Exploring Engagement in Household Activities and Decisions on Residential Tenure and Household Type

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Residential locations play an important role in the spatial distribution of household activities and travel decisions and, subsequently, in long-term forecasting models. This study examined the relationship between housing location choices, time allocation to out-of-home activities, and other socioeconomic attributes related to household life-cycle stages. A choice model of housing tenure and type was formulated and estimated to provide a methodological framework for examining the impacts of engagement in household activities and life-cycle stage. Engagement in household activities was represented by factor scores from a factor analysis on the proportion of time households spent on 14 activity types. The scores of the identified factors, in addition to other socioeconomic and travel characteristics of the household, were estimated in a nested-logit choice model of housing tenure and type. Furthermore, households were segmented into different life-cycle stages on the basis of household size and age of members. Results from this study revealed that the life-cycle stage of a household had a significant statistical impact on the tenure choice to rent relative to the choice to own a home. In relation to time allocation for household activities, the time allocated to eating, recreation, and social activities was found to have the strongest statistical significance with respect to the choice of tenure and housing type. Overall, estimation results revealed a relationship between the choice of housing tenure and type, attributes of the household, and the allocation of activity time among its members.

An improved understanding of household residential location choices is fundamental to informing long-term transportation planning models that forecast household transportation emissions and energy consumption. A well-informed travel demand model potentially enables decision makers to plan for a number of transportation and land use scenarios over multiyear time frames that explore the potential sway of various policy levers. Within the context of activity engagement and subsequent travel patterns, the home location often serves as an anchoring point connecting household members to the locations of their out-of-home activities, such as working, shopping, and recreating. Given the central role that residential location choice plays in the spatial distribution of household activities and travel decisions, as well as their importance in travel forecasting models, an enhanced knowledge of the relationship between housing location choices and time allocation for household activities would appear paramount. This study explores the relationship between the residential location choices of housing tenure and housing type with engagement in out-of-home activities by segmenting households on the basis of life-cycle stages.

The main dimensions of residential locations that households consider include tenure, housing type or structure, and neighborhood type. Factors affecting these residential location choices range across household life-cycle stages and vary by socioeconomic status and the access provided by a particular neighborhood to added transportation resources. Households generally favor residing in areas that provide access to the types of activities most preferable to their members. For example, a household with young children may choose to locate in a neighborhood with high access to open public spaces and good-quality educational institutions, whereas a younger household of nonrelated adults may place greater value on having high access to restaurants and other locations of social activity often more ubiquitous in urban areas. However, despite the significance of engagement in household activities in relation to choice of residential location, research on this topic has thus far provided only an opening exploration into understanding of this multifaceted relationship between the choices of housing tenure, housing type, and neighborhood, its disparity across household lifestyles or life-cycle stages, and the impact these residential location decisions have on activity engagement and subsequent travel outcomes.

BACKGROUND

In the literature on residential location choice, household lifestyle has been defined as a pattern of behavior that is revealed under constrained resources related to the separate factors of household formation, labor force participation, and leisure orientation (*1, 2*), all of which are believed to evolve over the long term but affect short-term decisions such as day-to-day travel (*3, 4*). Variations in household lifestyle have also incorporated the concept of life-cycle stage as well as the marital status and the gender of household participants when households are segmented by a classification scheme (*5*).

Life-cycle stages are largely determined by observed socioeconomic attributes of the household. In the literature on residential location choice, these socioeconomic attributes are commonly represented by measures of household size, age of household participants, and annual income. With respect to household size, Bhat

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and Guo found that households with multiple members were more hesitant to locate in areas with a high density of street blocks than single-member households (*6*). In relation to the determinant of the life-cycle stage of the age of a household participant, Bagley and Mokhtarian found that the average age of a household was negatively associated with living in a traditional neighborhood (*7*). In addition, they measured the presence of children in a household and found a negative relationship between the number of children in a household and the likelihood of the household residing in a traditional neighborhood within the San Francisco Bay area in California (*7*). In that context, the authors characterized a traditional neighborhood as having a high residential density and convenient access to public transit. These neighborhoods had smaller households occupying structures without backyards and with limited private parking. Elder and Zumpano found that socioeconomic characteristics describing the presence of children, income, and age of the household head were all positively related to the tenure choice to own (*8*).

Rashidi et al. developed a lifestyle classification scheme by using data from the 2001 National Household Travel Survey that produced 11 household lifestyle classes in which the two lifestyles characterized by high annual household incomes were generally located in suburban areas (*9*). Guo and Bhat found that households frequently chose to locate near households with a comparable income level (*10*), whereas Srinivasan and Ferreira also found that households with higher incomes generally resided in more suburban neighborhoods and were more likely to perform nonwork activities during their daily work tour (*11*). Aside from being distinguished by observed socioeconomic attributes, household lifestyles have also been represented by their observed orientation toward leisure time expenditure (*1, 12*), which may be further divided into out-of-home and home-based leisure activities (*4*). In regard to residential location, Bagley and Mokhtarian found that individuals who self-identified as having a culture-oriented lifestyle (i.e., often attended ballets, theaters, or concerts) were likely to select a residence within the urban core characterized by high residential density and strong accessibility to many cultural options (*7*).

Besides the segmentation of households by the composition of its members and their activities, the literature on household residential location has also differed with respect to the ways in which housing structure is defined. Housing structures range in their function and size and, therefore, the literature has also ranged in its approaches for representing different housing structures, from a simple division between single-family and multifamily housing (*2*) to more nuanced delineations of these two choices (*13*). In their stated-preference survey of Portland, Oregon, households, Walker and Li acknowledged differences in the choice sets of households by limiting renting to single-family units and apartments and owning to single-family units and condos (*2*). The household decision of where to locate is dependent on the matching of a household of a specified size to an appropriate structure size as well as the availability of the desired housing structure and related socioeconomic characteristics of the household (*8*).

