83.25
	% Difference	-73.36%	49.82%	-95.81%	56.66%	-76.88%	43.91%	-62.26%	29.83%
	Difference	-31.73	0.00	-1537.88	0.00	-15.82	0.00	-298.13	0.00
	Sig. ¹		*		*		**	*	
High regional accessibility (n=172)	Male heads	26.53	0.78	1312.64	3.12	2.96	0.34	1027.06	93.66
	Female heads	33.83	0.97	1382.36	3.91	4.01	0.44	298.83	113.60
	% Difference	27.50%	23.24%	5.31%	25.29%	35.56%	29.76%	-70.90%	21.29%
	Difference	7.30	0.00	69.72	0.00	1.05	0.00	-728.23	0.11
	Sig. ¹							***	
Hypothesis test for regional accessibility	Male heads²		**		*		***		
	Female heads²		***		***		***	**	
	Gendered differences²								

Significance: * p < .1, ** p < .05, *** p < .01.

Table H-5 Means and medians of the degree of bounding non-home activities by walkability

Degree of bounding non-home activities by walkability		AD _{SDE}		ADE _{SDE}		AD _{MCP}		AC _{MCP}	
		Mean	Median	Mean	Median	Mean	Median	Mean	Median
Car-dependent areas (n=392)	Male heads	31.04	0.39	781.60	1.60	17.86	0.18	608.60	75.22
	Female heads	6.53	0.47	48.83	1.83	1.75	0.22	177.17	85.18
	% Difference	-78.97%	21.40%	-93.75%	13.97%	-90.22%	20.20%	-70.89%	13.24%
	Difference	-24.51	0.00	-732.78	0.00	-16.11	0.00	-431.43	0.00
	Sig. ¹							**	
Somewhat walkable areas (n=201)	Male heads	6.23	0.48	44.34	1.95	1.99	0.27	818.14	82.15
	Female heads	18.22	0.56	277.22	2.52	7.05	0.37	201.60	88.76
	% Difference	192.66%	16.56%	525.29%	29.47%	254.94%	37.55%	-75.36%	8.05%
	Difference	11.99	0.00	232.89	0.00	5.07	0.00	-616.54	0.00
	Sig. ¹	*	*		**		**	**	
Very walkable areas or walker's paradise (n=152)	Male heads	34.01	0.91	1494.59	4.12	5.51	0.45	811.10	84.57
	Female heads	33.69	1.08	1480.48	4.88	6.29	0.54	315.01	109.27
	% Difference	-0.95%	19.02%	-0.94%	18.26%	14.30%	19.32%	-61.16%	29.20%
	Difference	-0.32	0.00	-14.10	0.00	0.79	0.00	-496.08	-0.02
	Sig. ¹							***	
<i>Hypothesis test for walkability</i>	<i>Male heads²</i>		***		**		***		
	<i>Female heads²</i>	*	***		***	*	***	***	
	<i>Gendered differences²</i>								

Significance: * p < .1, ** p < .05, *** p < .01.

¹ Paired t-test and Wilcoxon signed rank were used to test whether male and female heads had significant differences in mean and median spatial behaviors, respectively

² ANOVA and Kruscal-Wallis tests were respectively adopted to examine whether the mean and median spatial behaviors were significantly different by the presence of children

Appendix I: Estimations of the Gendered Activity Space Behaviors Based on the Weekday Full Sample for Chapter 3

This appendix provides the estimations of the gendered activity space behaviors for the 1,316 households with paired heads based on the weekday full sample. The comparisons between the results in this appendix and in the main text of Chapter 3 (PSM sample) can help clarify whether residential selection attenuated the influences of built environments. Tables I-1 to I-4 documents the estimated results of male and female heads' spatial behaviors in terms of "the size of activity space", "the degree of residential deconcentrating", "compactness degree", and "the degree of bounding non-home activities" based on feasible generalized least square models. Table I-5 shows the sample distributions for the responses of gendered differences in term of spatial behaviors. Note that the within-household gendered differences were rounded half to even, so paired heads were regarded to have the same spatial behaviors when the differences fell between -0.5 and 0.5. Tables I-6 to I-9 provides the estimation results based on binary logit models for the within-household gendered differences in spatial behaviors of the four categories.

