A Hazard Rate Analysis of Leavers and Stayers in Assisted Housing Programs

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Abstract

The study described in this article uses a random sample of households in the Multifamily Tenant Characteristics System database and the Tenant Rental Assistance Certification System database to address the following questions: Does a significant difference exist in the mobility patterns of households in each of the three primary assisted housing programs? What household characteristics affect the probability of leaving assisted housing? The analysis shows that individual characteristics play an important role in determining assisted housing tenure, and significant differences in individual characteristics exist across the three primary assisted housing programs. The analysis also shows that location and neighborhood factors do affect household tenure in assisted housing programs. The results from this study clearly confirm that basic economic conditions play a significant role in determining whether a household stays or leaves an assisted housing program.

Introduction

Public assisted housing has a long history in the United States, and the U.S. Department of Housing and Urban Development (HUD) is charged with implementing the nation's assisted housing programs and policies. Public housing policy for low-income individuals revolves around three primary programs: tenant-based certificates or vouchers, public housing, and project-based assistance. Today, more than 4.3 million low-income households receive federal housing support through one of these programs.[1]

As a support system for low-income households, HUD's assisted housing programs are part of the overall welfare system. As a result, public assisted housing was not designed to be a long-term housing solution but, rather, short-term assistance for households experiencing temporary economic dislocation. Thus, this article analyzes the duration of households in the various assisted housing programs in an effort to help policymakers in determining the factors that lead households to successfully make the transition out of assisted housing. To focus the analysis, I address the following questions: Does a significant difference exist in the mobility patterns of households in each of the three primary assisted housing programs? What household characteristics affect the probability of leaving assisted housing?

To preview the results, the study finds that individual characteristics play an important role in determining assisted housing tenure. Interestingly, the empirical analysis finds that significant differences in individual characteristics exist across the three primary assisted housing programs. The analysis also shows that location and neighborhood factors do affect household tenure in assisted housing programs. The results from this section should help policy analysts seeking to target specific programs that affect household tenure decisions within the assisted housing programs. Finally, and not surprisingly, the results from this study clearly confirm that basic economic conditions play a significant role in determining whether a household stays or leaves an assisted housing program.

U.S. Housing Programs

Assisted housing programs in the United States fall into three basic classifications: tenant-based vouchers (and formerly certificates), traditional public housing, and project-based assistance (Section 8). Housing vouchers are a tenant-based assistance program in which the subsidy flows directly to the assisted household. In contrast, the public housing and project-based assistance programs tie the federal subsidy to a particular unit.

The Housing Voucher Program

The housing voucher program is the primary tenant-based assistance program. Households provided with housing vouchers are eligible to lease units in the private market. According to Shroder (2002), households with children receiving housing vouchers exceed the number of households with children living in project-based and public housing combined. The housing voucher program is administered by the local public housing agencies, and under the housing voucher program eligible households may reside in any housing unit that meets the program requirements. The local housing agency determines the standard rent required to secure a "moderately priced dwelling" in the local housing market. The household holding the voucher is required to use 30 percent of its monthly adjusted gross income for rent. The housing voucher then covers the difference between the local housing market standard rent and the household's required contribution. If the household wishes to occupy a unit for which the rent is above the local standard rent, then the household must pay the differential not covered by the voucher. The household, however, may not move to a unit for which the rent is greater than 40 percent of the household's adjusted monthly income.

Shroder (2002) noted that the housing voucher program grants assisted households the freedom to choose their location at a lower cost than traditional project-based programs. In addition, vouchers provide flexibility to households in projects that no longer meet project-based subsidy guidelines.

Public Housing

Approximately 1.3 million households live in public housing units.[2] Congress created public housing to ensure safe and decent housing options for low-income families, the elderly, and people with disabilities. HUD provides federal aid to local housing agencies that manage housing for low-income residents. Public housing is targeted at households with incomes below 80 percent of area median income (lower income households) and households with incomes below 50 percent of area median income (very low income). Rent on public housing units is based on the household's expected gross annual income (less eligible deductions for dependents). Normally, rent is set at the highest of 30 percent of monthly adjusted gross income, 10 percent of monthly income, welfare rent, or a $25 to $50 minimum rent set by the local housing agency.

Section 8 Project-based Assistance

Congress created the Section 8 Program, currently known as the Housing Choice Voucher Program, in 1974 to provide rental subsidies to eligible households. The Section 8 Program covers housing units under several categories: Section 8 New Construction, Substantial Rehabilitation, and the Loan Management Set-Aside Programs. The housing assistance provided under the Section 8 Program is project based. Under a project-based assistance program, the federal subsidy resides with the housing unit for a contractually determined period. During this period, the owner receives rental subsidies equal to the difference between the approved contract rent for the unit and the required rental contribution of the tenant. Tenants in Section 8 subsidized properties generally pay rent that is calculated in a way that is similar to other assisted housing programs. Thus, project-based and tenant-based assisted housing programs are relatively transparent to the tenant, with two important exceptions. First, the tenant loses the rent subsidy on vacating a Section 8 Program unit and thus must either move to another project-based subsidized unit or receive a tenant-based voucher to continue to receive housing assistance. Second, project-based subsidies tend to have higher concentrations of poverty.[3]

Literature Review

Although research on tenure in assisted housing programs is relatively limited, extensive literature exists that examines tenure choice in the broader housing market. These studies concentrate on either rental markets or owner-occupied housing. Regarding the rental housing market, a natural question concerns the role of vacancy in the rental market. Because rental unit vacancy is directly related to tenant mobility and tenure choice, a number of recent studies have examined tenant duration in rental property. For example, Deng, Gabriel, and Nothaft (2003) and Gabriel and Nothaft (2001) examined the tenant duration in the rental housing market. Deng, Gabriel, and Nothaft (2003) estimated a hazard model of tenant duration using data from the Bureau of Labor Statistics' Consumer Price Index housing sample. Combining this data with metropolitan statistical area (MSA) level economic data, Deng, Gabriel, and Nothaft (2003) showed that positive changes in rent levels negatively affect the duration of rental occupancy. Their analysis also shows that areas with high rent costs have shorter tenant durations. These results are consistent with the findings of Gabriel and Nothaft (2001), who also linked tenant residence duration with the equilibrium natural vacancy rate. Their analysis showed that rental rates track tenant outflows and, thus, residential tenant duration is an important factor in determining market rents.

A strand of literature that is closely associated with tenant duration in assisted housing programs concerns the effect of rent control laws on tenant mobility and tenure choice. Beginning with Gyourko and Linneman (1989), a number of studies have empirically examined the effect of rent control regulations on household mobility. Gyourko and Linneman (1989) found that household mobility declines as the benefits associated with rent control increase. Following Gyourko and Linneman (1989), Ault, Jackson, and Saba (1994) and Nagy (1995) reexamined the benefits of rent control using improved econometric methods. While Ault, Jackson, and Saba (1994) confirmed that rent control regulations reduce household mobility, the results reported in Nagy (1995) imply that household characteristics and not regulations explain household mobility. Most recently, Munch and Svarer (2002) revisited the issue of rent control and household mobility using a proportional hazard model that corrects for both truncated tenancy durations and right-censored observations. After correcting for these censoring events, their analysis supports the conclusions of Gyourko and Linneman (1989) and Ault, Jackson, and Saba (1994) that rent control regulations significantly increase household tenancy duration.