In his stated-preference survey of residents in Edmonton, Alberta, Canada, Hunt further separated attached single-family units into duplexes and townhouses (*13*). Participants in the survey were then offered a choice of these wide-ranging classifications of housing structures, which also included detached single-family housing, low-rise apartment, and high-rise apartment structure options. Hunt found that most respondents preferred detached single-family housing structures when offered the array of detached, attached, and apartment options (*13*). This preference for detached single-family housing was echoed by the results of Louviere and Timmermans, who found the highest utility for residential relocation to be associated with selecting a detached single-family housing unit, followed in the hierarchy by the choices of an attached single-family structure or an apartment, which was the only structure with an associated disutility (*14*). An extended area of research has linked the choice of housing structure to tenure, or whether to rent or purchase certain housing types. Housing tenure has traditionally been viewed as a simple binary choice faced by the household between renting and owning a home (*15, 16*).

Decisions of housing tenure and type have been commonly examined in the literature on residential location choice but have been modeled with different approaches. One methodological approach has been to estimate a model for nested tenure housing type choice over time (*15, 17*). A second common approach has been to consider these choices as attributes of the location of residences (*14, 18, 19*). Independent of the modeling approach, the examination of tenure and housing type has been typically represented with a two-level choice structure, with choice sets related to housing structure being more varied in their representation.

Previous research on choice of household residential location has contributed to both the conceptual understanding and methodological advancement of modeling of residential location choice. However, while the links between residential location choice, household attributes, and travel have received adequate attention in the literature, the relationship of residential location choice with activity engagement has received considerably less. The overarching goal of this study is to address this gap in the literature and examine the residential location choices of housing tenure and type and their relationship with time allocation for household activities. To achieve that goal, a choice model of housing tenure and type is formulated and estimated to examine the impacts of these housing decisions on engagement in household activities across seven life-cycle stages. Engagement in household activities is represented by factor scores calculated from a principal component analysis of the proportion of time households spent on 14 activity classifications. The obtained factor scores, in addition to socioeconomic and travel characteristics attributes, are then used in a nested-logit choice model of tenure and housing type. Households in this model for residential location choice are segmented into life-cycle stages on the basis of household size and the age of household participants.

The next section provides an overview of the study area and the household activity survey used in this analysis, which is followed by a section presenting the methodological approach or, more specifically, the factor analysis and choice model of tenure and housing type and the life-cycle classes employed in this study. A description of the methodological approach is then followed by a section detailing the results of the choice model estimation and a concluding discussion presenting directions for future research on linking residential location choice and allocation of activity time.

DATA SOURCES AND STUDY AREA

Household observations from the Oregon household activity survey (OHAS) were used for the analysis of this study. The survey was administered across Oregon in 2011 and asked respondents to describe their travel and activity engagement and detail the duration of these activities for one selected weekday. The data set consisted of 18,166 households, which provided information on their activity

TABLE 1 Descriptive Statistics for OHAS Sample

Variable Measured	Household Average	Variable Measured	Sample Percentage
Socioeconomic Characteristics		Residential Location Choice Characteristics	
Household size	2.31	Housing type	
Members (≤6 years old)	0.12	Single family	82.86
Members (6–12 years old)	0.18	Attached single family/ multifamily	12.47
Members (13–17 years old)	0.15	Mobile home	4.63
Members (18–34 years old)	0.24	Housing tenure	
Members (35–64 years old)	1.10	Own	83.79
Members (≥65 years old)	0.50	Rent	16.05
Number of students	0.63	Accessibility class	
Number of workers	1.28	Major urban center	52.80
Number of retirees	0.39	Urban near major city	12.08
Income ($)	65,276	Rural near major city	14.11
Travel Characteristics		Isolated city	11.14
Vehicles owned	2.04	Rural	9.87
Vehicles per driver license holder	1.83		
Bicycles owned	1.35		

NOTE: Sample = 18,166 observed households.

decisions as well as additional socioeconomic, housing, and travel attributes unique to their respective households. Specifically, households identified whether their residence was rented or owned and whether their home was a detached single-family (SF), multifamily (MF), or attached single-family (ASF) structure.

The distribution of the households across different socioeconomic, travel, and residential location choice attributes is provided in Table 1. The distribution of households across housing types shows that the proportion of ASF households is relatively small, consisting of about 2% of all observations. This small percentage of surveyed ASF housing structures may be attributed to certain locations having a limited stock of ASF housing structures or to these households having different perceptions of what constitutes an ASF housing structure.

To supplement the residential choices of tenure and housing type identified in the OHAS data set, researchers determined five accessibility classes to provide a general area type for each household location:

1. Major urban center. Households located within 5 mi of 50,000 people and within 1 mi of 2,500 people, where the majority of households reside in a metropolitan planning organization's boundary.
2. Urban near major city. Households located within 1 mi of 2,500 people and within 15 mi of a major urban center.
3. Rural near major city. Households immediately surrounded by an area characterized by less than 2,500 people but within 15 mi of a major urban center.
4. Isolated city. Households located within 2 mi of 2,500 people that are also located more than 15 mi from a major urban center.
5. Rural. Households located more than 2 mi from 2,500 people and more than 15 mi from a major urban center.

Figure 1 provides a map of the study area and distribution of the five accessibility classes or area types. Furthermore, the distribution of the households in the complete data set across these area types is also shown in Table 1. As expected, the number of households in major urban centers is high relative to the other accessibility classes and accounts for more than half of all surveyed households in the data set.

METHODOLOGICAL FRAMEWORK AND MODEL STRUCTURE

The overarching goal of this study is to examine the link between decisions on engagement in household activities and choices of residential location, a link that has not been extensively examined in the literature. While neighborhood decisions undoubtedly contribute to residential location choice and have been extensively examined in the literature, this decision is not explicitly considered in the choice model that at this time represents an initial exploration into household residential choices by accounting for the choice of housing tenure and type. In relation to engagement in household activities, this spatially and temporally complex subject continues to be of great interest in travel behavior research. Activity-based approaches to travel analysis have recognized that activity engagement is not isolated but occurs in trip chains or tours. For example, an observed household travel pattern may be characterized as a home-to-work-to-shop-to-home trip chain. Present literature is rich with methods and models for capturing these complex travel patterns over dimensions of space and time, both for individuals and households where an interaction between individuals is probable.

