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Forest Amenities and Location Choice in the Southwest

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Locations with natural characteristics, such as forests, are thought to be attractive residential locations. This proposition is tested in the Southwest United States, composed of Arizona and New Mexico. This paper presents a conditional logit model of location choice estimated with household observations from the U.S. Census, geographic information system (GIS) data, and county-level data. Results suggest that forest area, both in one's own location and nearby, increases the probability of choosing a location. But significant heterogeneity in location choices exists; an income effect and life-cycle effects on the demand for forest amenities appear to determine location choices.

Key words: amenities, conditional logit, forests, location choice, Southwest

Introduction

Recent estimates from the U.S. Census confirm a long-acknowledged trend in national population movements: the Mountain West and South are growing rapidly, while other areas of the country are experiencing slow or negative population growth (U.S. Census Bureau, 2006). The national trends, however, mask considerable within-region variations in population growth. Population in the Southwest United States, composed of Arizona and New Mexico, on average grew by about 16% between 2000 and 2006. But the region contains the country's fastest growing city (Gilbert, AZ, which grew by 58% from 2000 to 2006), and several communities that experienced population decreases greater than 10%.¹ This paper asks whether residential location decisions within the Southwest, and thus observed differences in population growth, are affected by the availability of forest amenities.

Several authors have suggested that broad national trends in population movements can be explained by the demand for amenable climates and landscape characteristics (e.g., Graves and Linneman, 1979; Knapp and Graves, 1989). Areas with more amenable climates or other features have higher net in-migration rates (Mueser and Graves, 1995),

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¹ Calculations are taken from U.S. Census Bureau tables SUB-EST2005-02, SUB-EST2005-4-04, and SUB-EST2005-4-35, at <http://www.census.gov/popest/estimates.php> (accessed July 26, 2007).

and individual migration decisions at the national level have been shown to be influenced by climate (Cragg and Kahn, 1997; Clark and Cosgrove, 1991) and location-specific employment opportunities (Davies, Greenwood, and Li, 2001). But within the Southwest, where climate characteristics are relatively homogeneous, the distribution of forest resources may explain intra-regional trends.

A few studies suggest that intra-regional variation in landscape characteristics affects residential location decisions. County-level net migration rates in the northern forest region of the United States are positively associated with public conservation land and multiple-use public lands (Lewis, Hunt, and Plantinga, 2002, 2003) and "moderate" climate and topographic amenities (White and Hanink, 2004). Von Reichert and Rudzitis (1994) found that differences in the housing price and wage cost of wilderness-area amenities among 15 counties affect the probability of selecting a county to which to migrate.

The importance of natural characteristics to regional location decisions is policy relevant. The management of forests and other public lands often involves a combination of regional and local policies. For example, revisions of forest plans for the U.S. Forest Service are often left to the discretion of each forest, but regional teams can be used to coordinate the plans of all forests in the region.² The effects of changes in local forest characteristics on population movements, and the social and economic consequences of those movements, may be information the regional teams would want to consider.

Location-choice analysis can also confirm amenity-demand explanations of implicit prices generated in housing and labor markets. A combination of higher housing prices and lower wages may compensate individuals for access to amenable location-specific characteristics [see Hoehn, Berger, and Blomquist (1987) for a review of how implicit prices may be generated in housing and labor markets]. Recent work related to the Southwest shows that positive implicit prices exist for regionally delineated forest amenities (Hand et al., 2008). One interpretation of this result is that people demand forest amenities and select residential locations based on the availability of forests. Our paper seeks to explicitly test this interpretation.

In addition to the general hypothesis that people are choosing where to live based on the availability of forests, various populations may view amenities differently. For instance, retirees or other non-labor force participants may be more attracted to areas where amenities are capitalized in wages rather than housing prices (Graves and Waldman, 1991; von Reichert and Rudzitis, 1994). Other authors have posited that amenities are a normal good (Costa and Kahn, 2000), so higher income individuals are expected to have a greater demand for amenities.³ This paper tests whether higher income individuals have a greater demand for natural amenities and thus are more likely to choose amenable locations. It is also possible that life-cycle effects explain differences in location choices (Graves, 1979). This hypothesis is also explored.

² See the "Southwestern Region Plan Revision Strategy" (April 21, 2006, p. 4), available at <http://www.fs.fed.us/r3/plan-revision/strategy.shtml> (accessed September 19, 2006).

³ As pointed out by an anonymous reviewer, this statement does not necessarily imply that higher income people will be migrating to amenable locations. A familiar statement of the income effect relates changes in income to changes in the probability of migration (see Graves and Linneman, 1979). In the model of location choice, it suffices to say that higher income individuals will have a higher demand for amenities.

Using individual household observations from the Public Use Microdata Series (PUMS) matched with geographic information system (GIS) and county-level data, this study presents estimates of a conditional logit model of location choice within the Southwest United States. The estimates provide support for the broad hypothesis that forest and natural characteristics in part determine residential location decisions, and suggest that income effects and life-cycle patterns explain heterogeneous demands for amenities.

Model of Regional Location Choices

A simple model of residential location decisions assumes individuals are able to look across a regional landscape, observe the characteristics of each location, and choose the location that yields the highest utility. In addition to conceptual simplicity, an advantage of this model is that it is closely related to utility-theoretic models that underlie compensating differentials in a hedonic framework (e.g., Rosen, 1974; Roback, 1982; Hoehn, Berger, and Blomquist, 1987), differences in migration rates (Mueser and Graves, 1995; Gawande et al., 2000), and migration decisions (Cragg and Kahn, 1997; Davies, Greenwood, and Li, 2001).

Observed location choices are connected to unobserved utility comparisons using a random-utility model (RUM). Empirical applications of RUMs have been used across a variety of topics, including choice of transportation modes (McFadden, 1974), recreation site choices (see Freeman, 2003, p. 434), and location choices of welfare recipients (O'Keefe, 2004). Define unobserved utility derived by individual i in location j as composed of a deterministic (or representative) component and an idiosyncratic component, or:

$$(1) \quad U_{ij}^* = V(\mathbf{x}_j, \boldsymbol{\beta}) + \mu_{ij},$$

where \mathbf{x}_j is a vector of characteristics associated with location j , $\boldsymbol{\beta}$ is the corresponding vector of utility function parameters, and μ_{ij} is a zero-mean independently and identically distributed (i.i.d.) random component of utility.

We observe the choice of location j by the observable indicator variable Y_{ij} , where $Y_{ij} = 1$ indicates j has been chosen by the individual over the other available locations. For a given location,

$$(2) \quad Y_{ij} = 1 \text{ if } U_{ij}^* > U_{ik}^* \quad \forall k \neq j.$$

Since Y_{ij} is a random variable, the probability that location j is chosen is the probability that utility in location j is greater than the utility obtainable in all other locations, or:

$$(3) \quad \Pr[Y_{ij} = 1] = \Pr[U_{ij}^* > U_{ik}^*] = \Pr[V(\mathbf{x}_j, \boldsymbol{\beta}) + \mu_{ij} > V(\mathbf{x}_k, \boldsymbol{\beta}) + \mu_{ik}] \\ \forall k \neq j.$$

This model is capable of considering the choices of migrants and nonmigrants who choose to remain in their current location. That is, some individuals may make a location choice (which is the behavior we are interested in) without migrating. Both movers and nonmovers are economically interesting in this model.

A choice of functional form for $V(\mathbf{x}_j, \boldsymbol{\beta})$ and distribution for μ_{ij} allows for estimation of the parameters of the utility function, $\boldsymbol{\beta}$. Following McFadden (1974; and see Greene,

2003), using a linear functional form and Weibull extreme value distribution, it can be shown that

$$(4) \quad \Pr[Y_{ij} = 1] = \frac{e^{\mathbf{x}_j' \boldsymbol{\beta}}}{\sum_{k=1}^J e^{\mathbf{x}_k' \boldsymbol{\beta}}}.$$

Equation (4) is the conditional logit model. The effect of each location-specific characteristic on utility can be estimated by selecting $\boldsymbol{\beta}$ such that the joint likelihood of observing Y_{ij} for the N sampled individuals, given observations of \mathbf{x}_j in all J locations, is maximized.

This model is used to examine the primary hypothesis about location choice, that forest and other natural characteristics have a positive impact on utility. Under this hypothesis, the probability of selecting a location is positively associated with the amount of forests available in that location. However, this model does not include a role for individual characteristics (e.g., income). Other hypotheses, particularly that forest amenities are normal goods, require a model that incorporates classical heterogeneity by interacting an individual characteristic with a location-specific characteristic. This extension to the model is described in the next section.