This literature makes it clear that a number of factors determine the tenure of an individual in assisted housing. To assess the importance of individual/demographic factors versus economic factors, this article analyzes household tenure in public housing following the proportional hazard rate models in the spirit of Munch and Svarer (2002) and Hungerford (1996). Hungerford (1996) used the Survey of Income and Program Participation 1986, 1987, and 1988 Full Panel Microdata Research files to gather information about households residing in public housing. Similar to the goals of this study, Hungerford (1996) examined the household characteristics (for example, age, race, income) that affect the tenure in public housing. Thus, the results for this article will provide additional insights about the relationships Hungerford identified using a more complete data set covering a wider range of public assisted housing programs.

Data

To analyze the above questions, this study uses a random sample of the Multifamily Tenant Characteristics System (MTCS) database and the Tenant Rental Assistance Certification System (TRACS) database. Combined, these data sets contain information on 8,855,174 households residing in public assisted housing programs. The TRACS database contains information on 3,214,005 (36 percent of total) households living in project-based assisted housing involving such programs as Section 202, Section 236, and Section 8 New Construction and Substantial Rehabilitation. The MTCS database contains information on 2,910,718 (33 percent) households receiving tenant-based assistance under the Housing Choice Voucher Program and 2,530,247 (29 percent) households living in traditional public housing.[4]

The database consists of a series of annual updates from separate data extracts covering an 18-month window for the years ending December 31, 1995, to December 31, 2000. Thus, the complete database contains information on a significant number of households with exceptionally lengthy tenures in assisted housing. Because the database tracks the disposition of households after June 30, 1994 (18 months before December 31, 1995), significant bias exists in the sample. The bias results because no information exists for households that exited the assisted housing programs before June 30, 1994, which leaves the sample overpopulated with households having lengthy assisted housing spells. Thus, to control for this bias, I restrict the analysis to the 4,343,279 households that entered an assisted housing program after June 30, 1994. This figure represents approximately 49 percent of the households in assisted housing and has a slightly different composition of households in various programs. For example, the restricted sample consists of 31 percent residing in tenant-based programs (compared to 33 percent for the complete data set), 22 percent in traditional public housing (compared to 29 percent for the complete data set), and 44 percent in project-based housing (compared to 36 percent for the complete data set). Given the large number of records in these databases and the computational requirements for hazard rate analysis, I drew a 1-percent stratified random sample from each of these files.

Unfortunately, the data contained in the MTCS/TRACS databases contain a significant number of incorrectly coded observations. As a result, after cleaning the data for observations containing either missing or obviously incorrectly coded dates-of-admission or dates-of-action as well as missing demographic data, the sample data set contains 25,336 households that comprise 8,197 tenant-based records (32 percent), 6,288 public housing records (25 percent), and 10,851 project-based records (43 percent).

The preliminary step is to classify households as either still current in an assisted housing program or terminated from assisted housing. For observations in the tenant-based and public housing files (MTCS), I classify households as terminating their public housing

tenure if the household's final "type of action" variable recorded in the database is coded as either "portability move-out" or "end of participation." For observations in the project-based assisted database (TRACS), I classify households as terminating their public housing tenure if their final "type of action" variable recorded in the database is coded as "termination" or "move-out." All other observations in both systems are classified as still current in public housing as of "date_of_action" recorded in the database. Because each household in the database is tracked with a unique record identification number, the longitudinal files allow for tracking households that move from one assisted housing program to another. To control for this possibility, only households that exit from an assisted housing program and do not subsequently enter a new program are classified as terminating. Finally, to control for improvement in data recording and accuracy over time, I only include households not terminating from assisted housing in the analysis if the "date_of_action" is after December 31, 2000.[5]

Exhibit 1 reports the frequency distribution of the sample of households in each program by year of admission. The table indicates a slightly higher proportion of households (19.5 percent) entered the tenant-based housing voucher program in 2001 than the other programs (14.2 percent for project-based housing and 10.6 percent for public housing).[6]

Exhibit 1

Frequency Distribution of the Full Sample by Year of Admission

Admission Year	Project-based		Public Housing		Tenant-based		Total	
	Count	Percent	Count	Percent	Count	Percent	Count	Percent
1994	644	5.9	305	4.9	322	3.9	1,271	5.0
1995	1,253	11.5	723	11.5	729	8.9	2,705	10.7
1996	1,311	12.1	747	11.9	713	8.7	2,771	10.9
1997	1,402	12.9	810	12.9	980	12.0	3,192	12.6
1998	1,443	13.3	940	14.9	1,105	13.5	3,488	13.8
1999	1,526	14.1	1,091	17.4	1,231	15.0	3,848	15.2
2000	1,726	15.9	1,008	16.0	1,515	18.5	4,249	16.8
2001	1,546	14.2	664	10.6	1,602	19.5	3,812	15.0
Total	10,851	100.0	6,288	100.0	8,197	100.0	25,336	100.0

Exhibit 2 shows the distribution of the sample households across the 10 HUD regions. Overall, the cleaned random sample matches the general population of assisted households. For example, 5.9 percent of the random sample resides in Region 1 (New England) while 5.5 percent of the population is located in Region 1. Similarly, 21.4 percent of the sample is located in Region 4 (Southeast) while 22.2 percent of the population is located in Region 4. The cleaned random sample, however, does exhibit a slight difference from the overall population with respect to households residing in Region 5 (Midwest) and Region 6 (Southwest). The sample is overweighted in Region 5 (20.2 percent compared to 17.5 percent for the population) and underweighted in Region 6 (12.7 percent compared to 14.2 percent for the population). It is not clear that this discrepancy between the sample and the overall population biases the analysis.

Exhibit 2 does indicate that minor geographic variations exist in the various assisted housing programs. For example, 11.4 percent of the tenant-based households are located in Region 9 (Pacific) compared to 3.2 percent of the public housing households and 8.4 percent of the project-based households. Furthermore, Region 4 (Southeast) has a higher concentration of public housing households (31.4 percent), while Region 5 (Midwest) has a greater concentration of project-based households (23.8 percent).

Exhibit 2

Frequency Distribution of the Full Sample by HUD Region

HUD Region	Project-based		Public Housing		Tenant-based		Total	
	Count	Percent	Count	Percent	Count	Percent	Count	Percent
1: New England	722	6.7	283	4.5	489	6.0	1,494	5.9
2: New York/New Jersey	963	8.9	540	8.6	768	9.4	2,271	9.0
3: Mid-Atlantic	1,287	11.9	613	9.7	676	8.2	2,576	10.2
4: Southeast	2,057	19.0	1,977	31.4	1,382	16.9	5,416	21.4
5: Midwest	2,580	23.8	1,100	17.5	1,438	17.5	5,118	20.2
6: Southwest	1,129	10.4	945	15.0	1,136	13.9	3,210	12.7
7: Great Plains	542	5.0	359	5.7	602	7.3	1,503	5.9
8: Rocky Mountains	376	3.5	117	1.9	340	4.1	833	3.3
9: Pacific	913	8.4	199	3.2	932	11.4	2,044	8.1
10: Northwest	282	2.6	155	2.5	433	5.3	870	3.4
Total	10,851	100.0	6,288	100.0	8,196	100.0	25,335	100.0

Exhibit 3 reports the distribution of the sample households by MSA size. Again, we see a difference in the distribution of households across the assisted housing programs. For example, a greater percentage of public housing households (32.2 percent) reside in areas with a population less than 50,000 than do households receiving tenant-based assistance (26.3 percent). Note, however, that the majority of households (55.2 percent) receiving any type of housing assistance reside in cities with populations exceeding 500,000.