In this exploratory study, a factor analysis on the time allocation of households to activities is used as an initial strategy for identifying and capturing such complex activity patterns. Closely related to any discussion on engagement in household activities and residential location choices is a comprehension of the household life cycle. Life-cycle stages relate to the interrelationship of household members and overall composition of the decision-making unit and range from households with single adults to those characterized by two parents

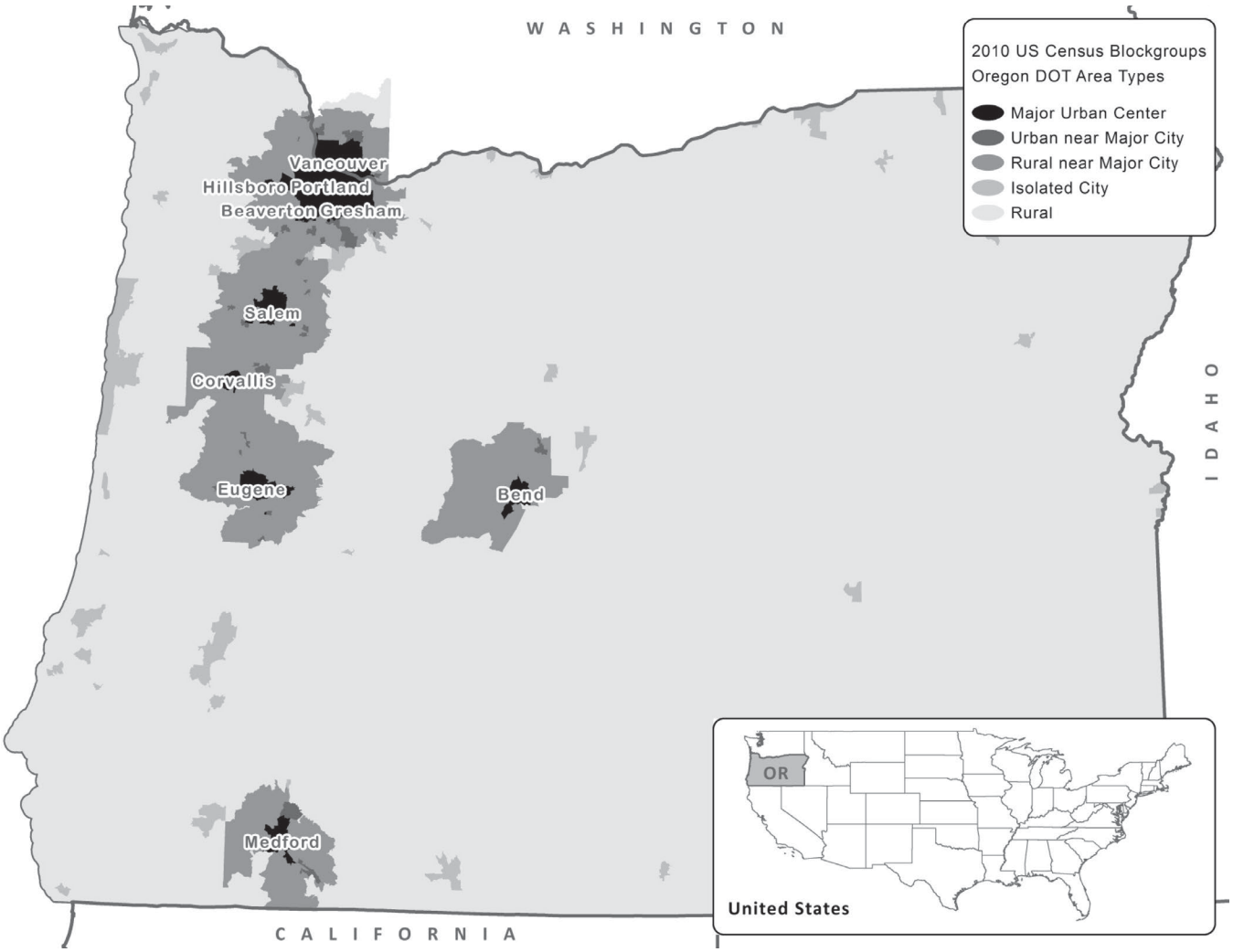

FIGURE 1 Study area and distribution of accessibility classes.

with more than one child. The next section discusses the life-cycle stages used to segment the households observed in the OHAS data set and to select socioeconomic attributes defining them. That is then followed by a description of the results from a factor analysis of time allocation for household activities for different activity types.

Household Life-Cycle Stages

In the context of this study, life-cycle stages are defined on the basis of three household attributes: (*a*) household size, (*b*) age of members, and (*c*) relationship status of household members (e.g., married or unrelated). Other household attributes considered in the literature include workforce status of the members, which is likely correlated with income, and transportation resources, such as number of vehicles owned. However, to limit the complexity and the number of life-cycle stages used in this study, these attributes were not considered. Tables 2 to 4 denote the 7 life-cycle stages defined in this study and provide descriptive statistics for these life-cycle stages that correspond to various socioeconomic, travel, and residential location characteristics.

An investigation of the distribution of these households attributes across life-cycle stages revealed that the majority of households are categorized in Stages 5 through 7, which reflect those households of parents with children and those composed of related adults. The life-cycle stage representing a single parent with children had the smallest proportion in the OHAS sample. With respect to housing type, the distribution of households living in single-family housing parallels the household distribution across the life-cycle stages. The majority of households living in single-family housing units are found to be in the life-cycle stages of parents with children and related adults. However, with respect to ASF housing structures, the majority of households are found in Stages 2 and 6, which are single adults younger than 65 and related adults without children, respectively, despite a higher percentage found in the life-cycle stage reflecting single parents. Similarly, the majority of total households are either single or related adults younger than 65 for the MF housing structures. With respect to housing tenure, the majority of renting households are single adult households younger than 65. Compared with the household distribution for housing type, the distribution of households across accessibility classes parallel the household distribution across life-cycle stages.