Empirical Framework of Location Choice Estimates

Estimation of (4) requires the selection of the appropriate population sample, a menu of available locations, and the vector of location-specific characteristics thought to influence utility. Extensions of equation (4) incorporating heterogeneity also require selecting the appropriate individual characteristics. Each of these issues is addressed in turn.

The first selection is of the population sample that constitutes the observation set. Specifically, who is observed to have made a location choice? Individual responses to the long form of the decennial U.S. Census are reported in the Public Use Microdata Series (PUMS), 5% sample, for Arizona and New Mexico. The approach here is to use the most general observation set possible. Thus, all households are considered to have made a location choice and are included in the sample. The sample includes households who migrated within the region between 1995 and 2000, those who migrated to Arizona or New Mexico from outside the region, and those who did not move but “implicitly” chose to remain in their current location.⁴ This yields a sample of 86,646 male-headed and 42,319 female-headed households. The empirical estimates are obtained using an 80% subsample of the data set.

The group missing from this analysis is households who originally lived in Arizona or New Mexico and moved to a location outside the region between 1995 and 2000. Although the behavior of this group is potentially interesting, the goal of the location choice model used here is to compare the relative attractiveness of locations within the region along dimensions that may be important only at a regional scale, e.g., area of forest land.

⁴ Approximately 50% of both the male- and female-headed household samples changed locations between 1995 and 2000. Results do not qualitatively change when the sample is restricted to those who explicitly changed locations. (Results are available from the authors upon request.)

Using the Southwest as a study region implicitly involves the selection of a specific choice menu, as must be done for any conditional logit analysis. The menu selected here includes all Public Use Microdata Areas (PUMAs) within Arizona and New Mexico. A PUMA is a Census Bureau-defined area with a population of at least 100,000. Each household in the Census data is linked to one of the PUMA locations. In the cases of Maricopa County (AZ), Pima County (AZ), and Bernalillo County (NM), several PUMAs are grouped together into a single location for each county. Geographic data available at the PUMA level for these counties are aggregated up to the county level. The region is composed of 20 possible locations.

A difficulty with using the publicly available PUMS data is the requirement that individuals be linked to geographic areas with a population of at least 100,000. These geographic units can be large in rural areas, but small in urban areas. Thus, the aggregation of the most populous counties into fewer locations has its advantages and drawbacks. An advantage is that it reduces somewhat the variability in the geographic size of the different locations. The largest location is New Mexico PUMA 800, composed of Hidalgo, Grant, Luna, Sierra, Catron, Socorro, and Torrance counties (35,512 square miles), and the smallest is Bernalillo County (1,168 square miles). Without aggregation, the smallest PUMA (in Pima County) would be 23 square miles. A disadvantage of aggregation is that it masks some potentially interesting intra-county location choices in the largest urban areas.⁵

The empirical model can be used to test hypotheses about differences in location choices between populations. One such hypothesis is that retirees are more likely than workers to seek locations with wage-compensated amenities (Graves and Waldman, 1991; von Reichert and Rudzitis, 1994). The PUMS data do not explicitly identify people who are retired; reported age and labor-force participation are used to construct the samples. Retirees are defined here as individuals aged 65 years and older and reported not in the labor force.⁶ The worker sample is defined as those aged between 25 and 64 years who reported themselves as labor-force participants.

Several location-specific characteristics may affect individual utility, and thus location choices. The characteristics of interest in this paper are forest and other natural amenities that vary within the Southwest. Gawande et al. (2000, p. 159) identified four broad categories of characteristics that may be important: "(i) [natural] amenities, (ii) employment-related factors, (iii) demographic factors, and (iv) other regional factors." Measures of characteristics in the first three of these categories are included as independent variables in the utility function.

The forest and natural characteristics include forest area measured by the proportion of U.S. Forest Service land (*AREA_FS*), the average proportion of U.S. Forest Service land in nearby locations (*AVG_FS*), surface water area (*SURFACE*), federally administered recreation sites (*REC_SITES*), and EPA-defined hazardous waste sites

⁵ Distance between locations may determine choices, but geographic aggregation of Census data makes these concepts difficult to incorporate in this context. Specifying distance between location centroids or borders would introduce significant measurement error. An initial exploration of omitting distance was made using a binary contiguity-based distance measure, i.e., close locations are those that share a political boundary. This measure may account for fixed costs associated with moving far from an individual's origin. Although this measure also introduces measurement error, its inclusion did not appear to alter the qualitative results for the variables of interest. (Results are available from the authors upon request.)

⁶ Other definitions of a retiree and worker populations are possible. For example, Graves and Waldman (1991) drop people aged 55 to 65 years from the "worker" sample in order to eliminate the possibility that early, amenity-seeking retirees are confounding the results.

(*HAZ_COUNT*). These characteristics were used to estimate implicit housing and wage prices for amenities in Hand et al. (2008); each of these characteristics were shown to generate implicit prices in the housing or labor markets (or both), which suggests they may be important in residential location choices. The data for the forest and natural characteristics have been gathered from GIS calculations and county-level data sets, and calculated for each of the 20 PUMAs in the region.⁷

The implicit price estimates in Hand et al. (2008) also allow for the calculation of money-metric natural amenity indexes. Price differentials (e.g., higher housing prices and lower wages) due to variation in a natural characteristic indicate the marginal willingness to pay for that characteristic in housing and labor markets. The total marginal implicit price for a natural characteristic is the sum of the housing price and wage differentials. These implicit prices—the housing price differential, wage differential, and total marginal implicit price—are used to create the money-metric amenity indexes.

The amenity indexes utilize the estimated price differentials and total marginal implicit prices by applying a technique from Graves and Waldman (1991). This technique multiplies the estimated price differentials by the corresponding amount of each natural amenity available in a given location, and sums the products. The housing-price amenity index (*HOUSECOMP*) for each j location is calculated as:

$$(5) \quad \text{HOUSECOMP}_j = \alpha_1 \text{AREA_FS}_j + \alpha_2 \text{AVG_FS}_j + \alpha_3 \text{SURFACE}_j \\ + \alpha_4 \text{REC_SITES}_j + \alpha_5 \text{HAZ_COUNT}_j,$$

where each α is the housing-price differential for each corresponding natural characteristic as estimated in Hand et al. (2008). *HOUSECOMP_j* gives the annual amount one would have to pay in the housing market for access to the natural amenity bundle available in location j .

The wage amenity index (*WAGECOMP*) is given by:

$$(6) \quad \text{WAGECOMP}_j = \beta_1 \text{AREA_FS}_j + \beta_2 \text{AVG_FS}_j + \beta_3 \text{SURFACE}_j \\ + \beta_4 \text{REC_SITES}_j + \beta_5 \text{HAZ_COUNT}_j,$$

where each β is the estimated wage differential for each corresponding natural characteristic. *WAGECOMP_j* represents the annual wages one would forego for access to the natural amenity bundle available in location j . Finally, a total amenity price index, *TOTCOMP*, is constructed as the sum of *HOUSECOMP* and *WAGECOMP* in each location.

An advantage of these measures is that they provide a money-metric index of the amenity bundle in each location. Because the implicit prices are assumed constant across the region, variation in the indexes represents variation in the amenable characteristics, scaled by the implicit price of each characteristic. The indexes are also integral to tests of the retiree hypothesis. For these tests, the wage and housing price indexes are included in the \mathbf{x}_j vector of characteristics instead of each forest and natural

⁷ Sources are as follows: *AREA_FS* and *AVG_FS*, U.S. Forest Service Southwestern Region, <http://www.fs.fed.us/r3/gis/datasets.html>; *SURFACE*, National Atlas, <http://nationalatlas.gov/atlasftp.html#hydrogm>; *HAZ_COUNT*, U.S. Environmental Protection Agency CERCLA database, <http://www.epa.gov/enviro/html/cerclis/index.html>; *REC_SITES*, National Outdoor Recreation Supply Information System, U.S. Forest Service Southern Research Station, contact information available at <http://www.srs.fs.usda.gov/trends/betz.html>.

characteristic measure. If the hypothesis is correct, the effect of wage-compensated (housing price-compensated) amenities on the probability of choosing a location would be larger (smaller) for retirees than for workers.