Exhibit 3

Frequency Distribution of the Full Sample by MSA Size

MSA Size	Project-based		Public Housing		Tenant-based		Total	
	Count	Percent	Count	Percent	Count	Percent	Count	Percent
Not in MSA	2,277	21.1	2,000	32.2	2,137	26.3	6,414	25.5
50,000–99,999	119	1.1	57	0.9	140	1.7	316	1.3
100,000–249,999	910	8.4	618	9.9	756	9.3	2,284	9.1
250,000–499,999	980	9.1	585	9.4	699	8.6	2,264	9.0
500,000–999,999	1,031	9.6	627	10.1	694	8.6	2,352	9.4
1,000,000–2,499,999	2,024	18.8	1,003	16.1	1,156	14.2	4,183	16.7
2,500,000–4,999,999	987	9.1	372	6.0	676	8.3	2,035	8.1
5,000,000 or more	2,461	22.8	953	15.3	1,857	22.9	5,271	21.0
Total	10,789	100.0	6,215	100.0	8,115	100.0	25,119	100.0

Note: 216 observations were eliminated from subsequent analysis due to incorrectly coded census tract values.

Baseline Hazard Rates

The purpose of this study is to examine the factors that lead a household to leave an assisted housing program. Hazard rate or duration analysis is a commonly used statistical technique that enables researchers to address this type of question.[7] I begin by defining the time that a household exits an assisted housing program, T, as a random variable, which has a continuous probability distribution, $f(t)$, where t is a realization of T. The cumulative probability is defined as

$$F(t) = \int_0^t f(s)ds = \Pr(T \le t) \tag{1}$$

and the survival function is defined as

$$S(t)=1-F(t)=\Pr(T>t). \tag{2}$$

The survival function provides an indication of the probability that the time to exit will be of length at least t. The probability (l) that a household will leave the program in the next short interval of time, Δt, given that the household has not left before time t is characterized as

$$l(t,\Delta t)=\Pr(t\le T\le t+\Delta t \mid T\ge t). \tag{3}$$

Furthermore, the function that characterizes this aspect of the distribution is the hazard rate and is defined as

$$h(t)=\lim_{\Delta t\to 0^+}\frac{\Pr(t\le T<t+\Delta t \mid T\ge t)}{\Delta t}=\frac{f(t)}{S(t)}. \tag{4}$$

The hazard rate provides an indication of the rate at which households leave the program at time t, given they remain in the program until t.

A preliminary step in analyzing the propensity to leave requires examining the basic household survival and hazard curves. Given that the data set consists of a large number of observations measured at discrete intervals (months), I compute the survival curves and hazard rates using the life-table method.[8] The life-table method estimates the conditional probability that a household will leave the program during month i, given that the household was still in the program at the start of i. Thus for month i, the probability of surviving to i is

$$\hat{S}(t_i)=\prod_{j=1}^{i-1}(1-q_j) \tag{5}$$

where q_j is the conditional probability of failure (leaving the program). For the first interval, the survival probability is set to 1.0. Exhibits 4 and 5 report the survival curves and hazard rates for each program. The survival and hazard rates (exhibits 4 and 5) clearly indicate differences in the underlying pattern of termination.

The above method provides an indication of the baseline hazard for households in each housing program (tenant-based, public housing, and project-based housing). I estimate the log-rank and Wilcoxon statistics testing the null hypothesis that the hazard rates are the same.[9] The log-rank and Wilcoxon statistics are computed as $\boldsymbol{v'V^{-1}v}$ where $\boldsymbol{v}$ is the vector $\boldsymbol{v}=(v_1,v_2,v_3)$ with

$$v_i=\sum_{j=1}^{u} w_j(d_{ij}-e_{ij}) \tag{6}$$

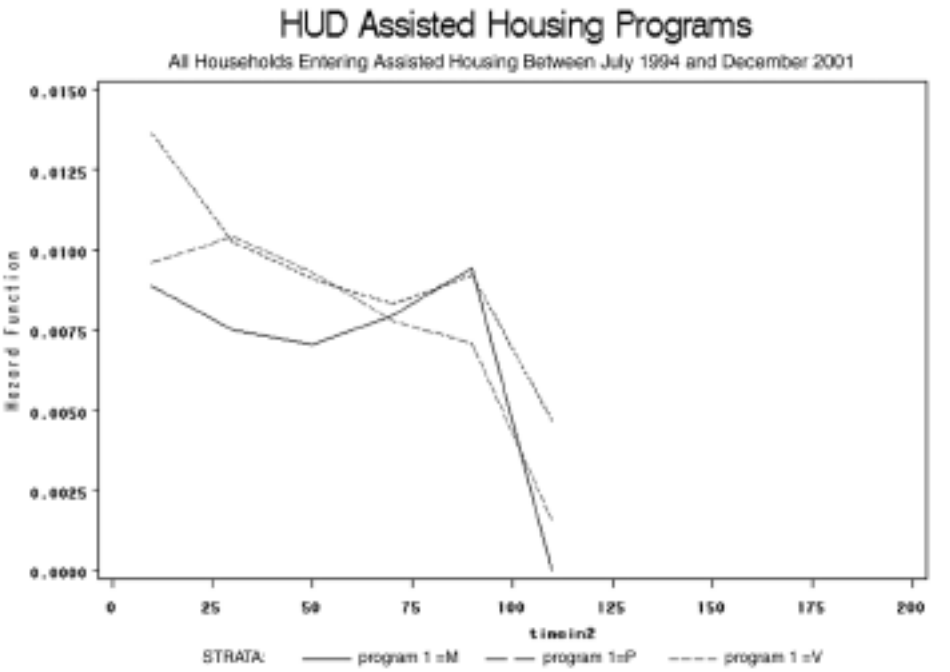
and $\boldsymbol{V}$ is the estimated covariance matrix. The summation is over all u unique event times, d_{ij} is the number of terminations in group i (i = 1,2,3) at time j, e_{ij} is the expected number of terminations in group i at time j, and w_j is the weight where w_j = 1 for the log-rank statistic and w_j equals the total number of households at risk at each time point for the Wilcoxon statistic. Both statistics have a chi-square distribution with degrees of freedom equal to the rank of $\boldsymbol{V}$. The Wilcoxon and log-rank statistics are computed as 231.8 and 195.4, respectively, and are highly significant (at the 1 percent level), supporting the conclusion that the three hazard rates are significantly different. As a result, in the next section I analyze each program separately.[10]

Exhibit 4

Baseline Survival Curves

Exhibit 5

Baseline Hazard Rates



Cox Proportional Hazard Analysis

The second step in the analysis incorporates specific individual characteristics and local economic factors into the hazard rates. To accomplish this step, I recognize that during the observation period a household will either leave the program or remain current through the end of the time period of study (censored). For a single spell, the model specifies the joint distribution of two variables: (1) the spell duration, t, assumed to be a continuous variable; and (2) the exit route, r, which is an integer variable taking values in the set {1,2} representing the two possible outcomes. Furthermore, I assume a latent duration, T_j, exists for each possible exit route, j, where T_j (j = 1,2) is the time required for the spell to end via exit route j. Therefore, the observed duration, t, is the minimum of the T_j.