TABLE 2 Descriptive Statistics for Life-Cycle Stages for Socioeconomic and Travel Characteristics

	Household Averages for Socioeconomic and Travel Characteristics						
Life-Cycle Stage	Household Total	Students	Workers	Retirees	Income ($)	Vehicles	Bicycles
Single adult (≥65 years old)	2,193	0.26	0.55	0.56	40,081	1.12	0.69
Single adult (18–64 years old)	2,536	0.26	0.90	0.05	42,633	1.12	0.77
Nonrelated adults	600	1.17	1.58	0.32	48,925	2.21	1.41
Single parent with children	521	1.66	0.99	0.21	49,311	1.64	1.81
Parents with children	3,674	1.83	1.84	0.06	79,766	2.47	2.58
Related adults (at least one adult 18–64 years old)	6,273	0.26	1.57	0.34	77,910	2.46	1.33
Related adults (all adults ≥65 years old)	2,369	0.23	0.78	1.26	61,377	2.14	0.61
Total	18,166	0.63	1.28	0.39	65,276	2.04	1.35

TABLE 3 Descriptive Statistics for Life-Cycle Stages for Residential Type and Tenure Choices Characteristics

	Housing Type and Tenure (%)						
Life-Cycle Stage	Sample Percentage	Detached Single Family	Attached Single Family	Multifamily	Mobile Home	Own	Rent
Single adult (≥65 years old)	12	66.94	3.83	19.65	9.35	77.06	22.75
Single adult (18–64 years old)	14	64.12	5.88	24.37	5.44	64.43	35.37
Nonrelated adults	03	77.00	3.83	13.67	5.17	72.83	27.00
Single parent with children	03	73.51	8.25	14.59	3.65	66.41	33.59
Parents with children	20	90.94	2.37	4.08	2.61	85.93	13.80
Related adults (at least one adult 18–64 years old)	35	89.80	1.79	4.72	3.60	90.59	9.29
Related adults (all adults ≥65 years old)	13	89.91	1.31	3.46	5.28	95.99	3.88
Total	100	82.81	2.91	9.55	4.62	83.79	16.05

TABLE 4 Descriptive Statistics for Life-Cycle Stages for Residential Accessibility Classes

	Accessibility Classification (%)					
Life-Cycle Stage	Sample Percentage	Major Urban Center	Urban Near City	Rural Near City	Isolated City	Rural
Single adult (≥65 years old)	12	52.94	14.68	11.63	13.22	7.52
Single adult (18–64 years old)	14	63.25	10.33	8.75	10.25	7.41
Nonrelated adults	03	54.50	19.67	12.67	7.17	6.00
Single parent with children	03	57.01	12.48	9.98	12.28	8.25
Parents with children	20	56.37	11.32	12.66	10.40	9.25
Related adults (at least one adult 18–64 years old)	35	50.10	10.55	16.96	10.71	11.67
Related adults (all adults ≥65 years old)	13	41.71	14.77	18.15	13.17	12.20
Total	100	52.80	12.08	14.11	11.14	9.87

Factors for Activity Engagement

The activity-based approach to travel analysis views travel as a demand derived from the need for households to engage in their selected activities. Applying this fundamental principle, past research on activity engagement has proposed a wide range of models capturing time and money expenditures by households and the complex activity patterns and trip-chaining decisions households undertake. However, for this exploratory study, household activity patterns are represented through a factor analysis of time allocation of household members across activity types. The time allocation for each household is represented as the proportion of the total household time budget allocated to different activity types. To account for the difference in household size, a household time budget constraint of 1,440 min (or 24 h) per member was assumed. The purpose of this factor analysis was to uncover different activity profiles that might not be evident by consideration of only individual activity durations. The identified factor loadings from this analysis are displayed in Table 5. One outcome of this factor analysis was the creation of household activity profiles that would help inform the residential choices of tenure and housing type. The representation of time allocation through identified factors from a factor analysis borrows from

TABLE 5 Analysis of Activity Factors

	Activity Bundle						
Activity Type	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
1 Home-based activity	**–0.949**	–0.213	0.050	–0.011	–0.012	**–0.300**	–0.012
2 Work	**0.637**	**–0.482**	**–0.405**	–0.032	**0.351**	–0.053	–0.011
3 Work at home	**0.409**	0.230	–0.172	–0.191	**–0.680**	0.250	**–0.311**
4 School	0.259	–0.221	**0.663**	0.217	–0.140	0.152	0.072
5 Passenger pick up–drop off	0.138	0.144	**0.455**	0.031	**0.355**	**0.344**	–0.104
6 Routine shopping	–0.276	**0.478**	–0.153	0.011	–0.046	0.085	–0.066
7 Major item shopping	–0.061	0.237	–0.144	0.016	0.257	**0.447**	–0.263
8 Personal business–household errands	0.175	**0.306**	–0.031	0.088	–0.161	–0.271	**0.625**
9 Out-of-home dining	0.016	**0.434**	–0.241	**0.340**	**0.314**	0.017	–0.070
10 Visiting friends or relatives	0.274	**0.372**	0.288	**–0.338**	0.280	–0.178	0.022
11 Recreation	0.148	0.271	0.128	**0.644**	–0.109	–0.266	–0.182
12 Health care	–0.016	0.300	0.162	**–0.568**	0.069	–0.247	–0.047
13 Civic–religious	–0.002	0.052	–0.051	–0.030	–0.064	**0.604**	**0.548**
14 Vehicle maintenance	–0.020	0.179	–0.172	0.053	0.130	0.030	0.298

NOTE: Bold entries are > 0.3 or < –0.3.

the approach outlined by Hanson and Hanson (*5*), who used factor analysis to represent complex space–time travel and activity patterns. The factor analysis used percentage of time allocated to various types of activities observed in the OHAS data set without trip-making or socioeconomic attributes.