Several different variables may indicate employment opportunities and local economic conditions. Included in this analysis are the unemployment rate in 1995 (*UNEMP95*) and industrial sector shares for each PUMA. The unemployment rate is thought to measure the probability of obtaining and keeping a job, while sector shares are included to control for the opportunities offered by employment concentration in different sectors. Included sectors are manufacturing (*MANF_SHARE*), services (*SERV_SHARE*), and farming (*FARM_SHARE*).⁸

Demographic factors are characteristics of a location's population that might be amenable or disamenable, or affect economic growth and employment outcomes. These typically include the racial composition of a location. The demographic factors used here are the percentage of the location's population that is Black (*BLACK_CONC*), Hispanic (*HISP_CONC*), and have a college education (*ED_SHARE*), each calculated from the PUMS data. Population density (*DENSITY*) and its square (*DENS2*) are also included as independent variables to control for the presence of urban amenities (e.g., cultural institutions) and disamenities (e.g., congestion). Table 1 describes the location-specific characteristics used in the conditional logit estimation.

A final consideration in the empirical approach is variation in location-choice behavior within populations. A hypothesis investigated here is that higher income individuals will have a higher demand for forests and natural characteristics, and will thus exhibit a higher probability of choosing amenable locations. Note, this is distinct from an expectation that we observe higher income individuals migrating to amenable locations; it is merely a statement that the demand function for amenities includes income as an argument, and that an individual with higher income will demand more amenities than an individual with less income.

The difficulty in empirically testing the income-effect hypothesis is that some measures of income (e.g., wages) and wealth (e.g., house value) are endogenous to the choice of location (Mathur and Stein, 1991). Hand et al. (2008) and other hedonic applications (e.g., Hoehn, Berger, and Blomquist, 1987) conclude that location-specific amenities are driving both wages and housing values. To avoid this problem, a measure of location-invariant income (*INC_INVAR*) is defined as the sum of retirement, welfare, Social Security, and investment income reported for each individual in the PUMS data.

While the empirical specification in equation (4) does not use any individual characteristics, they can be added by creating interactions with the location characteristics. The natural log of location-invariant income, $\ln(INC)$, is interacted with the various forest and natural characteristics measures, or the money-metric amenity indexes.

A second interaction term is added between the amenity measures and a binary categorical variable indicating whether or not an individual earned any location-invariant income (*INCBIN*). This term is added because of the large portion of the sample having zero location-invariant income. The amenity**INCBIN* interaction controls for having any location-invariant income on the probability of choosing an amenable location,

⁸ Sources are as follows: *UNEMP95*, U.S. Bureau of Labor Statistics, Local Area Unemployment Statistics, <http://www.bls.gov/lau/home.htm>; *MANF_SHARE*, *SERV_SHARE*, and *FARM_SHARE*, U.S. Bureau of Economic Analysis, Regional Economic Accounts table CA25 (total employment by industry), <http://www.bea.gov/bea/regional/reis/>.

Table 1. Summary Statistics for Location-Specific Characteristics

Variable	Description	Mean	Standard Dev.
<i>AREA_FS</i>	% PUMA area in USFS national forests and grasslands	13.6	12.0
<i>AVG_FS</i>	Average % USFS area in contiguous PUMAs	15.0	8.2
<i>SURFACE</i>	Area of surface water bodies (excluding streams) in sq. miles	40.9	68.4
<i>HAZ_COUNT</i>	Number of EPA-designated CERCLA sites	16.5	10.1
<i>REC_SITES</i>	Number of USFS and other federal recreation sites	47.4	63.0
<i>UNEMP95</i>	Unemployment rate in 1995	0.090	0.060
<i>ED_SHARE</i>	Share of population with at least a college education in 1995	0.193	0.079
<i>MANF_SHARE</i>	Share of employment in manufacturing in 1995	0.060	0.032
<i>SERV_SHARE</i>	Share of employment in services in 1995	0.258	0.052
<i>FARM_SHARE</i>	Share of employment in farming/agriculture in 1995	0.032	0.029
<i>HISP_CONC</i>	Share of population that is Hispanic in 1995	0.310	0.169
<i>BLACK_CONC</i>	Share of population that is Black in 1995	0.017	0.012
<i>DENSITY</i>	Population density in 1995	56.2	113.0
<i>DENS2</i>	Square of <i>DENSITY</i>	15,400	49,700
<i>TOTCOMP</i>	Total implicit cost of amenity characteristics ^a (\$):		
	► Men	2,890	1,430
	► Women	1,600	878
<i>WAGECOMP</i>	Wage-compensated implicit cost of amenity characteristics ^a (\$):		
	► Men	3,610	1,810
	► Women	3,030	1,610
<i>HOUSECOMP</i>	House price-compensated implicit cost of amenity characteristics ^a (\$):		
	► Men	-716	1,490
	► Women	-1,430	1,400

Note: Location-specific characteristics are calculated for each of the 20 PUMA-defined locations in the region.

^a Calculated using implicit prices of *AREA_FS*, *AVG_FS*, *HAZ_COUNT*, and *REC_SITES* from Hand et al. (2008, tables 3 and 4) for men and women, respectively.

and the amenity*ln(*INC*) interaction controls for the level of income on the probability of selecting an amenable location.

It is possible that location-invariant income is closely related to age. To isolate the effect of income from any life-cycle effects (discussed in more detail below), the age of the householder (*AGE*) is interacted with the natural characteristics or the money-metric amenity measures. The *AGE**amenity interaction is also required to explore alternatives to the retiree hypothesis.

Incorporating these interactions yields the following deterministic component of utility:

$$(7) \quad V(\mathbf{x}_j, \mathbf{z}_j, \ln(INC_i), AGE_i; \alpha, \beta, \delta, \gamma, \pi) = \mathbf{x}'_j \alpha + \mathbf{z}'_j \beta + (INC BIN_i * \mathbf{z}'_j) \delta \\ + (INC BIN_i * \ln(INC_i) * \mathbf{z}'_j) \gamma + (AGE_i * \mathbf{z}'_j) \pi,$$

where \mathbf{z}_j is the vector of forest and natural characteristics or the money-metric indexes, and \mathbf{x}_j is the remaining vector of location-specific characteristics. Table 2 summarizes the income and age variables for the sample.

Table 2. Summary Statistics for Income and Age

Variable	Description	Men		Women	
		Mean	Std. Dev.	Mean	Std. Dev.
<i>INCBIN</i>	Binary income indicator (= 1 if reports location-invariant income)	0.465	0.499	0.495	0.500
<i>INC_INVAR</i>	Location-invariant income: sum of retirement, welfare, Social Security, and investment income (\$)	9,320	22,700	7,050	17,200
<i>ln(INC)</i>	Natural log of location-invariant income	8.70	2.10	8.55	1.87
<i>AGE</i>	Age of household head in 1999	49.2	16.6	50.8	18.9

Patterns of Location Choice

General Empirical Findings

Since β is a vector of utility-function parameters, estimates of β from equation (4) can be used to qualitatively assess the impact of different location characteristics on utility (and with the linear utility function, the impact on the probability of choosing a location). That is, if coefficient β_1 is positive (negative), then an increase in characteristic x_1 in a particular location will increase (decrease) the utility derived from and probability of selecting that location.

The first hypothesis is that people demand forest and other natural characteristics and tend to choose locations where these characteristics are available. Table 3 reports the estimates of equation (4) using the vector of forest and natural characteristics, estimated separately for male- and female-headed households.⁹ Results support the hypothesis that individuals are attracted to areas with high measures of some forest and other natural characteristics. Estimated coefficients for *AVG_FS* and *SURFACE* are positive and significant for both men and women. The estimated coefficient for *AREA_FS* is positive and significant for men, but negative and not significant for women. Recreation sites (*REC_SITES*) have a negative impact on location decisions for both men and women. One interpretation is that men and women are more likely to choose a location if there is more surface water and nearby forest area. Men are more likely to choose a location if it has more forest area within that location.

Elasticities shed light on the magnitude of any amenity effect on location decisions. Following Greene (2003, p. 723), the elasticity of the t^{th} attribute z_{tj} on the probability of choosing location j is represented by:

$$(8) \quad \varepsilon_{tj} = \frac{\partial \Pr_j}{\partial z_{tj}} \frac{z_{tj}}{\Pr_j} = \beta_t z_{tj} [1 - \Pr_j].$$

⁹ In model 1, a likelihood-ratio test confirms the model is appropriately estimated separately for male- and female-headed households. Assuming a constant scale factor, the restriction that binary gender interactions with the independent variables are zero significantly reduces the likelihood function (Greene, 2003, p. 486). (Results are available from the authors upon request.)