Conditional on a set of explanatory variables, x_j, that capture time-varying financial/economic and personal characteristics, and parameters, θ_j, the probability density function (*pdf*) and cumulative density function (*cdf*) for T_j are

$$f_j(T_j \mid x_j;\theta_j) = h_j(T_j \mid x_j;\theta_j)\exp(-I_j(r_j \mid x_j;\theta_j)) \tag{7}$$

$$F_j(T_j \mid x_j;\theta_j) = 1-\exp(-I_j(r_j \mid x_j;\theta_j)) \tag{8}$$

where I_j is the integrated hazard for outcome j:

$$I_j(T_j \mid x_j;\theta) = \int_0^{T_j} h_j(s \mid x_j;\theta_j)\,ds \tag{9}$$

and h_j is the hazard function.

The joint distribution of the duration and outcome is

$$f(t,r \mid x;\theta) = h_r(t \mid x_r;\theta_r)\exp(-I_0(t \mid x;\theta)) \tag{10}$$

where $x = (x_1,x_2)$, $\theta = (\theta_1,\theta_2)$ and $I_0 = \Sigma I_j$ is the aggregated integrated hazard. Thus the conditional probability of an outcome is

$$\Pr(r \mid t,x;\theta) = \frac{h_r(t \mid x_r;\theta)}{\sum_{j=1}^{2} h_j(t \mid x;\theta)} \quad . \tag{11}$$

Equation (11) can be easily estimated via maximum likelihood.[11] One benefit of the Cox proportional hazard model is that it does not require an assumption about the shape of the baseline hazard functions.

Research Questions and Sample Characteristics

In the section on baseline hazard rates I described the estimation of the baseline hazard functions without respect to independent covariates. The purpose of that analysis was to answer the question of whether tenants in the three assisted housing programs had obviously different expected tenures in assisted housing without regard to individual characteristics. Because the answer was a qualified "yes," I now turn to a more meaningful analysis that controls for individual household characteristics to determine their effect on whether the individual stays or leaves assisted housing.

First, we must determine the extent to which individual demographic characteristics affect the decision to stay or leave. To answer this question, I include a series of variables in x that control for borrower demographic characteristics. These characteristics include the head of household's sex, age, and race; family income (relative to area median income); source of income (a dummy variable denoting whether income is from wage/salary); type

of household (with children or not); household size; household size relative to number of bedrooms; disability status; and number of dependents. Tenant age is reported as of the date of record in the database. To test whether the very young or elderly households have different propensities to leave assisted housing, I created dummy variables denoting whether the head of household was a teenager at date of admission (age less than 20 years) or was elderly at date of admission (age greater than 59 years). I also include a series of variables to denote whether the household is a member of the racial/ethnic majority for that particular census tract. Finkel and Kennedy (1992) found that households belonging to the racial/ethnic majority for a particular area have a greater likelihood of successfully leasing a unit under the voucher program. Thus, I test a natural extension of their hypothesis by including the "in majority" variables in the analysis. The "in majority" variables test the hypothesis that households residing in neighborhoods where they are in the ethnic/racial majority have a natural proclivity to remain in place.

The second question of interest is whether any systematic characteristics of the housing program affect tenure in assisted housing. To answer this question, I include variables that control for the program type (for example, Section 8 or Section 236). To the extent that these variables are correctly coded, analysis of individual programs will shed light on areas of future data collection efforts.

The third question is whether any systematic characteristics of the unit location contribute to the individual assisted housing tenure. Characteristics of the location include city size, demographic makeup of the census tract, poverty rate, and characteristics of the housing stock in the census tract.

The final question of interest is the extent that changes in local economic conditions and broader housing markets affect the assisted housing tenure. The local economic conditions that may affect the decision to remain in assisted housing include the local housing market affordability (percent growth in area house prices since admission to the assisted housing program) and general economic factors (such as the local unemployment rate, interest rates, and credit market conditions.) I also include general economic factors (such as mortgage interest rates) to effectively measure the effect of housing affordability constraints on assisted housing program participation.

Exhibit 6 reports the variable means and standard deviations for the total sample as well as for the three assisted housing programs. Exhibit 6 also reports the F-test statistics testing for equality of means across the three housing programs. With the exception of the variables denoting MSA size and racial differences in census tracts, the F-test statistics are significant for all variables, indicating that significant variation exists in the independent variables.

Exhibit 6, panel A, contains the household demographic variables. The mean demographic characteristics indicate that 7.3 percent of households were headed by a teenager at time of admission to the program while 22.2 percent of head of households were elderly. Furthermore, 16.8 percent of household heads were disabled and 51 percent of households contained children. Across the entire sample, 76.4 percent of households were headed by women and 36.3 percent of household heads were White (nonminority). We also note that 74.4 percent of the households resided in areas where their race or ethnicity corresponded to the racial/ethnic majority for that area. Consistent with the mission of serving low-income households, the average household income was 31 percent of area median income and only 18.6 percent of households reported receiving income from wages or salary.

Exhibit 6

Sample Means and Standard Deviations and F-test for Equality Across Housing Programs for the Full Sample

Panel A. Household Characteristic

Variable	Label	Total Sample		Multifamily		Public Housing		Tenant Based		
		MEAN	STDEV	MEAN	STDEV	MEAN	STDEV	MEAN	STDEV	F-stat
N	Number of households	25336		10851		6288		8197		
child	Indicator variable for household with children present	0.509	0.500	0.395	0.489	0.524	0.499	0.648	0.477	630.3***
teenager_orig	Indicator variable for household headed by teenager	0.073	0.260	0.090	0.286	0.090	0.287	0.037	0.190	114.8***
elderly	Indicator variable for household headed by elderly person	0.222	0.415	0.345	0.476	0.165	0.372	0.101	0.301	956.2***
disabled	Indicator variable for disabled head of household	0.168	0.374	0.136	0.342	0.179	0.383	0.203	0.402	81.4***
hh_1	Indicator variable for household consisting of 1 person	0.414	0.492	0.531	0.499	0.390	0.488	0.277	0.447	659.1***
hh_2	Indicator variable for household consisting of 2 people	0.259	0.438	0.251	0.434	0.253	0.435	0.275	0.447	7.0***
hh_3	Indicator variable for household consisting of 3 people	0.175	0.380	0.131	0.338	0.185	0.389	0.226	0.418	149.2***
hh_4	Indicator variable for household consisting of 4 people	0.090	0.286	0.059	0.236	0.095	0.294	0.126	0.332	130.5***
hh_5	Indicator variable for household consisting of 5 or more people	0.062	0.241	0.027	0.163	0.077	0.266	0.096	0.295	209.1***
female	Indicator variable if head of household is female	0.764	0.424	0.738	0.440	0.747	0.435	0.813	0.390	79.6***
White	Indicator variable if head of household is White	0.363	0.481	0.329	0.470	0.440	0.496	0.348	0.476	100.7***
Black	Indicator variable if head of household is African American	0.010	0.097	0.006	0.075	0.012	0.109	0.013	0.112	111.1***
Indian	Indicator variable if head of household is American Indian	0.021	0.143	0.026	0.160	0.016	0.127	0.017	0.130	14.9***
Asian	Indicator variable if head of household is Asian	0.104	0.306	0.088	0.283	0.114	0.318	0.118	0.323	13.9***
Hispanic	Indicator variable if head of household is Hispanic	0.764	0.424	0.738	0.440	0.747	0.435	0.813	0.390	26.6***

Exhibit 6

Sample Means and Standard Deviations and F-test for Equality Across Housing Programs for the Full Sample (continued)

Panel A. Household Characteristic (continued)