Seven factors (or "activity bundles") were identified from the application of this methodological approach to households in the OHAS sample. Those activity bundles all had eigenvalues greater than one. The activity bundles with the strongest correlations, which were defined as having a value greater than or equal to 0.3 or less than or equal to –0.3 among the factors, are boldfaced in Table 5. The complexity of these activity bundles do not often lend themselves to a clear interpretation. Of the 14 activity types that served as inputs to the factor analysis, three deserve special attention. "Service private vehicle" represents any maintenance performed by the household member on a personal vehicle (e.g., vehicle refueling), while "routine shopping" refers to shopping for products that are consumables (e.g., grocery shopping) and "major item shopping" refers to any shopping for durable goods (e.g., major appliances). The seven identified activity bundles that resulted from the factor analysis of these three general activity types and the other 11 are interpreted below:

Factor 1 (work-related activity). This activity bundle is strongly and positively correlated with work activities and negatively correlated with time allocation for home activities.

Factor 2 (routine out-of-home activity). This activity bundle is strongly correlated with frequent types of activities, such as shopping and dining, and negatively correlated with working.

Factor 3 (school-related activity). This activity bundle is strongly characterized by school-related activities and the activity of transporting an additional individual (e.g., student).

Factor 4 (recreation and dining activity). This activity bundle is strongly correlated with the general out-of-home social activities of recreating and dining.

Factor 5 (out-of-home working and dining activity). This activity bundle is strongly correlated with out-of-home working but differs from the first activity bundle by having strong correlations with transporting of other individuals and dining, which may be suggestive of an out-of-home work activity anchoring a more complex chain of trips.

Factor 6 (civic–religious and specialty shopping activity). This activity bundle is strongly characterized by civic–religious activities and specialty shopping.

Factor 7 (errand-related and civic–religious activity). This final activity bundle is characterized by a strong correlation with personal business and civic–religious activities.

Overall, these seven factors make intuitive sense once understood as a bundling of similar activity types. For instance, Factor 2 reveals that routine activities outside the workplace are correlated with one another and may subsequently be considered an activity bundle. Meanwhile, Factor 3 suggests that engagement in school activities from a household perspective is not simply the time spent as a student but also includes the time spent transporting school-aged children. All these factors are based on a single-day observation of time allocation for activities.

Specification of Model of Housing Tenure and Type Choice

A choice model for housing tenure and type was specified to examine the relationship between these residential location decisions and engagement in household activities across life-cycle stages. Household life-cycle stage has been shown to influence the choices of tenure and housing type. In regard to tenure choice, a household in an early life-cycle stage, such as a married couple without children, may choose to rent rather than own. As for the choice of housing type, parents with children may have a higher propensity to choose an SF housing type typically reflective as having greater floor space. Moreover, the activities undertaken by these two households likely differ and will be related to their observed tenure and housing type choices. To illustrate this point, households that tend to engage in fewer out-of-home activities may have a higher propensity to own an SF housing type.

For better understanding of such decision processes, a nested-choice structure based on similar models in the literature was specified (*18, 20*). The choice set in this model specification assumed that all households have a decision to rent or own their residence and a separate decision to reside in an SF housing type or an MF–ASF housing type (Figure 2). All households were assumed to have identical choice sets. Following a utility maximization framework, each combination of tenure and housing type was defined as follows:

$$U_{TH} = V_{TH} + V_T + V_H + \varepsilon_{TH} + \varepsilon_T + \varepsilon_H \tag{1}$$

where

T = own or rent;
H = SF, MF, or ASF;
V_{TH}, V_T, and V_H = systematic nonrandom components of utility function; and
ε_{TH}, ε_T, and ε_H = random component of utility function assumed to be Gumbel distributed.

An assumption of Gumbel error terms with different variances leads to the nested-logit choice probabilities having the following closed-form choice probabilities:

$$\Pr(T) = \frac{\exp(V_T + V_T')\mu_T}{\sum_{t\in T}\exp(V_T + V_T')\mu_T} \tag{2}$$

$$\Pr(H'|T) = \frac{\exp(V_{TH'})\mu_H}{\sum_{h\in TH}\exp(V_{TH'})\mu_H} \tag{3}$$

$$V_T' = \frac{1}{\mu_T}\cdot \ln\left[\sum_{h\in TH}\exp(V_{TH} + V_H)\cdot\mu_T\right] \tag{4}$$

The likelihood function for the observed sample is as follows:

$$L(\beta) = \prod_{n=1}^{N}[\Pr(H'|T)\cdot\Pr(T)] = \prod_{n=1}^{N}\left[\frac{\exp(V_{n,TH'})\cdot\mu_H}{\sum_{h\in TH}\exp(V_{n,TH'})\cdot\mu_H}\cdot\frac{\exp(V_{n,T} + V_{n,T}')\cdot\mu_T}{\sum_{t\in T}\exp(V_{n,T} + V_{n,T}')\cdot\mu_T}\right]\delta_{nTH} \tag{5}$$

where L is likelihood function, N is the total number of observations, and δ_{nTH} is 1 if combination TH is chosen by observation n and 0 otherwise.

The motivation for nesting housing type in tenure stems from the literature and not from a conceptual understanding of the household decision process. When the assumptions imposed by the nested-logit choice probabilities are followed, the ratio of the scale parameters may be interpreted as the correlation between any two total utilities for an alternative that shares a common tenure decision.