Table 3. Conditional Logit Estimates for the Total Population, by Gender, Amenity Vector Model

Variable	Men (no. observations = 69,316)			Women (no. observations = 33,855)		
	Coefficient	Standard Error	Elasticity	Coefficient	Standard Error	Elasticity
Model 1 – Vector of Amenities						
<i>AREA_FS</i>	0.784***	0.061	0.102	-0.135	0.088	-0.018
<i>AVG_FS</i>	5.390***	0.007	0.766	5.580***	0.322	0.793
<i>SURFACE</i>	0.002***	1.4e-4	0.080	0.002***	2.0e-4	0.096
<i>HAZ_COUNT</i>	0.023***	0.002	0.341	0.052***	0.002	0.776
<i>REC_SITES</i>	-7.3e-4***	1.7e-4	-0.033	-0.001***	2.4e-4	-0.051
<i>UNEMP95</i>	4.530***	0.169	0.393	4.960***	0.255	0.431
<i>ED_SHARE</i>	-2.980***	0.232	-0.543	-0.234	0.326	-0.043
<i>MANF_SHARE</i>	5.410***	0.390	0.302	7.240***	0.563	0.405
<i>SERV_SHARE</i>	9.960***	0.239	2.430	12.100***	0.336	2.950
<i>FARM_SHARE</i>	0.129	0.350	0.004	-2.980***	0.523	-0.092
<i>HISP_CONC</i>	0.439***	0.072	0.130	1.340***	0.103	0.396
<i>BLACK_CONC</i>	44.000***	0.860	0.704	48.800***	1.230	0.781
<i>DENSITY</i>	0.008***	7.1e-4	0.397	-0.004***	9.9e-4	-0.195
<i>DENS2</i>	-1.7e-5***	1.3e-6	-0.220	5.7e-6***	1.8e-6	0.073
Log Likelihood	-157,156			-77,092		
Pseudo- R^2	0.243			0.240		

Notes: Single, double, and triple asterisks (*) denote 90%, 95%, and 99% confidence levels, respectively. The dependent variable is binary location choice; elasticities are averaged across all locations in the region (see text for calculation of elasticities); pseudo- R^2 is McFadden's likelihood-ratio index.

This calculation yields $J = 20$ elasticities for each attribute in the \mathbf{z}_j and \mathbf{x}_j vectors. The reported elasticities are the mean across all J locations for each attribute. When the individual characteristics (income or age) are interacted with the location-specific characteristics, elasticities are calculated using the sample means of the individual characteristics.

The magnitude of the effect of *AREA_FS* on the probability of selecting a location is small in comparison with nearby forest area (*AVG_FS*). The average elasticity for *AREA_FS* is 0.1 for men, indicating that a 10% increase in forest area in a given location will result in an increase in the probability of selecting that location of 1%. Nearby forest area has a larger effect. A 10% increase in average nearby forest area to a given location results in about a 7.7% increase in the probability of selecting that location for men and a 7.9% increase for women.

The result that *AVG_FS* has a larger impact on the probability of location choice than *AREA_FS* is consistent with the implicit price calculations from Hand et al. (2008). Those results consistently showed larger implicit prices for nearby forest area than forests in one's own location. People may seek forests that are "close enough" in order to access both forests and good employment opportunities, and this behavior results in a premium that people must pay for this desirable combination of characteristics.

A common finding across specifications is that areas with more hazardous waste sites (*HAZ_COUNT*) appear to be more attractive to both men and women (with elasticities of about 0.34 and 0.78, respectively). Although hazardous waste sites are generally thought to be disamenities, a positive coefficient is not completely unexpected (Gawande et al., 2000), especially for total sites and not just high-risk Superfund sites. Since hazardous waste sites are associated with economic activity, this variable may be related to employment opportunities.

To deal with the interpretation of a variable like *HAZ_COUNT*, the money-metric indexes of amenity compensation are used instead of the vector of forest and other natural characteristics. These measures rely on calculated implicit prices for each of the variables in the vector. Models 2 and 3 in table 4 report results using *TOTCOMP* or *WAGECOMP* and *HOUSECOMP*, respectively. Using the measure of total amenity compensation (*TOTCOMP*), areas requiring a larger implicit price to be paid (i.e., *TOTCOMP* is higher) are more attractive locations, for both men and women, with respective elasticities of about 0.54 and 0.41.

Estimating equation (4) using *HOUSECOMP* and *WAGECOMP*, instead of *TOTCOMP* (table 4, model 3), allows a distinction between areas where the price of amenities is paid through labor markets (i.e., wages) or through housing markets (i.e., housing prices). The *WAGECOMP* coefficient is positive and significant for both men and women, which supports the hypothesis that locations with more amenities will increase the probability of choosing that location. The *HOUSECOMP* coefficient is positive and significant for men, but negative and significant for women. Men are more likely to choose locations where amenities are paid for through housing prices, but women are less likely to choose those locations. The average elasticity estimates confirm that amenities are, in general, a positive determinant of the probability of location choice. As indicated by the elasticities, a 10% increase in *WAGECOMP* yields a 7% increase in the probability of choosing a location for men, and a 10% increase for women; a 10% increase in *HOUSECOMP* changes the probability of location choice by 1% or less.

Population density appears to play a significant role in location choices. For men, *DENSITY* is positive and statistically significant and *DENS2* (the square of *DENSITY*) is negative and significant in all models. These results conform to the expectation that households will be attracted to locations that offer some urban amenities, such as cultural institutions or urban infrastructure (see Glaeser, Kolko, and Saiz, 2001), but at a decreasing rate as denser urban areas impose congestion costs (Adamson, Clark, and Partridge, 2004, p. 209). The results for women are more curious. Model 2 exhibits the same pattern of location choice as men with respect to *DENSITY* and *DENS2*. But models 1 and 3 exhibit the opposite relationship; only the highest density urban areas appear to be attractive to women. This result may be an artifact of the differences between the male and female samples. Female-headed households are more likely to be single-parent households, while male-headed households are more likely to be two-parent, two-income households. It is possible that women-headed households seek different employment opportunities that vary differently with urbanization than do two-parent households, and that this difference is only observable in the models where the amenity measures are not summarized by a single index (i.e., *TOTCOMP*). This is left as a topic for future research.

Table 4. Conditional Logit Estimates for the Total Population, by Gender, Amenity Index Models

Variable	Men (no. observations = 69,316)			Women (no. observations = 33,855)		
	Coefficient	Standard Error	Elasticity	Coefficient	Standard Error	Elasticity
Model 2—Total Amenity Index						
TOTCOMP	2.0e-4***	4.7e-6	0.537	2.7e-4***	1.3e-5	0.409
UNEMP95	2.700***	0.143	0.234	2.910***	0.213	0.253
ED_SHARE	-2.250***	0.128	-0.410	-3.470***	0.183	-0.630
MANF_SHARE	2.490***	0.232	0.139	7.950***	0.365	0.445
SERV_SHARE	6.140***	0.196	1.500	9.100***	0.284	2.220
FARM_SHARE	1.080***	0.295	0.033	2.860***	0.437	0.088
HISP_CONC	-0.751***	0.050	-0.223	-0.329***	0.076	-0.098
BLACK_CONC	36.700***	0.694	0.588	26.900***	0.904	0.431
DENSITY	0.017***	2.0e-4	0.806	0.017***	2.9e-4	0.811
DENS2	-3.2e-5***	3.9e-7	-0.416	-3.3e-5***	5.5e-7	-0.423
Log Likelihood	-157,585			-77,623		
Pseudo-R ²	0.241			0.235		
Model 3—Wage and House Price Indexes						
WAGECOMP	2.2e-4***	5.2e-6	0.738	3.7e-4***	1.3e-5	1.040
HOUSECOMP	8.1e-5***	1.1e-5	0.089	-8.2e-5***	1.7e-5	-0.107
UNEMP95	3.420***	0.157	0.297	5.530***	0.244	0.480
ED_SHARE	-0.344*	0.206	-0.063	1.160***	0.250	0.212
MANF_SHARE	4.250***	0.278	0.238	13.200***	0.429	0.736
SERV_SHARE	6.870***	0.205	1.670	12.800***	0.313	3.110
FARM_SHARE	-0.493	0.356	-0.015	-2.000***	0.474	-0.062
HISP_CONC	-0.261***	0.065	-0.078	1.480***	0.101	0.440
BLACK_CONC	43.400***	0.851	0.678	45.100***	1.140	0.724
DENSITY	0.009***	6.9e-4	0.430	-0.007***	9.1e-4	-0.350
DENS2	-1.8e-5***	1.3e-6	-0.229	1.2e-5***	1.7e-6	0.179
Log Likelihood	-157,515			-77,234		
Pseudo-R ²	0.241			0.239		

Notes: Single, double, and triple asterisks (*) denote 90%, 95%, and 99% confidence levels, respectively. The dependent variable is binary location choice; elasticities are averaged across all locations in the region (see text for calculation of elasticities); pseudo- R^2 is McFadden's likelihood-ratio index.