Variable	Label	Total Sample		Multifamily		Public Housing		Tenant Based		
		MEAN	STDEV	MEAN	STDEV	MEAN	STDEV	MEAN	STDEV	F-stat
in_majority	Indicator variable if household is member of racial majority in census tract	0.744	0.437	0.764	0.425	0.730	0.444	0.727	0.445	16.2***
White_in_majority	Indicator variable if household is White and in majority in census tract	0.549	0.498	0.575	0.494	0.471	0.499	0.575	0.494	100.6***
Black_in_majority	Indicator variable if household is African American and in majority in census tract	0.189	0.392	0.183	0.387	0.255	0.436	0.147	0.354	140.4***
Indian_in_majority	Indicator variable if household is American Indian and in majority in census tract	0.000	0.021	0.000	0.021	0.000	0.022	0.000	0.019	0.1
Asian_in_majority	Indicator variable if household is Asian and in majority in census tract	0.005	0.068	0.005	0.070	0.004	0.062	0.005	0.069	0.5
Hispanic_in_majority	Indicator variable if household is Hispanic and in majority in census tract	0.080	0.271	0.067	0.250	0.082	0.274	0.095	0.293	25.4***
person_room	Number of persons per bedroom	1.211	0.515	1.139	0.370	1.244	0.610	1.282	0.584	199.9***
wage	Indicator variable denoting that income is from wage and salary (0 = otherwise)	0.186	0.389	0.127	0.332	0.218	0.413	0.242	0.428	233.3***
income	Household income	8,421	5,791	8,745	5,943	7,406	5,643	8,771	5,606	130.8***
pct_med_income	Income as % of census tract median income	0.311	0.263	0.322	0.274	0.327	0.303	0.286	0.207	57.8***

***Significant at the 1% level.

Note: Indian means Native American.

Exhibit 6

Sample Means and Standard Deviations and F-test for Equality Across Housing Programs for the Full Sample (continued)

Panel B. Area and Neighborhood Characteristic

Variable	Label	Total Sample		Multifamily		Public Housing		Tenant Based		
		MEAN	STDEV	MEAN	STDEV	MEAN	STDEV	MEAN	STDEV	F-stat
N	Number of Households									
msa_size_50	MSA ≥ 50,000 and MSA < 99,999	0.012	0.111	0.011	0.104	0.009	0.095	0.017	0.130	11.1***
msa_size_100	MSA ≥ 100,000 and MSA < 249,999	0.090	0.286	0.084	0.277	0.098	0.298	0.092	0.289	5.8***
msa_size_250	MSA ≥ 250,000 and MSA < 999,999	0.089	0.285	0.090	0.287	0.093	0.291	0.085	0.279	1.4
msa_size_1000	MSA ≥ 1,000,000 and MSA < 2,499,999	0.165	0.371	0.187	0.390	0.160	0.366	0.141	0.348	34.9***
msa_size_2500	MSA ≥ 2,500,000 and MSA < 4,999,999	0.080	0.272	0.091	0.288	0.059	0.236	0.082	0.275	27.0***
msa_size_5000	MSA ≥ 5,000,000	0.208	0.406	0.227	0.419	0.152	0.359	0.227	0.419	80.0***
pct_poverty	Census tract percent poverty rate	0.220	0.137	0.213	0.135	0.273	0.154	0.189	0.114	725.2***
pct_old_units	Percentage of units in census tract built before 1940	0.199	0.189	0.185	0.183	0.214	0.175	0.207	0.205	59.3***
pct_owner_occupied	Percentage of units in census tract that are owner occupied	0.499	0.224	0.482	0.226	0.480	0.231	0.534	0.212	152.9***
pct_old	Percentage of population in census tract that is elderly	0.137	0.064	0.145	0.070	0.138	0.056	0.126	0.060	203.1***
pct_vacant	Percentage of units in census tract that are vacant	0.143	0.072	0.139	0.068	0.148	0.079	0.143	0.071	37.1***
pct_college	Percentage of population in census tract that have college degree	0.108	0.073	0.118	0.076	0.087	0.064	0.111	0.071	387.8***
pct_high_school	Percentage of population in census tract that have high school diploma	0.195	0.041	0.196	0.040	0.188	0.043	0.201	0.040	174.6***
pct_isolated	Percentage of population in census tract that are language isolated	0.048	0.073	0.047	0.073	0.041	0.065	0.053	0.079	48.9***
pct_hh_poverty	Percentage of households in census tract that are below poverty line	0.632	0.179	0.634	0.179	0.585	0.200	0.665	0.153	850.8***
pct_married	Percentage of population in census tract that are married	30,875	12,906	31,558	13,597	26,191	11,414	33,555	12,060	367.4***
P53_1	Census tract median income	0.108	0.073	0.118	0.076	0.087	0.064	0.111	0.071	629.8***
pct_Black	Percentage of population in census tract that are African American	0.246	0.300	0.249	0.298	0.307	0.324	0.197	0.273	246.3***

Exhibit 6

Sample Means and Standard Deviations and F-test for Equality Across Housing Programs for the Full Sample (continued)

Panel B. Area and Neighborhood Characteristic (continued)

Variable	Label	Total Sample		Multifamily		Public Housing		Tenant Based		
		MEAN	STDEV	MEAN	STDEV	MEAN	STDEV	MEAN	STDEV	F-stat
pct_Hispanic	Percentage of population in census tract that are Hispanic	0.121	0.191	0.111	0.180	0.111	0.186	0.141	0.207	66.0***
pct_Indian	Percentage of population in census tract that are African Indian	0.009	0.026	0.008	0.026	0.010	0.030	0.009	0.021	11.2***
pct_Asian	Percentage of population in census tract that are Asian	0.025	0.058	0.027	0.061	0.016	0.047	0.029	0.062	91.9***
pct_White	Percentage of population in census tract that are White	0.634	0.309	0.635	0.307	0.590	0.324	0.668	0.294	112.5***
pct_male	Percentage of population in census tract that are male	0.476	0.038	0.474	0.040	0.470	0.041	0.482	0.031	211.1***
pct_young_hh	Percentage of households in census tract headed by teenager	0.077	0.062	0.078	0.064	0.078	0.058	0.074	0.061	14.0***
Sec 8	Section 8 program = 1	0.358	0.479	0.835	0.371	0.000	0.000	0.000	0.000	
Sec 236	Section 236 program =1	0.036	0.185	0.083	0.276	0.000	0.000	0.000	0.000	
region_1	HUD Region 1: New England	0.059	0.236	0.067	0.249	0.045	0.207	0.060	0.237	16.2***
region_2	HUD Region 2: New York/New Jersey	0.090	0.286	0.089	0.284	0.086	0.280	0.094	0.291	1.3
region_3	HUD Region 3: Mid-Atlantic	0.102	0.302	0.119	0.323	0.097	0.297	0.082	0.275	33.7***
region_4	HUD Region 4: Southeast	0.214	0.410	0.190	0.392	0.314	0.464	0.169	0.374	267.6***
region_5	HUD Region 5: Midwest	0.202	0.402	0.238	0.426	0.175	0.380	0.175	0.380	73.6***
region_6	HUD Region 6: Southwest	0.127	0.333	0.104	0.305	0.150	0.357	0.139	0.346	46.9***
region_7	HUD Region 7: Great Plains	0.059	0.236	0.050	0.218	0.057	0.232	0.073	0.261	23.9***
region_8	HUD Region 8: Rocky Mountains	0.033	0.178	0.035	0.183	0.019	0.135	0.041	0.199	30.6***
region_9	HUD Region 9: Pacific	0.081	0.272	0.084	0.278	0.032	0.175	0.114	0.317	166.1***
region_10	HUD Region 10: Northwest	0.034	0.182	0.026	0.159	0.025	0.155	0.053	0.224	63.2***

Exhibit 6, panel B, reports the mean values for the location control variables. Using the HUD regions as natural state geographic groupings, I categorize each household based on its geographic location. The values for HUD region and MSA size summarize the frequency counts reported in exhibits 2 and 3. The mean census tract poverty rate for households receiving housing assistance is 22 percent. The neighborhood factors reflecting education confirm the findings of Newman and Harkness (2000) that households living in public housing units reside in neighborhoods with lower levels of educational attainment as reflected in the lower proportion of the populations having high school or college degrees. Given the nature of the data set, census tract racial variables are calculated from the 2000 census and thus may not reflect the rates at move-in or any changes over time. Given that the majority of households exited assisted housing between 2000 and 2002, however, using information from the 2000 census most closely matches the conditions experienced by the household at the time of departure.