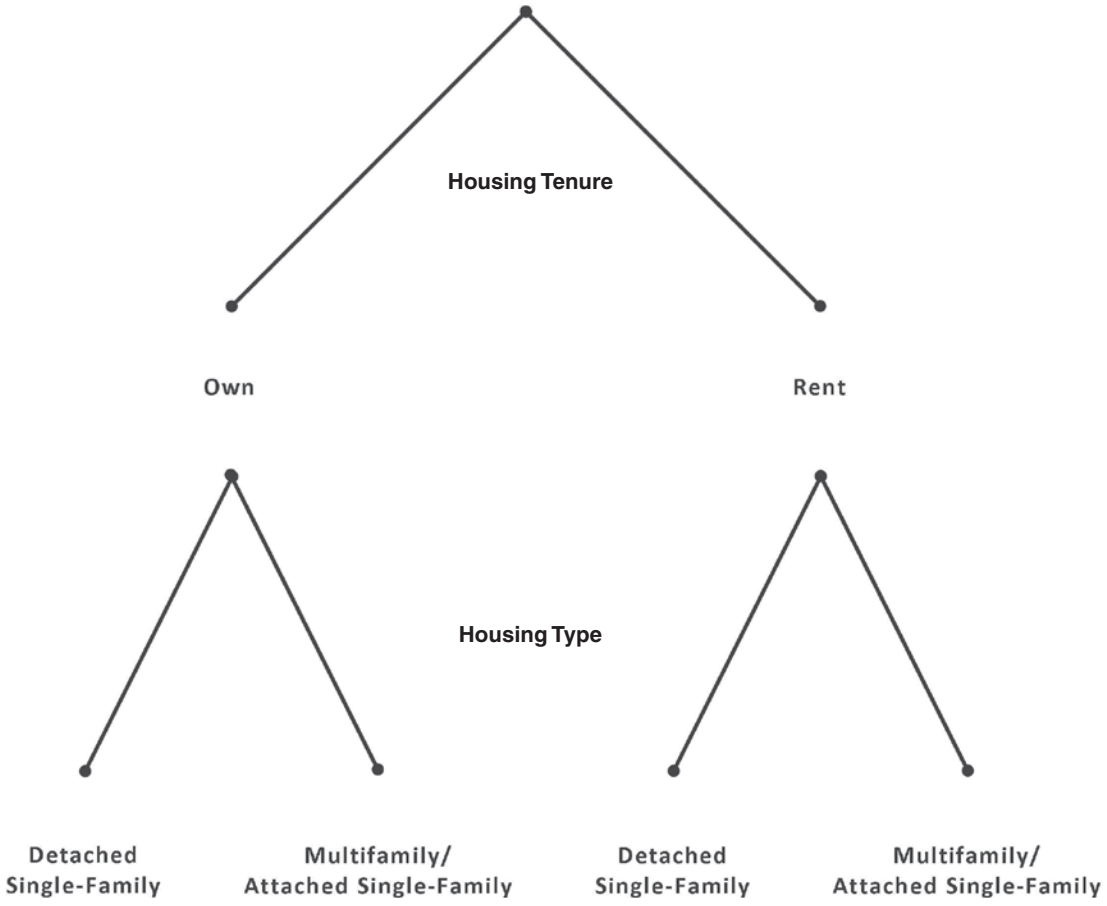

FIGURE 2 Nesting structure for choices of housing tenure and type.

RESULTS OF MODEL ESTIMATION

The nested-logit choice model specified by Equations 2 through 4 was estimated by using a procedure for full-information maximum-likelihood estimation. For identification purposes, the scale parameter (μ_T) for the tenure level was set to 1. Table 6 displays the results from this estimation process. The ratio of scale parameters (μ_T/μ_H) was 0.9823, which, although statistically significant, suggested that the dissimilarity between the two nests was somewhat marginal. Moreover, following Skaburskis (*15*) and Cho (*20*), the price value of all four alternatives was estimated by a linear regression of housing value on household size and Public Use Microdata Area by using data from the 2007 to 2009 American Community Surveys (*21*).

With respect to travel characteristics, estimated coefficients for the number of owned vehicles revealed that the number of household vehicles decreased as the propensity to choose renting increased. However, the number of vehicles owned was treated as an exogenous variable, although it may actually be endogenous with housing tenure and type choice. For households that chose to own their residence, increasing the number of vehicles owned reduced the propensity to choose an MF or ASF housing type. As vehicle ownership increased, the propensity to buy a single-family home generally increased. While parking availability at residential locations was not examined for this study, this quality of the housing unit may significantly contribute to the lower propensity to rent an MF or ASF housing types. Furthermore, households with a car-share subscription had a higher propensity to own an MF or ASF housing structure. Furthermore, an additional telecommuter per household resulted in a reduction in the likelihood that a household chose renting as a tenure option.

In the examination of the spatial location of the observed household that was represented by the five area types or accessibility classes, households in all area types were found to have a negative propensity for selecting the MF or ASF housing type compared with the own–SF base case. As mentioned earlier, all alternatives were assumed to be available to all households, when in actuality fewer MF or ASF structures were available relative to SF homes. Figure 3 displays the coefficients estimated across accessibility classes and life-cycle stages. This spatial attribute of the residential location decision was found to have similar impacts on the choice of a SF housing type for each tenure choice. Likewise, all accessibility classes generally had similar impacts on the propensity to choose the MF or ASF option. A household in a rural area near a major city has a noticeably lower propensity for selecting the rent–MF or ASF option compared with the base case of owning an SF structure.