Table I-1 Male and female heads spatial behaviors in terms of the size of activity space

Size of the activity space	ln(SDE area)				ln (MCP area)			
	Male		Female		Male		Female	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	0.933		0.961		1.250		1.136	
Household characteristics								
Presence of children	-0.393	**	-0.666	***	-0.188		-0.347	***
HH income: \$0-\$49,999	-0.292		-0.279		-0.150		-0.174	
HH income: \$50,000-\$99,999	0.014		-0.120		0.109		-0.057	
Number of vehicles	0.129		-0.061		0.121	*	-0.093	
Head's characteristics								
Age	0.023		0.048		0.043		0.071	
Square age	0.000		-0.001		-0.001		-0.001	
Hispanic	0.501	***	-0.212		0.409	***	-0.196	
Valid driver license	0.937	**	0.491		0.843	**	0.615	**
Employed	0.921	***	1.049	***	0.403	**	0.592	***
Regional accessibility								
Low-medium	0.022		0.050		0.094		-0.040	
Medium-high	-0.149		0.159		-0.083		0.038	
High	-0.198		0.328		-0.117		0.164	
Walkable neighborhood								
Walk Score	-0.017	***	-0.021	***	-0.016	***	-0.018	***
Sample size	1,316		1,316		1,316		1,316	
Breush-Pegan test	0.40		0.01		0.70		3.56E-03	
Adjusted R²	0.08		0.11		0.08		0.09	
P-value of F-statistic	< 2.2e-16		< 2.2e-16		< 2.2e-16		< 2.2e-16	

Significance: * p < .1, ** p < .05, *** p < .01.

Table I-2 Male and female heads spatial behaviors in terms of the degree of residential deconcentrating

Degree of centering activity space on residence	ln (D _{SDE})				ln (D _{MCP})			
	Male		Female		Male		Female	
Independent variable	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-0.021		1.360		0.869		1.889	***
Household characteristics								
Presence of children	-0.033		-0.338	***	-0.103		-0.185	***
HH income: \$0-\$49,999	-0.432	***	-0.070		-0.197	*	-0.028	
HH income: \$50,000-\$99,999	-0.154		-0.211	*	-0.025		-0.055	
Number of vehicles	0.018		0.056		0.084	**	0.008	
Head's characteristics								
Age	0.036		-0.058		0.032		-0.011	
Square age	0.000		0.001		0.000		0.000	
Hispanic	0.317	***	-0.003		0.256	***	-0.078	
Valid driver license	-0.206		-0.096		0.182		0.137	
Employed	1.313	***	1.432	***	0.352	***	0.438	***
Regional accessibility								
Low-medium	0.042		0.072		-0.023		-0.089	
Medium-high	-0.074		-0.024		-0.216	**	-0.121	
High	-0.230		0.215		-0.357	***	-0.039	
Walkable neighborhood								
Walk Score	-0.010	***	-0.012	***	-0.007	***	-0.010	***
Sample size	1,316		1,316		1,316		1,316	
Breush-Pegan test	1.01E-03		0.13		0.02		0.14	
Adjusted R²	0.12		0.18		0.10		0.11	
P-value of F-statistic	< 2.2e-16		< 2.2e-16		< 2.2e-16		< 2.2e-16	

Significance: * p < .1, ** p < .05, *** p < .01.

Table I-3 Male and female heads spatial behaviors in terms of the compactness degree

Degree of localizing activity space	ln(E _{SDE})				ln(SC _{MCP})			
	Male		Female		Male		Female	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	2.192	**	3.296	***	4.657	***	4.264	***
Household characteristics								
Presence of children	0.185	*	0.084		0.143		0.356	***
HH income: \$0-\$49,999	-0.210		0.164		0.230		0.062	
HH income: \$50,000-\$99,999	-0.146		-0.053		-0.047		0.066	
Number of vehicles	0.043		0.162	***	-0.147	**	-0.043	
Head's characteristics								
Age	0.046		-0.060		-0.054		-0.033	
Square age	-0.001		0.001		0.001		0.000	
Hispanic	0.065		0.165		-0.445	***	0.079	
Valid driver license	-0.814	***	-0.336	*	-0.604	*	-0.556	**
Employed	0.472	***	0.521	***	-0.572	***	-0.731	***
Regional accessibility								
Low-medium	-0.036		-0.062		-0.026		0.149	
Medium-high	-0.082		-0.237	*	0.259		0.149	
High	-0.286	*	-0.250		0.463	**	0.107	
Walkable neighborhood								
Walk Score	0.000		0.004	*	0.014	***	0.016	***
Sample size	1,316		1,316		1,316		1,316	
Breush-Pegan test	0.47		0.21		0.04		0.02	
Adjusted R²	0.02		0.03		0.10		0.10	
P-value of F-statistic	1.97E-05		3.33E-07		< 2.2e-16		< 2.2e-16	

Significance: * p < .1, ** p < .05, *** p < .01.