In all of the specifications for men and women, the *UNEMP95* coefficient is positive and significant—i.e., areas with higher unemployment rates appear to be more attractive. Though unexpected, a positive sign for the unemployment rate is not unprecedented (Enchautegui, 1997; Davies, Greenwood, and Li, 2001). A sample dominated by employed individuals who are unconcerned with unemployment may yield the observed result (Greenwood, 1997, p. 682). Further, we cannot observe employment status at the time the location choice was made, which makes it difficult to examine the precise role of unemployment in this context (Greenwood, 1985, p. 532). An additional explanation is

that unemployment may be related to the tradeoffs people make between wages, housing prices, and natural amenities. Blanchflower and Oswald (1994) suggest the demand for amenities may explain a negative relationship between wages and unemployment. If people are willing to accept higher unemployment to access natural amenities, in addition to an implicit price paid in housing and labor markets, then a positive coefficient for *UNEMP95* is expected.

The estimated models appear to fit the data reasonably well. The pseudo- R^2 s (i.e., McFadden's likelihood-ratio index) reported in tables 3 and 4 are between 0.23 and 0.24, and a χ^2 statistic (not reported) did not reject the hypothesis that the estimated model is an improvement on the "null" model with all coefficients restricted to zero. Table 5 reports the actual choice probabilities for the 80% estimated sample and the 20% holdout sample, the predicted choice probabilities from model 1, and a Pearson's χ^2 statistic for each location. The predicted probabilities are generally within a few tenths of a percent of the actual probabilities. These deviations are close in magnitude to those found in O'Keefe (2004), who employed a similar location-choice empirical application.

The Pearson's χ^2 indicates whether the predicted choice probabilities for each location significantly differ from the actual sample probabilities.¹⁰ This statistic is included as a more rigorous comparison of actual and predicted choice probabilities. For men, nine of the 20 locations do not reject the hypothesis that the estimated model fits the data well. Ten of the 20 locations do not reject the hypothesis that the model fits well for women.¹¹ The Pearson's χ^2 statistic reveals model 1 yields the best fit of the data.

Location-Invariant Income and Migration

The second hypothesis is that there is an income effect for amenities; people will demand more amenities and be more likely to choose amenable locations if they have higher incomes. To test this, the utility function in equation (7), in which the location-invariant income measures and age are interacted with the forest and natural characteristics or the amenity indexes, is used for estimation. The direct amenity effect shows the impact on utility of amenities common to the entire population (on average), while the income*amenity interaction shows (for those who have location-invariant income) the effect of income differences on the utility derived from amenities in a particular location. The binary-income*amenities interaction shows any difference in the desirability of amenities between those who have any location-invariant income and those who have none.

¹⁰ Following Wackerly, Mendenhall, and Scheaffer (2002, p. 682), the Pearson's χ^2 statistic ($df = 1$) is calculated for each $j = 1, \dots, J$ locations as: $\chi^2 = (n_j - n\hat{p}_j)^2 / n\hat{p}_j(1 - \hat{p}_j)$, where n_j is the actual number of households who choose location j , n is the total number of households in the sample, and \hat{p}_j is the predicted probability that a household chooses location j . The use of a "global" goodness-of-fit measure such as the Pearson's χ^2 is relatively unique in this type of application. Other similar empirical applications (including Costa and Kahn, 2000; Cragg and Kahn, 1997; Davies, Greenwood, and Li, 2001; and O'Keefe, 2004) present the pseudo- R^2 or the value of the log-likelihood function to assess fit.

¹¹ It is not immediately clear why the model would predict location choices better for some of the locations in the study area. As suggested by an anonymous reviewer, there may be a relationship between geographic or population size and the accuracy of model predictions. But at first glance, there does not appear to be a correlation between these characteristics and goodness of fit. Other explanations left to future research could be related to movements between locations and unobservable movements within locations.

Table 5. Actual and Predicted Probabilities of Location Choice, by Gender

PUMA-Based Locations (location number)	Men				Women			
	80% Sample	20% Sample	Model 1	χ^2	80% Sample	20% Sample	Model 1	χ^2
Arizona Locations:								
Maricopa (41)	0.419	0.420	0.421	1.07**	0.403	0.419	0.405	1.07**
Pima (42)	0.116	0.118	0.110	26.60	0.134	0.124	0.127	15.50
Apache, Navajo (43)	0.023	0.023	0.023	0.157**	0.028	0.029	0.027	1.07**
Coconino (44)	0.018	0.017	0.022	64.10	0.019	0.020	0.026	69.50
Yavapai (45)	0.031	0.031	0.027	51.50	0.029	0.032	0.024	29.10
La Paz, Mohave (46)	0.034	0.035	0.035	1.20**	0.030	0.033	0.030	0.002**
Yuma (47)	0.023	0.024	0.025	4.99	0.016	0.016	0.018	2.63**
Gila, Pinal (48)	0.038	0.039	0.045	84.80	0.034	0.032	0.041	45.20
Cochise, Graham, Greenlee, Santa Cruz (49)	0.038	0.040	0.032	83.30	0.034	0.031	0.027	57.60
New Mexico Locations:								
San Juan (351)	0.013	0.012	0.010	39.00	0.011	0.011	0.010	5.18
Rio Arriba, Taos, San Miguel, Mora, Guadalupe (352)	0.023	0.023	0.024	2.37**	0.027	0.027	0.027	0.019**
Colfax, Union, Harding, Quay, De Baca, Curry, Roosevelt, Lincoln (353)	0.024	0.026	0.023	0.912**	0.022	0.024	0.021	3.75**
Santa Fe (354)	0.019	0.020	0.022	26.50	0.024	0.025	0.025	1.42**
Valencia, Sandoval, Los Alamos (355)	0.021	0.020	0.020	1.67**	0.020	0.019	0.020	0.124**
Bernalillo (356)	0.072	0.071	0.071	0.367**	0.082	0.075	0.081	0.322**
McKinley, Cibola (357)	0.010	0.010	0.011	4.64	0.015	0.015	0.014	2.05**
Catron, Socorro, Torrance, Sierra, Grant, Luna, Hidalgo (358)	0.023	0.022	0.019	59.20	0.023	0.020	0.020	10.50
Doña Ana (359)	0.020	0.018	0.020	0.108**	0.019	0.020	0.021	7.20
Otero, Chaves (3510)	0.019	0.017	0.018	0.809**	0.018	0.015	0.015	12.30
Eddy, Lea (3511)	0.017	0.016	0.022	76.40	0.013	0.013	0.020	86.90

Notes: Predicted probabilities are estimated using models without income or age interactions. Model 1 is the model with the vector of location-specific natural characteristics. The 80% sample is used to generate the model predictions, while the 20% sample is not used in estimation. Probabilities may not sum to 1 due to rounding. The chi-squared statistic is a Pearson's χ^2 calculated for each location comparing the actual probability of location choice in the 80% sample to the predicted probabilities. Double asterisks (**) denote locations where the Pearson's statistic failed to reject the hypothesis that the predicted number of households choosing a particular location differed from the actual number. The critical χ^2 value (df = 1) at the 5% level is 3.84.