An investigation of life-cycle stages as they relate to the residential location choices of tenure and housing type revealed that all household life-cycle stages had a higher propensity to rent than the base-case stage of related adults older than 65, which represents retired couples. Compared with households in life-cycle Stages 5 and 6 (those of parents with children and of related adults with a member between 18 and 64, respectively), households of retired couples were found to be less likely to own an MF or ASF housing type. For the tenure decision to own, the life-cycle stages representing

TABLE 6 Estimation Results of Residential Location Choice Model

Variable Measured	Coefficient	*t*-Statistic	Variable Measured	Coefficient	*t*-Statistic
Constant own/MF-ASF	–1.879	–31.607	Life-cycle stage 1, own/MF-ASF	0.381	9.289
Constant rent/SF	–3.136	–97.883	Life-cycle stage 2, own/MF-ASF	0.374	8.047
Constant rent/MF-ASF	–1.526	–93.919	Life-cycle stage 5, own/MF-ASF	–0.859	–4.340
Housing value/(income*20 or income)	–1.238	–32.849	Life-cycle stage 6, own/MF-ASF	–0.306	–3.959
Household vehicles, own/MF-ASF	–0.620	–11.602	Life-cycle stage 1, rent/SF	0.276	9.123
Household vehicles, rent/SF	–0.787	–70.481	Life-cycle stage 2, rent/SF	1.478	73.080
Household vehicles, rent/MF-ASF	–1.542	–94.135	Life-cycle stage 3, rent/SF	1.869	9.043
Household car-share subscription, own/MF-ASF	0.832	2.057	Life-cycle stage 4, rent/SF	2.055	13.827
Household car-share subscription, rent/SF	–0.527	–9.765	Life-cycle stage 5, rent/SF	1.834	15.836
Household telecommuters, rent/SF	–0.728	–23.631	Life-cycle stage 6, rent/SF	1.085	33.316
Household telecommuters, rent/MF-ASF	–0.505	–42.787	Life-cycle stage 1, rent/MF-ASF	1.125	33.370
Scale parameter housing type	1.018	62.536	Life-cycle stage 2, rent/MF-ASF	1.766	62.096
Urban near major city, own/MF-ASF	–0.787	–5.015	Life-cycle stage 3, rent/MF-ASF	1.816	15.635
Rural near major city, own/MF-ASF	–0.959	–4.624	Life-cycle stage 4, rent/MF-ASF	1.939	16.074
Isolated city, own/MF-ASF	–1.049	–5.209	Life-cycle stage 5, rent/MF-ASF	1.293	15.074
Rural, own/MF-ASF	–2.274	–9.493	Life-cycle stage 6, rent/MF-ASF	1.226	31.611
Urban near major city, rent/SF	0.088	14.703	Activity factor 2, rent/SF	–0.038	–22.790
Rural near major city, rent/SF	–0.198	–14.156	Activity factor 3, rent/MF-ASF	0.109	41.621
Isolated city, rent/SF	0.275	11.253	Activity factor 4, rent/SF	–0.145	–15.484
Rural, rent/SF	0.385	20.934	Activity factor 4, rent/MF-ASF	–0.065	–29.494
Urban near major city, rent/MF-ASF	–0.392	–22.108	Activity factor 5, rent/MF-ASF	0.119	15.543
Rural near major city, rent/MF-ASF	–1.740	–26.216	Activity factor 6, rent/SF	–0.174	–71.341
Isolated city, rent/MF-ASF	–0.378	–80.422	Activity factor 6, rent/SF × life-cycle stage 2	0.214	19.625
Rural, rent/MF-ASF	–2.401	–13.900	Activity factor 6, rent/SF × life-cycle stage 6	0.224	13.889

NOTE: Model performance of log likelihood is –9,479 and log likelihood (constants only-model) is –11,949.