Hazard Estimation Results

Exhibit 7 presents the estimation results of the Cox proportional hazard model of household termination from the three primary assisted housing programs. For each variable in the model, exhibit 7 reports the estimated coefficient, standard error, chi-square statistic, and the hazard ratio or marginal coefficient. The table is divided into three panels reflecting the results for each model. For dummy variables, the hazard ratio is the estimated hazard rate when the variable is 1 divided by the hazard rate when the variable is 0, controlling for the other covariates. For example, the public housing hazard ratio (panel A) for the elderly variable indicates that the hazard of leaving public housing for elderly households is 56 percent of the hazard of leaving public housing for households not headed by an elderly person. In other words, elderly households are significantly less likely to leave public housing, all else being equal, than younger households.

Consistent with expectations that elderly households are less likely to leave assisted housing programs, the coefficients for the variable *elderly* (indicating that the household was elderly at admission to the program) are significantly negative with the hazard ratios indicating that elderly households in tenant-based vouchers, public housing, and project-based housing have termination hazards that are 48.2 percent, 56.2 percent, and 59.3 percent, respectively, of nonelderly households. At the other end of the age spectrum, the variable indicating that the household was a teenager at origination is significantly positive. The positive coefficients indicate that households headed by teenagers in tenant-based voucher programs, public housing, and project-based housing are 31.1 percent, 16.3 percent, and 19.8 percent more likely to exit, respectively, than other households.

The variable *disabled* indicates whether the head of household is disabled. The estimated coefficients are significantly negative indicating that households headed by an individual who is disabled are much less likely to leave assisted housing programs.

Gender is also a significant factor in determining the likelihood of leaving assisted housing. The significantly negative coefficients indicate that women are less likely to leave an assisted housing program than men. The hazard ratios indicate that women have a termination hazard that is between 69 percent and 78 percent of the termination hazard for men, all else held constant.

In general, household race and ethnicity are also important factors in determining the probability that a household will exit from assisted housing. For example, the significantly negative coefficients for *Black* indicate that African-American households have a much lower probability of leaving an assisted housing program than White households (the control group). The public housing termination hazard rate for African-American households is 62 percent of the termination hazard for White households. In other words, the probability

Exhibit 7

Cox Proportional Hazard Model

Panel A. Public Housing Model

Variable	Parameter Estimate	Standard Error	Chi-Square Statistic	P-value	Hazard Ratio
child	– 0.104	0.080	1.667	0.197	0.902
teenager_orig	0.151	0.067	5.051	0.025	1.163
elderly	– 0.577	0.078	54.498	< .0001	0.562
disabled	– 0.274	0.067	16.746	< .0001	0.760
hh_2	0.257	0.081	10.053	0.002	1.293
hh_3	0.312	0.097	10.401	0.001	1.366
hh_4	0.358	0.110	10.491	0.001	1.430
hh_5	0.323	0.120	7.214	0.007	1.382
female	– 0.262	0.048	29.341	< .0001	0.769
Black	– 0.481	0.115	17.386	< .0001	0.618
Indian	0.155	0.194	0.642	0.423	1.168
Asian	– 0.603	0.246	6.032	0.014	0.547
Hispanic	– 0.419	0.163	6.623	0.010	0.657
in_majority	– 0.079	0.483	0.027	0.870	0.924
White_in_majority	0.022	0.496	0.002	0.965	1.022
Black_in_majority	0.073	0.489	0.022	0.882	1.075
Indian_in_majority	– 0.234	0.879	0.071	0.790	0.791
Hispanic_in_majority	0.236	0.181	1.714	0.190	1.267
person_room	– 0.093	0.042	4.969	0.026	0.911
wage	0.100	0.052	3.744	0.053	1.105
pct_med_income	0.182	0.088	4.319	0.038	1.200
region_2	– 0.405	0.160	6.400	0.011	0.667
region_3	0.291	0.137	4.480	0.034	1.338
region_4	0.446	0.137	10.679	0.001	1.563
region_5	0.365	0.130	7.947	0.005	1.441
region_6	0.674	0.140	23.247	< .0001	1.963
region_7	0.488	0.144	11.441	0.001	1.629
region_8	0.243	0.187	1.698	0.193	1.275
region_9	0.153	0.179	0.736	0.391	1.166
region_10	0.106	0.189	0.311	0.577	1.111
msa_size_50	– 0.127	0.214	0.351	0.554	0.881
msa_size_100	– 0.093	0.066	1.984	0.159	0.911
msa_size_250	– 0.126	0.069	3.281	0.070	0.882
msa_size_1000	– 0.144	0.064	5.031	0.025	0.866
msa_size_2500	– 0.394	0.106	13.767	0.000	0.674
msa_size_5000	– 0.443	0.095	21.534	< .0001	0.642
pct_poverty	– 0.416	0.375	1.232	0.267	0.660
pct_old_units	0.131	0.142	0.849	0.357	1.140
pct_owner_occupied	0.221	0.200	1.222	0.269	1.247
pct_old	– 0.241	0.450	0.287	0.592	0.786
pct_vacant	0.386	0.251	2.364	0.124	1.471
pct_college	– 0.078	0.486	0.026	0.873	0.925
pct_high_school	0.698	0.663	1.109	0.292	2.009
pct_isolated	– 0.870	0.480	3.292	0.070	0.419
pct_married	0.255	0.299	0.728	0.394	1.290
P53_1	– 4.80E-06	4.64E-06	1.069	0.301	1.000
cum_house_retn	0.459	0.440	1.090	0.296	1.583
mortgage_rate	– 0.051	0.040	1.592	0.207	0.950
mortg_spread	– 0.192	0.106	3.278	0.070	0.825
unemploy_rate	0.066	0.022	9.023	0.003	1.068
Likelihood Ratio	1110.1			< .0001	

Notes: Year and month of admission control variables not reported. Indian means Native American.