Table 6 reports the estimates of model 1 (vector of characteristics) with income and age interactions. Results tend to support the hypothesis of an income effect for amenities, although the results are stronger for men than for women. The coefficients of the interactions of income with forest area and surface water [$AREA_FS * \ln(INC)$ and $SURFACE * \ln(INC)$, respectively] are positive for men and women, though only marginally significant for women; high-income individuals are more likely to choose locations

Table 6. Conditional Logit Estimates with Income and Age Interactions, by Gender, Amenity Vector Model

Variable	Men (no. observations = 69,316)			Women (no. observations = 33,855)		
	Coefficient	Standard Error	Elasticity	Coefficient	Standard Error	Elasticity
Model 1 – Vector of Amenities						
<i>AREA_FS</i>	-1.070***	0.184	-0.138	-1.650***	0.236	-0.214
* <i>INCBIN</i>	-1.350***	0.334	-0.082	-1.110**	0.507	-0.071
* <i>ln(INC)</i>	0.161***	0.039	0.182	0.098	0.601	0.109
* <i>AGE</i>	0.036***	0.004	0.233	0.032***	0.005	0.212
<i>AVG_FS</i>	7.690***	0.574	1.090	8.710***	0.748	1.240
* <i>INCBIN</i>	3.480***	1.010	0.230	1.970	1.540	0.138
* <i>ln(INC)</i>	-0.087	0.120	-0.108	-0.144	0.185	-0.175
* <i>AGE</i>	-0.071***	0.012	-0.497	-0.068***	0.016	-0.489
<i>SURFACE</i>	-0.002***	3.2e-4	-0.091	-1.3e-4	4.1e-4	-0.005
* <i>INCBIN</i>	-0.002***	5.4e-4	-0.044	-0.002*	8.1e-4	-0.031
* <i>ln(INC)</i>	1.5e-4**	6.3e-5	0.053	1.7e-4*	9.7e-5	0.059
* <i>AGE</i>	9.5e-5***	6.4e-6	0.184	5.0e-5***	8.1e-6	0.100
<i>HAZ_COUNT</i>	0.034***	0.002	0.513	0.056***	0.003	0.843
* <i>INCBIN</i>	-0.001	0.002	-0.008	-0.005*	0.003	-0.035
* <i>ln(INC)</i>	6.8e-5	2.0e-4	0.009	1.6e-4	3.2e-4	0.021
* <i>AGE</i>	-2.2e-4***	2.2e-5	-0.166	-6.1e-5**	2.7e-5	-0.047
<i>REC_SITES</i>	8.9e-4**	3.9e-4	0.040	-6.1e-4	0.003	-0.028
* <i>INCBIN</i>	6.0e-4	6.6e-4	0.013	-6.1e-4	9.8e-4	0.014
* <i>ln(INC)</i>	-2.1e-4***	7.9e-5	-0.084	-2.3e-4*	1.2e-4	-0.089
* <i>AGE</i>	-2.0e-5**	8.1e-6	-0.044	4.0e-6	1.0e-5	0.009
Log Likelihood	-156,650			-76,977		
Pseudo- R^2	0.246			0.241		
LRT Statistic (df = 15)	1,010			230		

Notes: Single, double, and triple asterisks (*) denote 90%, 95%, and 99% confidence levels, respectively. The dependent variable is binary location choice. Elasticities are averaged across all locations in the region (see text for calculation of elasticities). Estimates for employment-related, demographic, and density variables are suppressed for brevity. LRT is the test statistic for the likelihood-ratio test between the model with income and age interactions and the basic model without interactions. All LRT statistics reject the hypothesis that interaction coefficients are zero.

with larger forest tracts and more surface water. But the coefficients for the interactions with the binary income indicator (*AREA_FS*INCBIN* and *SURFACE*INCBIN*) are negative. People with any location-invariant income are less likely to choose a location with forest area and surface water (as compared to those without any such income), but the desirability of those locations is increasing with income. The opposite relationship appears to hold for *REC_SITES*; the probability of selecting locations with more recreation sites is greater if an individual has location-invariant income, but decreasing in income. Nearby forest area (*AVG_FS*) and hazardous waste sites (*HAZ_COUNT*) do not exhibit a significant income effect, although the interaction of these measures with the binary income indicator is positive and significant.

Table 7. Conditional Logit Estimates with Income and Age Interactions, by Gender, Amenity Index Models

Variable	Men (no. observations = 69,316)			Women (no. observations = 33,855)		
	Coefficient	Standard Error	Elasticity	Coefficient	Standard Error	Elasticity
Model 2—Total Amenity Index						
<i>TOTCOMP</i>	3.4e-6	1.3e-5	0.011	1.5e-4***	2.7e-5	0.224
* <i>INCBIN</i>	-7.6e-5***	2.3e-5	-0.097	-2.3e-5	5.5e-5	-0.018
* <i>ln(INC)</i>	7.0e-6**	2.7e-6	0.167	9.6e-6	6.7e-6	0.126
* <i>AGE</i>	4.0e-6***	2.8e-6	0.538	1.8e-6***	5.6e-7	0.145
Log Likelihood	-157,392			-77,594		
Pseudo- <i>R</i> ²	0.242			0.235		
LRT Statistic (df = 3)	388			57.6		
Model 3—Wage and House Price Indexes						
<i>WAGECOMP</i>	5.9e-5***	1.3e-5	0.198	3.0e-4***	3.1e-5	0.842
* <i>INCBIN</i>	-7.5e-5***	2.4e-5	-0.116	-6.6e-5	6.3e-5	-0.092
* <i>ln(INC)</i>	6.8e-6**	2.8e-6	0.200	1.4e-5*	7.6e-6	0.331
* <i>AGE</i>	3.3e-6***	2.9e-7	0.548	8.4e-7	6.5e-7	0.120
<i>HOUSECOMP</i>	-1.7e-4***	1.7e-5	-0.189	-2.0e-4***	3.1e-5	-0.259
* <i>INCBIN</i>	-7.8e-5***	2.5e-5	-0.040	-3.4e-5	5.8e-5	-0.022
* <i>ln(INC)</i>	6.9e-6**	2.9e-6	0.066	1.1e-5	7.0e-6	0.154
* <i>AGE</i>	5.2e-6***	3.0e-7	0.279	1.6e-6***	5.9e-7	0.109
Log Likelihood	-157,188			-77,185		
Pseudo- <i>R</i> ²	0.243			0.239		
LRT Statistic (df = 6)	655			97.7		

Notes: Single, double, and triple asterisks (*) denote 90%, 95%, and 99% confidence levels, respectively. The dependent variable is binary location choice. Elasticities are averaged across all locations in the region (see text for calculation of elasticities). Estimates for employment-related, demographic, and density variables are suppressed for brevity. LRT is the test statistic for the likelihood-ratio test between the model with income and age interactions and the basic model without interactions. All LRT statistics reject the hypothesis that interaction coefficients are zero.

Specifications using the money-metric amenity indexes, reported in table 7, provide a clearer interpretation of the role of income in amenity demand. In model 2, the main amenity effect from *TOTCOMP* is not significant for men, but the desirability of amenities is increasing with location-invariant income. For a given level of *TOTCOMP*, a 10% increase in income will result in about a 1.7% increase in the probability of location choice. For women, the *TOTCOMP* coefficient is positive and significant, but the income interaction is not statistically significant.

The effect of having any location-invariant income (*TOTCOMP*INCBIN*) is negative and significant for men but insignificant for women. A valid question is why, in the presence of a positive income effect, men with small amounts of location-invariant income have a smaller demand for amenities. The most plausible explanation in this context is the presence of retirees receiving Social Security as their primary source of income. This group tends to be on the lower end of the income spectrum and may also make location decisions based on availability of social and health care services or the

need to be closer to adult children (see discussion below). Thus, the group of low location-invariant income households may appear to avoid natural amenities relative to those with no location-invariant income. This non-amenity-seeking group may be a smaller portion of the population at higher incomes, so the positive income effect eventually overtakes the negative binary effect of having some location-invariant income.

Using *HOUSECOMP* and *WAGECOMP* to measure natural amenities, model 3 shows similar evidence for an income effect. The coefficients for the *HOUSECOMP***ln(INC)* and *WAGECOMP***ln(INC)* interactions are positive and significant for men, and marginally significant for women. Amenities paid for through both housing prices and wages have a larger positive impact on utility for those with more income.

Independent of the evidence for an income effect, the results suggest that age plays a role in the demand for amenities. Estimated coefficients for age interactions with *TOTCOMP* in model 2 and *HOUSECOMP* and *WAGECOMP* in model 3 are positive and significant for men (and marginally significant for women), indicating that the demand for amenities increases with age. The implications of this result on a potential life-cycle story of amenity demand are further explored in the context of the workers versus retirees hypothesis.