Table I-4 Male and female heads spatial behaviors in terms of the degree of bounding non-home activities

Degree of bounding non-home activities	ln(ADE _{SDE})				ln(AC _{MCP})			
	Male		Female		Male		Female	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	1.748		-0.221		7.955	***	6.081	***
Household characteristics								
Presence of children	0.421	**	0.859	***	0.214		0.656	***
HH income: \$0-\$49,999	0.398		0.293		0.375	*	0.092	
HH income: \$50,000-\$99,999	0.098		0.188		0.104		0.177	
Number of vehicles	-0.148	*	0.005		-0.136	*	-0.161	*
Head's characteristics								
Age	-0.022		0.040		-0.066		0.020	
Square age	0.000		0.000		0.001		0.000	
Hispanic	-0.580	***	0.126		-0.574	***	0.135	
Valid driver license	-1.066	**	-0.326		-0.939	*	-0.327	
Employed	-1.628	***	-1.737	***	-1.824	***	-1.837	***
Regional accessibility								
Low-medium	0.002		-0.136		-0.038		-0.019	
Medium-high	0.145		-0.147		0.227		0.061	
High	0.311		-0.440	*	0.424	*	-0.239	
Walkable neighborhood								
Walk Score	0.019	***	0.025	***	0.017	***	0.020	***
Sample size	1,316		1,316		1,316		1,316	
Breush-Pegan test	0.08		0.02		0.01		0.04	
Adjusted R²	0.12		0.16		0.14		0.16	
P-value of F-statistic	< 2.2e-16		< 2.2e-16		< 2.2e-16		< 2.2e-16	

Significance: * p < .1, ** p < .05, *** p < .01.

Table I-5 Sample distributions for the responses of gendered differences in terms of spatial behaviors

Sample distribution	Size of area		Degree of residential deconcentrating		Compactness degree		Degree of bounding non-home activities	
	SDE	MCP	SDE	MCP	SDE elongation	MCP spatial concentration	SDE activity density	MCP activity concentration
MHH Greater ¹	676	668	666	642	645	397	328	414
MHH=FHH ²	209	194	341	295	189	210	374	119
FHH Greater ³	431	454	309	379	482	709	614	783
Total	1,316	1,316	1,316	1,316	1,316	1,316	1,316	1,316

¹ Male household head (MHH) has greater spatial behavior than his counterpart (female household head, FHH)

² Paired male and female household heads have the same spatial behaviors

³ Female household head (FHH) has greater spatial behavior than her counterpart (MHH)

Table I-6 Gendered difference in the sizes of activity spaces

Size of activity space	SDE area						MCP area					
	MHH Greater		MHH=FHH		FHH Greater		MHH Greater		MHH=FHH		FHH Greater	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-1.969		4.282	**	-3.169	**	-1.246		4.846	***	-4.056	***
Household characteristics												
Presence of children	0.127		0.099		-0.211		0.295	**	-0.151		-0.247	
HH income: \$0-\$49,999	0.051		0.140		-0.136		-0.127		0.194		0.040	
HH income: \$50,000-\$99,999	0.228		-0.026		-0.221		0.070		0.020		-0.071	
Number of vehicles	0.232	***	-0.185	*	-0.148	*	0.250	***	-0.332	***	-0.104	
Male head's characteristics												
Age	-0.031		-0.109		0.128		-0.070		-0.090		0.141	
Square age	0.000		0.002		-0.001		0.000		0.001		-0.001	
Hispanic	0.225		-0.083		-0.198		0.080		0.380		-0.296	
Valid driver license	0.419		-0.396		-0.111		1.120	**	-0.902	**	-0.292	
Employed	0.797	***	-0.575	***	-0.421	**	0.312	*	-0.411	*	-0.052	
Female head's characteristics												
Age	0.078		-0.102		-0.040		0.059		-0.100		-0.011	
Square age	-0.001		0.001		0.000		0.000		0.001		0.000	
Hispanic	-0.080		0.374		-0.171		0.286		-0.226		-0.208	
Valid driver license	0.080		-0.326		0.436		-0.052		-0.393		0.540	
Employed	-0.814	***	-0.419	**	1.308	***	-0.542	***	-0.164		0.732	***
Regional accessibility												
Low-medium	0.156		-0.463	**	0.135		0.113		-0.572	**	0.228	
Medium-high	0.117		-0.750	***	0.356	*	-0.030		-0.544	**	0.372	*
High	-0.149		-0.415		0.471	*	-0.202		-0.492		0.535	**
Walkable neighborhood												
Walk Score	0.001		0.004		-0.004		0.002		-0.003		-0.001	
Sample size	1,316		1,316		1,316		1,316		1,316		1,316	
Log likelihood	-856.89		-533.02		-768.39		-876.60		-510.78		-812.97	
McFadden pseudo R²	0.06		0.08		0.08		0.04		0.07		0.04	
P-value of Chi-Square	3.74E-15		7.57E-11		< 2.2e-16		3.23E-08		1.21E-09		4.83E-08	

Significance: * p < .1, ** p < .05, *** p < .01.