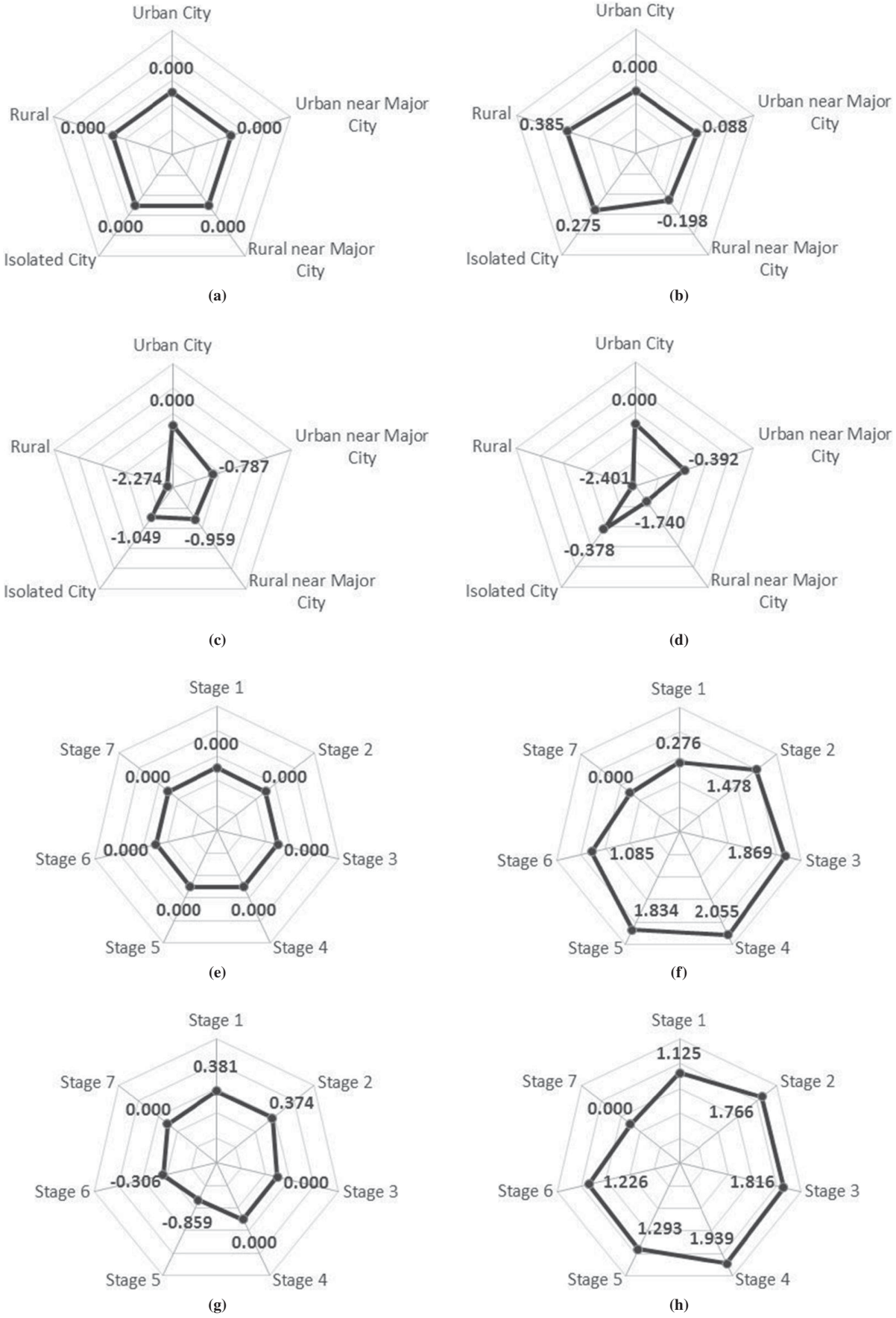

FIGURE 3 Radar plots of estimated coefficients for residential accessibility classes (*a*) own–SF (base case), (*b*) rent–SF, (*c*) own–MF and ASF, and (*d*) rent–MF and ASF and for life-style stages (*e*) own–SF (base case), (*f*) rent–SF, (*g*) own–MF and ASF, and (*h*) rent–MF and ASF.

unrelated households and a single-parent household were not statistically different from a retired-couple household with respect to the choice of an MF or ASF housing type. Compared with the coefficients for the base case, those for the household of single parent with children had the highest magnitude for both housing types within the rent tenure option, a finding that implies a high propensity for households in this life-cycle stage to rent their homes.

Finally, the activity bundles developed by the factor analysis on household time allocation across 14 general-activity types were also estimated in the residential location choice model. Significant results revealed that an increase in the recreation and dining activity bundle (Factor 4) largely decreased the propensity for a household to choose the rent–MF or ASF alternative, whereas an increase in the school-related (Factor 3) and out-of-home working and dining (Factor 5) activity bundles increased the propensity to choose the rent–MF or ASF alternative compared with the base-case alternative of owning a detached SF home. Results of the routine out-of-home activity bundle (Factor 2) as well as the recreation and dining (Factor 4) and civic–religious and specialty shopping activity (Factor 6) bundles revealed that those households selecting these activity bundles tended to have a negative association with choosing the rent or detached SF alternative in comparison to the base alternative. This finding suggested that households who allocate more time toward these out-of-home activity bundles tended to own detached single-family homes over the other three alternatives. These impacts are reduced for the life-cycle stages in which the household is either comprised of an individual younger than 65 years or of related adults with at least one individual younger than 65 years.

Only the estimation results for the work-related and errand-related activity bundles, Factor 1 and Factor 7, respectively, were found to have no statistically significant coefficients in the model. One explanation may be that these activity bundles do not statistically explain the difference in choices of tenure and housing type. Accordingly, households may reach tenure and housing type decisions with minimal regard to their time allocation toward work-related or errand-related activity bundles. Plausibly there are some activities that statistically explain tenure and type choices and other activity types that do not. Future work in this area may wish to incorporate the residential location choice dimension of neighborhood type to investigate whether these activity bundles may be significant to this third choice.

CONCLUSION

Since long-term forecasts of household emissions, energy consumption, and travel behavior derived from travel demand models remain important outcomes for decision makers assessing potential policy levers and planning scenarios, an understanding of residential location choices will continue to be essential in modeling decisions. In the context of activity engagement, the home location often serves as an anchoring point for all out-of-home activities and subsequent travel decisions. Given this prominent role that household location has in the spatial distribution of household activities and the results of travel demand models, an improved understanding of the complex relationships between residential choice and activity engagement would seem paramount. As such, this study explored the relationship between the residential location choices of tenure and housing type and their association with the out-of-home activity engagement of households across varying life-cycle stages.

A two-level nested logit model for the household decisions of tenure and housing type was estimated on household activity and travel data for the state of Oregon. Out-of-home household activity time allocation was represented as seven activity bundles calculated from a principle component analysis on the proportion of time households spend on 14 general activity descriptions. These seven activity bundles were used in the choice model in addition to five statewide area types and seven unique life-cycle stages that were based on the size of the household as well as the age and relation of its members. General results of this estimation revealed that households in each of the five area types had a negative propensity toward selecting the MF-ASF housing type when compared to the own–single-family base case, each household life-cycle stage had a higher propensity to rent than the base-case life-cycle stage of retired couples, and that an increase in time allocated to activity bundles related to school (Factor 3) or out-of-home working and dining (Factor 5) led to an increase in the propensity to choose the tenure–housing type option of rent–MF-ASF. Overall, estimation results revealed a relationship between the choice of housing tenure and type, attributes of the household, and time allocation for activities among its members.

This study represented an initial exploration into the relationship between residential location choice and time allocation for time allocation for household activities. Therefore, several possible extensions remain to be explored by future work. One potential extension concerns an alternate representation of time allocation for activities. Activity-based approaches to travel analysis acknowledge that travel is a derived demand from activity participation and that activity participation must be viewed from the perspective of complex travel patterns. This intricacy was captured in this exploratory study by applying a factor analysis on time allocation for household activities. However, the literature is rich with models of person-level activity time allocation, which may be better integrated within the framework of the model for choice of residential location presented in this study. A second extension involves altering the representation of membership in a household life-cycle stage. In this study, observed attributes were used to a priori define life-cycle stages. However, the use of latent class models within a discrete choice framework has become more common in the literature, and a similar approach may be explored in future work. Finally, this study examined the dimensions for residential location choice of tenure and housing type. However, the complementary choice of neighborhood type, which may more appropriately address the activity opportunities presented to households at different locations, should be considered in future adaptations of this research. Of course, careful attention must be given to the method for making operational the concept of neighborhood when this residential location choice is integrated into the current estimation framework.

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