Workers versus Retirees

The money-metric amenity indexes allow for a direct test of the hypothesis that retirees are more likely to seek locations where the amenities are capitalized in wages rather than housing prices. Following Graves and Waldman (1991), because a retiree only participates in the housing market, retirees can avoid paying for amenities by selecting locations where wages are lower but housing prices are not higher due to amenities. Thus, we would expect to observe that retirees relative to workers are more attracted to locations where *WAGECOMP* is high and less attracted to locations where *HOUSECOMP* is high. This argument relies on the assumption that retirees are not a large enough part of the housing market to bid up housing prices in wage-compensated locations (Graves and Waldman, 1991).

Table 8 presents estimates separately for retirement-age individuals who are not in the labor force (panel A of table 8) and working-age individuals identified as labor force participants (panel B). In model 2 (using the *TOTCOMP* index with income and age interactions), retirees are more likely to choose a location if it has a higher measure of amenable characteristics, but the effect is insignificant for workers. Retirees appear to have a stronger attraction to amenable areas than do workers.

Other differences between populations, some unexpected, become apparent when *WAGECOMP* and *HOUSECOMP* are used as amenity measures (model 3). For the working population, the *WAGECOMP* elasticity is positive and significant, while the *HOUSECOMP* elasticity is positive for men and negative for women. The *HOUSECOMP* elasticity is relatively small for both men and women. For retirees, the *WAGECOMP* elasticity is positive and larger than for workers; a 10% increase in *WAGECOMP* increases the probability of choosing a location by between 9% and 13%. The *HOUSECOMP* elasticity is also positive for retirees; a 10% increase in *HOUSECOMP* increases the probability of choosing a location by about 3%.

These results indicate mixed support for the workers versus retirees hypothesis. Retirees exhibit a stronger attraction to wage-compensated amenable locations than

Table 8. Conditional Logit Estimates with Income and Age Interactions for Retirees and Workers, by Gender

	Men			Women		
Variable	Coefficient	Standard Error	Elasticity	Coefficient	Standard Error	Elasticity
PANEL A. RETIREES						
Model 2–Total Amenity Index						
TOTCOMP	6.9e-4***	8.7e-5	1.900	6.4e-4***	1.8e-4	0.980
* INCBIN	6.0e-4***	8.3e-5	1.590	5.3e-4***	1.9e-4	0.775
* ln(INC)	−6.1e-5***	7.6e-6	−1.650	−3.0e-5	1.9e-5	−0.441
* AGE	−5.7e-6***	1.1e-6	−1.160	−6.3e-6***	2.2e-6	−0.742
Model 3–Wage and House Price Indexes						
WAGECOMP	6.2e-4***	9.0e-5	2.080	3.4e-4*	2.0e-4	0.941
* INCBIN	4.2e-4***	8.6e-5	1.350	−1.2e-4	2.1e-4	−0.310
* ln(INC)	−4.2e-5***	7.9e-6	−1.410	4.7e-5**	2.1e-5	1.270
* AGE	−4.7e-6***	1.1e-6	−1.170	−2.4e-6	2.5e-6	−0.521
HOUSECOMP	8.1e-4***	9.7e-5	0.899	3.1e-4*	1.9e-4	0.408
* INCBIN	9.6e-4***	9.2e-5	1.030	4.1e-4**	2.0e-4	0.512
* ln(INC)	−9.7e-5***	8.4e-6	−1.070	−1.7e-5	1.9e-5	−0.206
* AGE	−7.6e-6***	1.2e-6	−0.629	−5.8e-6**	2.3e-6	−0.581
No. of Observations	12,090			8,124		
PANEL B. WORKERS						
Model 2–Total Amenity Index						
TOTCOMP	−2.3e-6	2.2e-5	−0.006	−7.1e-5	5.2e-5	−0.110
* INCBIN	−1.1e-4***	3.1e-5	−0.092	−9.9e-5	7.3e-5	−0.045
* ln(INC)	3.4e-6	4.0e-6	0.067	1.6e-5	9.8e-6	0.170
* AGE	4.6e-6***	4.9e-7	0.547	7.1e-6***	1.2e-6	0.463
Model 3–Wage and House Price Indexes						
WAGECOMP	7.4e-5***	2.2e-5	0.247	1.3e-4**	6.1e-5	0.370
* INCBIN	−9.9e-5***	3.2e-5	−0.101	−7.6e-6	8.7e-5	−0.006
* ln(INC)	2.8e-6	4.1e-6	0.068	2.4e-6	1.2e-5	0.048
* AGE	3.5e-6***	5.0e-7	0.501	4.7e-6***	1.4e-6	0.558
HOUSECOMP	−2.3e-4***	2.6e-5	−0.250	−4.0e-4***	5.8e-5	−0.521
* INCBIN	−1.4e-4***	3.3e-5	−0.048	−7.4e-5	7.8e-5	−0.028
* ln(INC)	5.7e-6	4.2e-6	0.046	1.2e-5	1.0e-5	0.111
* AGE	6.7e-6***	5.2e-7	0.314	6.7e-6***	1.2e-6	0.369
No. of Observations	42,482			16,708		

Notes: Single, double, and triple asterisks (*) denote 90%, 95%, and 99% confidence levels, respectively. All estimates use the utility function specified in equation (7). The retiree population (Panel A) is householders who are over age 65 and not in the workforce. The worker population (Panel B) is householders age 25 to 64 who are in the workforce. Estimates for employment-related, demographic, and density variables are suppressed for brevity. [Refer to table 7 for other notes.]

workers, and a stronger attraction to wage-compensated amenities than housing price-compensated amenities. These findings fit with the story of retirees choosing locations to avoid paying for amenities through the housing market. But the hypothesis also suggests retirees will be less attracted to housing price-compensated locations; the results here do not support this hypothesis.

It is possible that the workers versus retirees hypothesis is still valid, but other factors are obscuring it. First, retirees may be attracted to locations with high housing prices (and abundant natural amenities) because homes are assets. Property ownership creates wealth effects under certain economic conditions, and the pursuit of consumption opportunities may explain counterintuitive location choices (Mueser, 1997). This may be particularly true if homes are perceived as rapidly appreciating assets, or, in the case of older retirees, their homes can represent an income source (e.g., through a reverse mortgage). A second possibility is that retirees may represent a significant portion of the housing market; particular locations within the Southwest have long been desirable retirement destinations. Although retirees make up only about 10% of all migrants [which is close to the estimates in Graves and Waldman (1991)], they comprise nearly 25% of the total population sample.¹² To state that this group is not affecting housing markets in the Southwest is unreasonable.

It may not be possible under either of these scenarios to assess the behavioral theory that underlies the Graves and Waldman (1991) hypothesis with cross-sectional data. But the results raise the interesting question of why retirees seem to have stronger preferences for amenities, regardless of how they are paid for. Rather than being a function of labor market participation, the results suggest a life-cycle story of location choice. We explore this story below.

Table 8 also reports estimates of the *AGE* interaction with the amenity indexes. For the worker sample when *TOTCOMP* is used, amenities alone (i.e., the amenity main effect) and the income interaction do not have a significant effect on location choice for men or women. But the age-amenity interaction (*TOTCOMP*AGE*) coefficient is positive and statistically significant; older workers are more likely to choose a location if it is more amenable. Using *WAGECOMP* and *HOUSECOMP* yields a similar story. Wage-compensated amenities alone are attractive, while housing price-compensated amenities deter location choice. But the age interactions are positive and significant for men and women. In fact, the age interactions appear to be the primary avenue through which amenities affect choices for workers since the income interactions are insignificant.

Retirees exhibit a different relationship between age and amenity measures. When age interactions are used in the specification, amenity levels increase the probability of choosing a location independent of age. The age-amenity interactions, however, are of the opposite sign of the amenity main effects and opposite of the results for workers; older retirees are less attracted to amenable locations than younger retirees, regardless of how amenities are paid for.¹³

These results begin to describe a life-cycle story of work, retirement, and amenities. Many younger workers may be most concerned with establishing careers, starting a family, and becoming homeowners. Natural amenities would not be a top priority. As

¹² Figures are calculated from the full PUMS data set using the above retiree definition.

¹³ A similar pattern of age interactions emerges when model 1 is estimated for retirees and workers. (Results are available from the authors upon request.)

workers establish themselves, they may turn more toward satisfying other preferences that include natural amenities. Thus, older workers would exhibit a stronger attraction to amenable locations.

Retirees, on the other hand, may begin to shift their preferences from natural amenities (a holdover from their working years) to preferences for access to transportation, health care, and social services. Or, they may need to move closer to adult children in less amenable locations [see Graves (1979) for a similar life-cycle explanation].¹⁴ While retirees may seek out natural amenities at the beginning of their retirement period, older retirees appear to seek out locations that have fewer natural amenities and may have more of the services that meet these preferences.