Table I-7 Gendered difference in the degrees of residential deconcentrating

Degree of residential deconcentrating	D _{SDE}						D _{MCP}					
	MHH Greater		MHH=FHH		FHH Greater		MHH Greater		MHH=FHH		FHH Greater	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-3.359	**	2.929	*	-2.434		-3.680	***	3.410	**	-1.404	
Household characteristics												
Presence of children	0.184		-0.030		-0.236		0.066		-0.126		0.024	
HH income: \$0-\$49,999	-0.330		0.128		0.340		-0.408	*	0.146		0.405	*
HH income: \$50,000-\$99,999	0.043		-0.011		-0.049		-0.016		0.207		-0.127	
Number of vehicles	0.084		-0.132		0.041		0.194	**	-0.302	***	0.006	
Male head's characteristics												
Age	0.000		-0.063		0.055		-0.024		-0.054		0.080	
Square age	0.000		0.001		0.000		0.000		0.001		-0.001	
Hispanic	-0.063		0.143		-0.058		0.292		-0.001		-0.358	*
Valid driver license	0.328		-0.374		0.113		0.099		-0.150		0.093	
Employed	1.788	***	-0.821	***	-1.037	***	0.607	***	-0.422	**	-0.288	
Female head's characteristics												
Age	0.090		-0.044		-0.065		0.149	*	-0.077		-0.113	
Square age	-0.001		0.001		0.000		-0.001		0.001		0.001	
Hispanic	0.132		-0.088		-0.099		0.045		0.064		-0.125	
Valid driver license	-0.157		-0.054		0.450		0.127		-0.549	*	0.766	*
Employed	-0.958	***	-0.366	***	2.376	***	-0.703	***	-0.189		1.116	***
Regional accessibility												
Low-medium	-0.015		-0.148		0.206		0.126		-0.428	**	0.242	
Medium-high	-0.104		-0.114		0.317		-0.009		-0.511	**	0.477	**
High	-0.330		-0.152		0.641	**	-0.333		-0.053		0.487	*
Walkable neighborhood												
Walk Score	0.003		0.000		-0.005		0.007	**	-0.003		-0.007	*
Sample size	1,316		1,316		1,316		1,316		1,316		1,316	
Log likelihood	-822.34		-724.53		-612.27		-868.69		-663.65		-744.35	
McFadden pseudo R²	0.1		0.04		0.14		0.05		0.05		0.06	
P-value of Chi-Square	< 2.2e-16		6.69E-06		< 2.2e-16		6.88E-11		1.26E-08		8.05E-12	

Significance: * p < .1, ** p < .05, *** p < .01.

Table I-8 Gendered difference in the compactness degrees

Compactness degree	E _{SDE}						SC _{MCP}					
	MHH Greater		MHH=FHH		FHH Greater		MHH Greater		MHH=FHH		FHH Greater	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-2.757	**	2.069		-0.148		-1.137		2.057		-2.264	
Household characteristics												
Presence of children	0.048		-0.536	**	0.209		-0.110		-0.420	**	0.318	**
HH income: \$0-\$49,999	-0.250		-0.269		0.408	*	0.217		-0.124		-0.079	
HH income: \$50,000-\$99,999	-0.070		-0.221		0.185		-0.115		-0.018		0.120	
Number of vehicles	0.020		-0.258	**	0.113		-0.042		-0.198	*	0.145	*
Male head's characteristics												
Age	0.063		0.063		-0.100		0.103		-0.035		-0.061	
Square age	-0.001		-0.001		0.001		-0.001		0.000		0.001	
Hispanic	0.089		0.198		-0.197		-0.292		0.321		0.053	
Valid driver license	-0.473		-0.199		0.780	*	-0.719		-0.510		0.880	**
Employed	0.777	***	-0.953	***	-0.176		-0.096		-0.747	***	0.593	***
Female head's characteristics												
Age	0.058		-0.108		-0.007		-0.128		0.006		0.096	
Square age	0.000		0.001		0.000		0.001		0.000		-0.001	
Hispanic	-0.352	*	0.223		0.260		-0.456	**	0.025		0.330	*
Valid driver license	0.276		-0.399		0.051		0.854	**	-0.609	*	-0.012	
Employed	-0.353	***	-0.483	***	0.657	***	1.160	***	-0.297	*	-0.720	***
Regional accessibility												
Low-medium	0.002		-0.275		0.160		0.190		-0.502	**	0.173	
Medium-high	0.205		-0.477	*	0.030		0.407	**	-0.510	**	-0.012	
High	0.083		-0.372		0.112		0.459	*	-0.392		-0.100	
Walkable neighborhood												
Walk Score	-0.003		-0.001		0.004		-2.56E-04		-0.009	**	0.005	
Sample size	1,316		1,316		1,316		1,316		1,316		1,316	
Log likelihood	-883.50		-503.83		-842.40		-749.42		-540.03		-866.02	
McFadden pseudo R²	0.03		0.07		0.03		0.07		0.07		0.05	
P-value of Chi-Square	6.56E-06		5.50E-09		0.0005		1.01E-15		5.64E-09		1.43E-10	

Significance: * p < .1, ** p < .05, *** p < .01.