Exhibit 7

Cox Proportional Hazard Model (continued)

Panel B. Tenant-based Model

Variable	Parameter Estimate	Standard Error	Chi-Square Statistic	P-value	Hazard Ratio
child	– 0.055	0.076	0.521	0.470	0.946
teenager_orig	0.271	0.085	10.236	0.001	1.311
elderly	– 0.730	0.088	68.115	< .0001	0.482
disabled	– 0.610	0.067	83.478	< .0001	0.543
hh_2	0.061	0.081	0.579	0.447	1.063
hh_3	0.032	0.094	0.115	0.735	1.032
hh_4	– 0.025	0.106	0.054	0.817	0.976
hh_5	– 0.159	0.119	1.792	0.181	0.853
female	– 0.246	0.051	23.231	< .0001	0.782
Black	– 0.491	0.122	16.262	< .0001	0.612
Indian	0.317	0.181	3.060	0.080	1.373
Asian	– 0.278	0.221	1.584	0.208	0.757
Hispanic	– 0.398	0.175	5.139	0.023	0.672
in_majority	0.164	0.388	0.178	0.674	1.178
White_in_majority	– 0.242	0.408	0.353	0.552	0.785
Black_in_majority	– 0.396	0.398	0.990	0.320	0.673
Indian_in_majority	– 9.141	86.362	0.011	0.916	0.000
Hispanic_in_majority	0.178	0.190	0.871	0.351	1.195
person_room	0.024	0.037	0.415	0.520	1.024
wage	0.015	0.047	0.098	0.755	1.015
pct_med_income	0.542	0.114	22.776	< .0001	1.720
region_2	0.248	0.129	3.694	0.055	1.282
region_3	0.589	0.125	22.080	< .0001	1.803
region_4	0.821	0.126	42.728	< .0001	2.273
region_5	0.690	0.114	36.538	< .0001	1.994
region_6	1.086	0.128	71.984	< .0001	2.961
region_7	0.931	0.122	58.257	< .0001	2.538
region_8	0.655	0.140	21.780	< .0001	1.924
region_9	0.442	0.134	10.846	0.001	1.556
region_10	0.629	0.146	18.617	< .0001	1.875
msa_size_50	– 0.237	0.133	3.170	0.075	0.789
msa_size_100	– 0.137	0.063	4.678	0.031	0.872
msa_size_250	– 0.304	0.073	17.281	< .0001	0.738
msa_size_1000	– 0.253	0.064	15.650	< .0001	0.777
msa_size_2500	– 0.432	0.088	24.315	< .0001	0.649
msa_size_5000	– 0.319	0.080	15.864	< .0001	0.727
pct_poverty	– 0.687	0.388	3.136	0.077	0.503
pct_old_units	– 0.020	0.126	0.025	0.876	0.981
pct_owner_occupied	0.247	0.185	1.776	0.183	1.280
pct_old	– 0.964	0.411	5.516	0.019	0.381
pct_vacant	0.237	0.254	0.867	0.352	1.267
pct_college	– 0.705	0.428	2.705	0.100	0.494
pct_high_school	1.362	0.660	4.254	0.039	3.904
pct_isolated	– 2.512	0.454	30.621	< .0001	0.081
pct_married	0.807	0.294	7.516	0.006	2.240
P53_1	– 1.20E-05	4.34E-06	7.678	0.006	1.000
cum_house_retn	1.139	0.356	10.257	0.001	3.123
mortgage_rate	0.007	0.040	0.034	0.855	1.007
mortg_spread	– 0.313	0.103	9.175	0.003	0.731
unemploy_rate	0.013	0.021	0.362	0.548	1.013
Likelihood Ratio	1439.2			< .0001	

Notes: Year and month of admission control variables not reported. Indian means Native American.

Exhibit 7

Cox Proportional Hazard Model (continued)

Panel C. Multifamily Model

Variable	Parameter Estimate	Standard Error	Chi-Square Statistic	P-value	Hazard Ratio
child	0.282	0.080	12.395	0.000	1.325
teenager_orig	0.180	0.055	10.577	0.001	1.198
elderly	– 0.523	0.059	79.662	< .0001	0.593
disabled	– 0.569	0.065	76.740	< .0001	0.566
hh_2	– 0.230	0.079	8.587	0.003	0.794
hh_3	– 0.211	0.100	4.424	0.035	0.810
hh_4	– 0.210	0.119	3.145	0.076	0.810
hh_5	– 0.332	0.146	5.179	0.023	0.718
female	– 0.379	0.041	84.752	< .0001	0.685
Black	– 0.230	0.095	5.879	0.015	0.795
Indian	0.379	0.200	3.599	0.058	1.461
Asian	– 0.357	0.167	4.576	0.032	0.700
Hispanic	– 0.411	0.162	6.427	0.011	0.663
in_majority	– 0.864	0.525	2.711	0.100	0.421
White_in_majority	0.861	0.533	2.615	0.106	2.366
Black_in_majority	0.758	0.531	2.041	0.153	2.135
Indian_in_majority	– 0.301	1.150	0.068	0.794	0.740
Hispanic_in_majority	0.291	0.177	2.707	0.100	1.338
person_room	– 0.076	0.059	1.658	0.198	0.927
wage	– 0.011	0.059	0.032	0.859	0.990
pct_med_income	0.132	0.080	2.712	0.100	1.142
region_2	0.118	0.103	1.321	0.250	1.125
region_3	0.187	0.096	3.782	0.052	1.206
region_4	0.264	0.098	7.303	0.007	1.302
region_5	0.309	0.088	12.318	0.000	1.363
region_6	0.159	0.106	2.265	0.132	1.172
region_7	0.198	0.107	3.397	0.065	1.219
region_8	0.246	0.119	4.265	0.039	1.279
region_9	0.019	0.113	0.028	0.867	1.019
region_10	0.016	0.140	0.013	0.909	1.016
msa_size_50	– 0.015	0.148	0.010	0.920	0.985
msa_size_100	– 0.034	0.060	0.319	0.572	0.967
msa_size_250	– 0.043	0.059	0.530	0.466	0.958
msa_size_1000	– 0.175	0.052	11.518	0.001	0.839
msa_size_2500	– 0.190	0.070	7.311	0.007	0.827
msa_size_5000	– 0.453	0.067	45.231	< .0001	0.636
pct_poverty	– 0.003	0.289	0.000	0.992	0.997
pct_old_units	0.115	0.114	1.017	0.313	1.122
pct_owner_occupied	0.127	0.159	0.633	0.426	1.135
pct_old	– 0.133	0.306	0.189	0.664	0.875
pct_vacant	0.119	0.245	0.235	0.628	1.126
pct_college	– 0.903	0.359	6.325	0.012	0.405
pct_high_school	– 0.074	0.561	0.018	0.895	0.928
pct_isolated	– 1.202	0.398	9.145	0.003	0.301
pct_married	0.292	0.228	1.644	0.200	1.339
P53_1	– 2.50E-07	3.31E-06	0.006	0.940	1.000
sec8	– 0.022	0.067	0.111	0.740	0.978
sec236	0.175	0.085	4.199	0.041	1.191
cum_house_retn	– 0.714	0.300	5.673	0.017	0.490
mortgage_rate	– 0.159	0.036	19.860	< .0001	0.853
mortg_spread	– 0.196	0.091	4.618	0.032	0.822
unemploy_rate	0.055	0.018	8.979	0.003	1.056
Likelihood Ratio	1286.5			< .0001	

Notes: Year and month of admission control variables not reported. Indian means Native American.

of an African-American household leaving public housing is 38 percent lower than the probability of a White household leaving public housing, all else being equal. While still significantly lower, the difference between the African-American and White household project-based program termination hazard is smaller. The coefficients also indicate that Asian and Hispanic households have significantly lower assisted housing termination hazard rates than White households. In contrast, Native American households have significantly higher probabilities of leaving tenant-based and project-based programs than White households. Finally, I also test for the effect that a household is a member of the neighborhood majority racial or ethnic group.[12] The hypothesis is that households may feel an affinity toward an area where their racial or ethnic group represents the majority and thus would be less likely to leave. None of the coefficients are significant, however, indicating that being a member of the majority population within the census tract does not affect the probability of leaving assisted housing.