Discussion and Conclusions

Our empirical analysis has investigated the importance of forests and other natural characteristics within the Southwest by observing residential location choices. Results indicate that the density of forest area in a location is positively associated with the probability of selecting a location. Further, money-metric amenity indexes are positively associated with the probability of location choice. The results tend to confirm that forests are amenable characteristics and people locate themselves across the region in part based on the availability of these resources.

Beyond broad conclusions about forests and location choice, tests of specific hypotheses indicate an important role for population heterogeneity. The results support the idea of an income effect for forest and other natural characteristics that can be observed in residential location choices, and there also is evidence of a life-cycle story of amenity demand. In the latter case, older workers are more attracted to amenable locations than younger workers, and retirees exhibit a strong attraction to natural amenities that decreases with age.

An implication of the results is that the attractiveness of forests and other natural characteristics is policy relevant. This relevance stems from the fact that forests are not uniformly distributed across the landscape, and policies affecting the supply of forests may not have a spatially uniform impact. For example, if a policy reduces the supply of natural amenities in one location, other locations begin to look relatively more attractive to residents (although the region as a whole would look less attractive than other areas of the country).

This raises at least two policy issues in a regional context. First, locations in the Southwest, where the supply of amenities may be upwardly bounded, may need to view preservation as an important economic development policy. Protecting amenities already in place may buttress a steady influx of human resources to those locations. Second, the geographic level of decision making is potentially important. Policies made at the region-wide level may create spatial distribution issues, and decisions made at the local level can have external effects. Local decisions that do not account for these effects may result in policies that are efficient at the local level, but inefficient at the regional level.

A caveat to these conclusions should be noted. It is still not known precisely what characteristics generate the observed location choice behavior. Is it open space, recreation

¹⁴ We thank an anonymous reviewer for pointing out this connection.

opportunities, or wildlife habitat that is attractive to people, of which forest area may simply be a proxy? Or is it the higher altitudes and varied topography associated with many forest areas in the Southwest that are important? These questions remain unanswered and require more geographically precise micro data to pursue them. The U.S. Forest Service, Southwestern Region recently conducted a survey that will partially address this issue by allowing survey respondents to be located to individual zip codes or points on the map. This geographic level of response can provide more refined measures of access to natural amenities for future research.

Finally, other regions of the country may have a different set of policy tools available. In the Midwest, for example, land is often moved in and out of agricultural and conservation uses, and can be done so on a year-to-year basis. To the extent these differences in land use represent differences in amenable characteristics (e.g., conservation lands may provide habitat that supports recreational fishing and hunting), policies that affect land use can affect location choices. This type of application in other regions deserves attention in future research.

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References

- Adamson, D. W., D. E. Clark, and M. D. Partridge. "Do Urban Agglomeration Effects and Household Amenities Have a Skill Bias?" *J. Regional Sci.* 44,2(2004):201–223.
- Blanchflower, D. G., and A. J. Oswald. "Estimating a Wage Curve for Britain." *Economic J.* 104, no. 426(1994):1025–1043.
- Clark, D. E., and J. C. Cosgrove. "Amenities versus Labor Market Opportunities: Choosing the Optimal Distance to Move." *J. Regional Sci.* 31,3(1991):311–328.
- Costa, D. L., and M. E. Kahn. "Power Couples: Changes in the Locational Choice of the College Educated." *Quart. J. Econ.* 115,4(2000):1287–1315.
- Cragg, M., and M. Kahn. "New Estimates of Climate Demand: Evidence from Location Choice." *J. Urban Econ.* 42,2(1997):261–284.
- Davies, P. S., M. J. Greenwood, and H. Li. "A Conditional Logit Approach to U.S. State-to-State Migration." *J. Regional Sci.* 41,2(2001):337–360.
- Enchautegui, M. E. "Welfare Payments and Other Economic Determinants of Female Migration." *J. Labor Econ.* 15,3(1997):529–554.
- Freeman, A. M., III. *The Measurement of Environmental and Resource Values, Theory and Methods*, 2nd ed. Washington, DC: Resources for the Future, 2003.
- Gawande, K., A. K. Bohara, R. P. Berrens, and P. Wang. "Internal Migration and the Environmental Kuznets Curve for U.S. Hazardous Waste Sites." *Ecological Econ.* 33,1(2000):151–166.
- Glaeser, E. L., J. Kolko, and A. Saiz. "Consumer City." *J. Econ. Geography* 1,1(2001):27–50.
- Graves, P. E. "A Life-Cycle Empirical Analysis of Migration and Climate, by Race." *J. Urban Econ.* 6,2(1979):135–147.
- Graves, P. E., and P. D. Linneman. "Household Migration: Theoretical and Empirical Results." *J. Urban Econ.* 6,3(1979):383–404.
- Graves, P. E., and D. M. Waldman. "Multimarket Amenity Compensation and the Behavior of the Elderly." *Amer. Econ. Rev.* 81,5(1991):1374–1381.
- Greene, W. H. *Econometric Analysis*. Upper Saddle River, NJ: Prentice-Hall, 2003.
- Greenwood, M. J. "Human Migration: Theory, Models, and Empirical Studies." *J. Regional Sci.* 25,4(1985):521–544.
- . "Internal Migration in Developed Countries." In *Handbook of Population and Family Economics*, Vol. 1B, eds., M. R. Rosenzweig and O. Stark, pp. 647–720. Amsterdam: Elsevier, 1997.

- Hand, M. S., J. A. Thacher, D. W. McCollum, and R. P. Berrens. "Intra-Regional Amenities, Wages, and Home Prices: The Role of Forests in the Southwest." *Land Econ.* 84,4(November 2008): forthcoming.
- Hoehn, J. P., M. C. Berger, and G. C. Blomquist. "A Hedonic Model of Interregional Wages, Rents, and Amenity Values." *J. Regional Sci.* 27,4(1987):605–620.
- Knapp, T. A., and P. E. Graves. "On the Role of Amenities in Models of Migration and Regional Development." *J. Regional Sci.* 29,1(1989):71–87.
- Lewis, D. J., G. L. Hunt, and A. J. Plantinga. "Public Conservation Land and Employment Growth in the Northern Forest Region." *Land Econ.* 78,2(2002):245–259.
- . "Does Public Lands Policy Affect Local Wage Growth?" *Growth and Change* 34,1(2003):64–86.
- Mathur, V. K., and S. H. Stein. "A Dynamic Interregional Theory of Migration and Population Growth." *Land Econ.* 67,3(1991):292–298.
- McFadden, D. "Conditional Logit Analysis of Qualitative Behavior." In *Frontiers in Econometrics*, ed., P. Zarembka, pp. 105–142. New York: Academic Press, 1974.
- Mueser, P. R. "Two-Way Migration in a Model with Identical Optimizing Agents." *J. Regional Sci.* 37,3(1997):395–409.
- Mueser, P. R., and P. E. Graves. "Examining the Role of Economic Opportunity and Amenities in Explaining Population Redistribution." *J. Urban Econ.* 37,2(1995):176–200.
- O'Keefe, S. "Locational Choice of AFDC Recipients Within California: A Conditional Logit Analysis." *J. Public Econ.* 88,7-8(2004):1521–1542.
- Roback, J. "Wages, Rents, and the Quality of Life." *J. Polit. Econ.* 90,6(1982):1257–1278.
- Rosen, S. "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition." *J. Polit. Econ.* 82,1(1974):34–55.
- U.S. Census Bureau. *Annual Estimates of the Population for the United States, Regions, States, and for Puerto Rico: April 1, 2000 to July 1, 2006*. Washington, DC, 2006. Online. Available at <http://www.census.gov/popest/states/NST-ann-est.html>. [Accessed July 2007.]
- von Reichert, C., and G. Rudzitis. "Rent and Wage Effects on the Choice of Amenity Destinations of Labor Force and Nonlabor Force Migrants: A Note." *J. Regional Sci.* 34,3(1994):445–455.
- Wackerly, D. D., W. Mendenhall, III, and R. L. Scheaffer. *Mathematical Statistics with Applications*, 6th ed. Pacific Grove, CA: Duxbury Press, 2002.
- White, K. D., and D. M. Hanink. "Moderate Environmental Amenities and Economic Change: The Nonmetropolitan Northern Forest of the Northeast U.S., 1970–2000." *Growth and Change* 35,1(2004):42–60.