Table I-9 Gendered difference in the degrees of bounding non-home activities

Degree of bounding non-home activities	ADE _{SDE}						AC _{MCP}					
	MHH Greater		MHH=FHH		FHH Greater		MHH Greater		MHH=FHH		FHH Greater	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-2.174		2.237		-2.416	*	-0.726		4.850	**	-3.110	**
Household characteristics												
Presence of children	0.046		-0.467	***	0.383	**	0.096		-0.647	**	0.127	
HH income: \$0-\$49,999	0.114		-0.240		0.146		0.173		-0.261		-0.042	
HH income: \$50,000-\$99,999	-0.085		-0.267	*	0.306	**	0.079		-0.314		0.031	
Number of vehicles	-0.059		-0.033		0.079		0.045		-0.272	*	0.072	
Male head's characteristics												
Age	0.065		0.005		-0.049		0.091		0.018		-0.086	
Square age	0.000		0.000		0.000		-0.001		0.000		0.001	
Hispanic	-0.085		0.284		-0.177		-0.143		0.282		0.019	
Valid driver license	-0.191		-0.101		0.140		0.378		-0.852	*	0.322	
Employed	-1.098	***	-0.078		1.140	***	-1.318	***	-0.511	*	1.433	***
Female head's characteristics												
Age	-0.043		-0.087		0.098		-0.149		-0.177		0.191	**
Square age	0.000		0.001		-0.001		0.001		0.002		-0.002	*
Hispanic	-0.368		0.198		0.084		-0.149		0.427		-0.039	
Valid driver license	0.431		-0.387		0.041		0.097		-0.528		0.330	
Employed	1.275	***	0.513	***	-1.277	***	1.801	***	-0.487	**	-1.253	***
Regional accessibility												
Low-medium	0.118		-0.183		0.100		0.200		-0.648	**	0.134	
Medium-high	0.077		0.080		-0.095		0.376	*	-0.779	**	0.004	
High	0.727	***	-0.039		-0.577	**	0.818	***	-0.845	**	-0.369	
Walkable neighborhood												
Walk Score	0.002		-0.017	***	0.013	***	-0.005		-0.008		0.007	**
Sample size	1,316		1,316		1,316		1,316		1,316		1,316	
Log likelihood	-666.76		-749.98		-816.03		-712.16		-357.47		-796.83	
McFadden pseudo R²	0.0977		0.0452		0.1025		0.1310		0.1051		0.1030	
P-value of Chi-Square	< 2.2e-16		3.05E-08		< 2.2e-16		< 2.2e-16		1.75E-10		< 2.2e-16	

Significance: * p < .1, ** p < .05, *** p < .01.

Appendix J: Multinomial Estimations on Gendered Differences in Activity Space Behaviors Based on the Weekday Full and PSM Sample

This appendix provides the multinomial logistic estimations on the within-household gendered differences in activity space behaviors for the 1,316 and 415 households with paired heads based on the weekday full data and PSM sample, respectively. The models are used to investigate how socio-demographics and built environmental variables affect paired heads' choices from "having the same spatial behaviors (reference level)" to "male head's spatial behavior is greater than female head's" or "female head's spatial behavior is greater than male head's". Below describes the multinomial model (Washington et al., 2003).

$$P(y_{k|i} = j) = \frac{\exp(\beta_{ij} \cdot X_k)}{\sum_{m=1}^M \exp(\beta_{im} \cdot X_k)}$$

β_{ij} indicates the estimated coefficients for the independent variables on the probability of choosing from response i to j .

Table J-1 provide the sample distributions for the responses of gendered differences in terms of spatial behaviors. Recall that the within-household differences were rounded half to even, so paired heads with differences between -0.5 and 0.5 are regarded to have same spatial behaviors. Tables J-2 and J-3 document the estimated results in terms of the size of activity space based on the full and PSM samples, respectively.

Tables J-4 and J-5 provide the estimations on the gendered differences in the degree of residential deconcentrating based on the full and PSM samples, respectively. Tables J-6 and J-7 show the results of the gendered differences in the compactness degree based upon the full and

PSM samples, respectively. Table J-8 and J-9 show the results of the difference in “the degree of bounding non-home activities” based on the full and PSM samples, respectively.

Table J-1 Sample distributions for the responses of gendered differences in terms of spatial behaviors

Sample distribution	Size of area		Degree of residential deconcentrating		Compactness degree		Degree of bounding non-home activities	
	SDE	MCP	SDE	MCP	SDE elongation	MCP spatial concentration	SDE activity density	MCP activity concentration
Full Sample								
MHH Greater ¹	676	668	666	642	645	397	328	414
MHH=FHH ²	209	194	341	295	189	210	374	119
FHH Greater ³	431	454	309	379	482	709	614	783
Total	1,316	1,316	1,316	1,316	1,316	1,316	1,316	1,316
PSM Sample								
MHH Greater ¹	208	194	209	198	200	137	112	127
MHH=FHH ²	67	58	103	100	55	62	105	31
FHH Greater ³	140	163	103	117	160	216	198	257
Total	415	415	415	415	415	415	415	415

¹ Male household head (MHH) has greater spatial behavior than his counterpart (female household head, FHH)

² Paired male and female household heads have the same spatial behaviors

³ Female household head (FHH) has greater spatial behavior than her counterpart (MHH)

Table J-2 Gendered difference in the sizes of activity spaces based on the full data

Size of activity space (Ref. MHH=FHH)	SDE area				MCP area			
	MHH Greater		FHH Greater		MHH Greater		FHH Greater	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-4.640	**	-5.808	***	-4.845	**	-6.787	***
Household characteristics								
Presence of children	-0.020		-0.221		0.278		-0.029	
HH income: \$0-\$49,999	-0.090		-0.192		-0.236		-0.141	
HH income: \$50,000-\$99,999	0.128		-0.120		0.011		-0.064	
Number of vehicles	0.264	**	0.054		0.404	***	0.216	*
Male head's characteristics								
Age	0.075		0.173		0.039		0.169	
Square age	-0.001		-0.002	*	-0.001		-0.002	
Hispanic	0.177		-0.071		-0.283		-0.524	*
Valid driver license	0.481		0.147		1.272	**	0.369	
Employed	0.906	***	0.184		0.508	**	0.304	
Female head's characteristics								
Age	0.122		0.061		0.114		0.077	
Square age	-0.001		0.000		-0.001		-0.001	
Hispanic	-0.356		-0.441		0.320		0.043	
Valid driver license	0.236		0.559		0.251		0.676	
Employed	-0.039		1.271	***	-0.123		0.628	***
Regional accessibility								
Low-medium	0.457	**	0.479	*	0.535	**	0.637	**
Medium-high	0.682	**	0.874	***	0.443	*	0.709	**
High	0.260		0.666	**	0.308		0.767	**
Walkable neighborhood								
Walk Score	-0.003		-0.006		0.003		0.001	
Sample size	1,316				1,316			
Log likelihood	-1209.40				-1233.70			
McFadden pseudo R²	0.08				0.06			
P-value of Chi-Square	< 2.22e-16				1.80E-15			

Significance: * p < .1, ** p < .05, *** p < .01.

Table J-3 Gendered difference in the sizes of activity spaces based on the PSM data

Size of activity space (Ref. MHH=FHH)	SDE area				MCP area			
	MHH Greater		FHH Greater		MHH Greater		FHH Greater	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-4.082		-8.232	**	-1.641		-7.487	**
Household characteristics								
Presence of children	0.045		-0.063		0.785	**	0.322	
HH income: \$0-\$49,999	-0.576		-0.373		-0.427		-0.302	
HH income: \$50,000-\$99,999	-0.148		0.280		0.151		0.522	
Number of vehicles	0.724	***	0.444	*	0.463	*	0.303	
Male head's characteristics								
Age	0.066		0.156		0.027		0.267	
Square age	-0.001		-0.002		0.000		-0.002	
Hispanic	0.275		0.137		-0.289		-0.174	
Valid driver license								
Employed	0.661		0.249		-0.042		-0.025	
Female head's characteristics								
Age	0.118		0.143		0.044		0.011	
Square age	-0.001		-0.002		0.000		-0.001	
Hispanic	-0.511		-0.255		0.078		0.220	
Valid driver license								
Employed	-0.465		1.491	***	-0.316		1.103	***
Regional accessibility								
Low-medium	1.079	**	1.237	**	0.614		1.117	**
Medium-high	0.918	*	1.095	**	0.872		1.362	**
High	0.371		0.705		0.824		1.415	**
Walkable neighborhood								
Walk Score	-0.003		-0.007		-0.007		-0.012	
Sample size	415				415			
Log likelihood	-373.81				-383.76			
McFadden pseudo R²	0.11				0.07			
P-value of Chi-Square	3.56E-07				1.73E-03			

Significance: * p < .1, ** p < .05, *** p < .01.

Table J-4 Gendered difference in the degrees of residential deconcentrating based on the full data

Degree of residential deconcentratng (Ref. MHH=FHH)	D _{SDE}				D _{MCP}			
	MHH Greater		FHH Greater		MHH Greater		FHH Greater	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-3.913	**	-3.894	*	-4.508	***	-3.586	*
Household characteristics								
Presence of children	0.111		-0.161		0.133		0.116	
HH income: \$0-\$49,999	-0.257		0.195		-0.348		0.173	
HH income: \$50,000-\$99,999	0.027		-0.033		-0.182		-0.260	
Number of vehicles	0.141		0.130		0.333	***	0.242	**
Male head's characteristics								
Age	0.043		0.084		0.025		0.092	
Square age	0.000		-0.001		-0.001		-0.001	
Hispanic	-0.131		-0.144		0.148		-0.262	
Valid driver license	0.397		0.289		0.106		0.139	
Employed	1.705	***	-0.226		0.660	***	0.105	
Female head's characteristics								
Age	0.073		-0.023		0.139		-0.018	
Square age	-0.001		0.000		-0.001		0.000	
Hispanic	0.126		-0.018		-0.024		-0.142	
Valid driver license	-0.083		0.401		0.394		0.961	**
Employed	-0.234		2.234	***	-0.208		0.971	***
Regional accessibility								
Low-medium	0.092		0.265		0.389	*	0.501	**
Medium-high	0.026		0.334		0.394	*	0.745	***
High	-0.076		0.593	*	-0.138		0.395	
Walkable neighborhood								
Walk Score	0.001		-0.004		0.006		-0.002	
Sample size	1,316				1,316			
Log likelihood	-1209.10				-1290.10			
McFadden pseudo R²	0.11				0.06			
P-value of Chi-Square	< 2.22e-16				< 2.22e-16			

Significance: * p < .1, ** p < .05, *** p < .01.

Table J-5 Gendered difference in the degrees of residential deconcentrating based on the PSM data

Degree of residential deconcentratng (Ref. MHH=FHH)	D _{SDE}				D _{MCP}			
	MHH Greater		FHH Greater		MHH Greater		FHH Greater	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-2.429		-0.518		-3.450		-1.898	
Household characteristics								
Presence of children	0.169		-0.188		0.351		-0.105	
HH income: \$0-\$49,999	-0.542		0.166		-0.429		0.268	
HH income: \$50,000-\$99,999	0.019		0.739	*	-0.304		0.121	
Number of vehicles	0.391	*	-0.004		0.648	***	0.527	**
Male head's characteristics								
Age	-0.081		-0.008		-0.081		-0.055	
Square age	0.001		0.001		0.000		0.001	
Hispanic	-0.026		-0.029		-0.038		-0.090	
Valid driver license								
Employed	1.120	***	-0.495		0.097		-0.162	
Female head's characteristics								
Age	0.157		-0.047		0.204		0.089	
Square age	-0.001		0.000		-0.002		-0.001	
Hispanic	0.031		0.199		0.089		-0.283	
Valid driver license								
Employed	-0.534	*	1.911	***	-0.141		0.961	**
Regional accessibility								
Low-medium	0.091		0.528		0.509		1.234	**
Medium-high	0.219		0.279		0.655		1.673	***
High	0.077		0.535		0.442		1.348	**
Walkable neighborhood								
Walk Score	-0.002		-0.005		-0.002		-0.015	**
Sample size	415				415			
Log likelihood	-383.80				-407.70			
McFadden pseudo R²	0.11				0.07			
P-value of Chi-Square	6.66E-08				0.0029			

Significance: * p < .1, ** p < .05, *** p < .01.

Table J-6 Gendered difference in the compactness degrees based on the full data

Compactness degree (Ref. MHH=FHH)	E _{SDE}				SC _{MCP}			
	MHH Greater		FHH Greater		MHH Greater		FHH Greater	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-3.416	*	-2.068		-2.632		-2.927	
Household characteristics								
Presence of children	0.487	**	0.597	***	0.278		0.496	**
HH income: \$0-\$49,999	0.101		0.486		0.252		0.063	
HH income: \$50,000-\$99,999	0.161		0.310		-0.064		0.066	
Number of vehicles	0.233	**	0.293	**	0.133		0.228	**
Male head's characteristics								
Age	-0.019		-0.118		0.103		0.001	
Square age	0.000		0.001		-0.001		0.000	
Hispanic	-0.125		-0.294		-0.483	*	-0.245	
Valid driver license	-0.145		0.668		-0.201		0.825	
Employed	1.221	***	0.659	***	0.526	**	0.895	***
Female head's characteristics								
Age	0.121		0.091		-0.095		0.039	
Square age	-0.001		-0.001		0.001		0.000	
Hispanic	-0.371		-0.026		-0.367		0.111	
Valid driver license	0.448		0.319		1.170	**	0.449	
Employed	0.231		0.830	***	1.101	***	-0.066	
Regional accessibility								
Low-medium	0.232		0.335		0.545	**	0.481	**
Medium-high	0.514	*	0.430		0.717	**	0.414	
High	0.352		0.381		0.657	*	0.276	
Walkable neighborhood								
Walk Score	0.000		0.004		0.007		0.009	**
Sample size	1,316				1,316			
Log likelihood	-1250.00				-1208.50			
McFadden pseudo R²	0.05				0.07			
P-value of Chi-Square	3.07E-11				< 2.22e-16			

Significance: * p < .1, ** p < .05, *** p < .01.

Table J-7 Gendered difference in the compactness degrees based on the PSM data

Compactness degree (Ref. MHH=FHH)	E _{SDE}				SC _{MCP}			
	MHH Greater		FHH Greater		MHH Greater		FHH Greater	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-3.578		2.351		-0.144		0.258	
Household characteristics								
Presence of children	0.774	*	1.044	**	0.521		0.983	***
HH income: \$0-\$49,999	-0.118		0.667		0.119		-0.118	
HH income: \$50,000-\$99,999	-0.080		0.289		0.315		-0.062	
Number of vehicles	0.416		0.329		0.209		0.482	**
Male head's characteristics								
Age	-0.086		-0.309		0.038		-0.114	
Square age	0.001		0.003		0.000		0.001	
Hispanic	0.249		-0.149		0.043		0.099	
Valid driver license								
Employed	1.340	***	0.272		0.391		0.502	
Female head's characteristics								
Age	0.166		0.094		-0.165		0.032	
Square age	-0.001		-0.001		0.002		0.000	
Hispanic	-0.023		0.098		-0.291		-0.115	
Valid driver license								
Employed	0.627	*	0.919	**	1.729	***	0.053	
Regional accessibility								
Low-medium	0.633		0.914	*	1.175	**	0.272	
Medium-high	0.764		0.688		1.169	**	0.467	
High	0.804		0.605		1.440	**	0.630	
Walkable neighborhood								
Walk Score	-0.011		0.006		-0.002		0.004	
Sample size	415				415			
Log likelihood	-381.48				-374.91			
McFadden pseudo R²	0.07				0.09			
P-value of Chi-Square	0.0050				0.0001			

Significance: * p < .1, ** p < .05, *** p < .01.

Table J-8 Gendered difference in the degrees of bounding non-home activities based on the full sample

Degree of bounding non-home activities (Ref. MHH=FHH)	ADE _{SDE}				AC _{MCP}			
	MHH Greater		FHH Greater		MHH Greater		FHH Greater	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-3.161		-3.072	*	-5.064	**	-5.852	***
Household characteristics								
Presence of children	0.357	*	0.539	***	0.664	**	0.640	**
HH income: \$0-\$49,999	0.231		0.256		0.364		0.235	
HH income: \$50,000-\$99,999	0.112		0.357	**	0.337		0.296	
Number of vehicles	-0.028		0.067		0.280	*	0.275	*
Male head's characteristics								
Age	0.044		-0.030		0.042		-0.051	
Square age	0.000		0.000		-0.001		0.000	
Hispanic	-0.253		-0.290		-0.361		-0.247	
Valid driver license	-0.100		0.133		0.910		0.775	
Employed	-0.690	***	0.807	***	-0.401		1.148	***
Female head's characteristics								
Age	0.029		0.111		0.055		0.232	*
Square age	0.000		-0.001		0.000		-0.002	
Hispanic	-0.418		-0.096		-0.502		-0.410	
Valid driver license	0.597		0.288		0.505		0.540	
Employed	0.644	***	-1.010	***	1.743	***	-0.053	
Regional accessibility								
Low-medium	0.207		0.168		0.713	**	0.621	**
Medium-high	0.004		-0.118		0.964	***	0.694	**
High	0.547	*	-0.311		1.317	***	0.592	
Walkable neighborhood								
Walk Score	0.013	***	0.018	***	0.003		0.010	*
Sample size	1,316				1,316			
Log likelihood	-1265.00				-1020.70			
McFadden pseudo R²	0.10				0.13			
P-value of Chi-Square	< 2.22e-16				< 2.22e-16			

Significance: * p < .1, ** p < .05, *** p < .01.

Table J-9 Gendered difference in the degrees of bounding non-home activities based on the PSM sample

Degree of bounding non-home activities (Ref. MHH=FHH)	ADE _{SDE}				AC _{MCP}			
	MHH Greater		FHH Greater		MHH Greater		FHH Greater	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Intercept	-0.850		-0.292		-2.416		-1.307	
Household characteristics								
Presence of children	1.081	***	1.218	***	1.401	**	1.555	***
HH income: \$0-\$49,999	0.440		0.323		0.787		0.184	
HH income: \$50,000-\$99,999	0.822	**	0.382		0.764		-0.035	
Number of vehicles	-0.164		0.239		0.390		0.613	*
Male head's characteristics								
Age	0.076		-0.014		-0.153		-0.153	
Square age	-0.001		0.000		0.001		0.001	
Hispanic	0.151		-0.176		-0.260		-0.198	
Valid driver license								
Employed	-0.745	*	0.442		-0.498		0.881	
Female head's characteristics								
Age	-0.137		-0.048		0.103		0.135	
Square age	0.002		0.001		0.000		0.000	
Hispanic	-0.526		-0.144		-0.655		-0.743	
Valid driver license								
Employed	1.001	**	-0.821	**	2.983	***	0.663	
Regional accessibility								
Low-medium	0.554		0.092		1.879	**	1.436	*
Medium-high	0.510		0.426		1.548	**	0.977	
High	1.086	**	0.406		1.915	**	1.109	
Walkable neighborhood								
Walk Score	0.001		0.004		-0.006		0.000	
Sample size	415				415			
Log likelihood	-394.08				-297.72			
McFadden pseudo R²	0.10				0.16			
P-value of Chi-Square	5.77E-07				6.95E-11			

Significance: * p < .1, ** p < .05, *** p < .01.

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