Turning to characteristics of the household with respect to income and housing consumption, the variable *person_room* is significantly negative only in the public housing model. This condition indicates that as the number of persons per bedroom increases, the less likely the household will leave public housing. The hazard ratio suggests that each additional person per bedroom reduces the hazard of leaving public housing by 8.9 percent ([.919-1]*100). This implication is counter to expectations that the probability of leaving should increase as the number of persons per bedroom unit increases. As a result, this suggests that the model may suffer from omitted variables bias.

The significantly positive coefficient for *pct_med_income* indicates that every one point increase in the ratio of the household income to the area median income increases the hazard of leaving the tenant-based program by 72 percent ([1.72-1]*100), public housing by 20 percent ([1.20-1]*100), and project-based housing by 14 percent ([1.142-1]*100). The coefficient for *wage* income is significant and positive in the public housing model, suggesting that households earning income from wage or salary have a higher probability of leaving public housing. *Wage* is not significant in the tenant-based or project-based models, however, suggesting that wage or salary income does not affect the tenure in these assisted housing programs.

The final set of individual characteristics captures the number of persons living in the housing unit. The most consistent results appear in the public housing and project-based models. The significantly positive coefficients for *hh_2* through *hh_5* indicate that the hazard of leaving public housing increases as the number of people living in the unit increases. For example, the marginal effect for *hh_4* suggests that households with four people are 43 percent more likely to terminate than a single-person household, and households with five or more people are 38 percent more likely to leave public housing than households with a single person. The negative coefficients for project-based housing indicate the opposite effect. The estimated coefficients indicate that program-specific factors do not affect the hazard of leaving the program.

Examining the variables controlling for household location and city size, I find significant variation in the statistical significance of the coefficients. To provide a more meaningful test of these control variables, exhibit 8 reports the chi-square statistics testing the linear hypotheses that the various sets of variables are equal. For example, the regional equality row reports the test statistics that the regional dummy variable coefficients are equal. The test statistics confirm that the individual regional dummy variables are significantly different, indicating that regional variation in the hazard of leaving the assisted housing programs does exist. I also find that for the public housing and project-based programs, the coefficients for MSA size are significantly different.

Exhibit 8

Wald Chi-square Statistic Tests of Linear Hypotheses

		Full Sample		
		Tenant-based	Public Housing	Project-based
Regional equality	Region 2 = … = Region 10	97.3***	76.8***	20.1*
City size	MSA50 = … = MSA5000	10.1*	17.2***	37.4***
Number in household	hh_2 = … = hh_5	7.7**	2.0	1.3

*** Significant at the 1% level.
** Significant at the 5% level.
* Significant at the 10% level.

The analysis also includes a number of variables designed to capture neighborhood variation at the census tract level. For example, I include variables that provide information on the housing market (percentage of old housing units, percentage of owner-occupied units, and percentage of vacant units), and demographic characteristics (percentage of elderly in population, percentage with a college degree, percentage with high school diploma, percentage of households with married couples, the area median income, and percentage of households living in census tracts that are language isolated). Overall, the results are mixed, with only the tenant-based model having consistently significant coefficients. The negative coefficients for *pct_isolated* indicates that as the proportion of the population that does not speak the majority language increases, the less likely the household is to leave assisted housing. Because this variable is a proxy for areas with significant immigrant populations, this suggests that households in these areas are more dependent on assisted housing programs. In the tenant-based model, the poverty and education characteristics have the expected effect. The significantly negative coefficient for *pct_poverty* indicates that the probability of leaving assisted housing declines as the household's census tract poverty rate increases. The significantly positive coefficients for *pct_high_school* and *pct_married*, however, indicate that the probability of exiting assisted housing is positively related to the number of residents in the household's census tract with a high school education and the percentage of households with a married couple. Finally, consistent with the effect of household age on tenure, the tenant-based model indicates that the probability of leaving assisted housing is negatively related to the proportion of elderly residing in the census tract.

Turning to the final question concerning the extent that changes in local economic conditions and broader housing markets affect assisted housing tenure, I include four time-varying variables to capture changes in local economic conditions during the household's tenure in assisted housing. All variables are measured starting at the month the household entered the assisted housing program (admission date) and are tracked monthly until either the household terminated from assisted housing, or the end of the sample data collection period (the censoring date). The first variable, *cum_house_retn*, measures the cumulative house price return for the state where the household is located. State level house price returns are collected from the Office of Federal Housing Enterprise Oversight repeat sales index. The cumulative return provides an overall measure of house price appreciation (or depreciation) from the date the household entered assisted housing and thus provides a proxy for the general level of housing affordability. Given the overall price appreciation that occurred nationwide between 1994 and 2001, in general, the longer a household remains in assisted housing, the greater the cumulative house price return and the less likely that housing will become more affordable.

The second and third variables measure the housing finance system. First, the *mortgage_rate* is the 1-month lagged conventional 30-year mortgage interest rate as reported by Freddie Mac. Because *mortgage_rate* is an interest rate level, higher values translate into lower housing affordability. Mortgage interest rates, however, also track the overall health of the economy, and higher rates, in general, are an indicator that the economy is in an expansion phase.[13] In addition to the level of mortgage interest rates, I also include the difference between the mortgage interest rates and the 10-year Treasury rate (*mortg_spread*). This variable captures the overall market risk premium assessment. During periods of economic uncertainty, investors seek safer investments and thus demand higher risk premiums (spreads over Treasury) to invest in investments that are not risk free. As with *mortgage_rate*, the mortgage spread is lagged by 1 month.

Finally, the fourth variable designed to capture variations in local economic risk is the state-level unemployment rate (*unemploy_rate*). I collect the monthly state-level (nonseasonally adjusted) unemployment rates from the Bureau of Labor Statistics. As with the mortgage rates and house price return, I lag the current unemployment rate by 1 month.

Overall, the time-varying variables are statistically significant and carry the expected signs. For *cum_house_retn,* the negative coefficient in the project-based model indicates that the greater the cumulative housing price return since entering the program, the less likely the household is to leave assisted housing. The marginal effect indicates that higher cumulative house prices have a significant effect. The results also indicate that current mortgage interest rates have the expected effect. For households in all three assisted housing programs, the estimated coefficient for the current mortgage interest rate (lagged 1 month) is negative and significant. This indicates that during periods when mortgage interest rate levels are higher, the probability of termination from assisted housing is lower. The mortgage spread measures the difference between the current mortgage interest rate and the 10-year Treasury rate and thus is a measure of the market credit risk premium. During periods of economic contraction, market credit spreads widen as investors seek safer investments. Thus, the negative coefficients for *mortg_spread* confirm that during periods of economic uncertainty, households are less likely to leave assisted housing programs. Interestingly, and counter to expectations, the coefficients for the monthly state level unemployment rate (*unemploy_rate*) are positive and statistically significant in the public housing and project-based models. Overall, the economic factors do have the expected effect on tenure in assisted housing and the marginal effects indicate that some variation exists in the sensitivity of households in the three programs to these factors. For example, households in the project-based program are most sensitive to the level of mortgage interest rates.

Comparing the results in this study with the findings of Hungerford (1996), it is interesting to note the similarities. Recall that the data set in Hungerford (1996) covered the period from 1986 to 1989, while this study covers the period from 1994 to 2002. Although roughly a decade exists between study periods, a number of similarities in the results exist. First, both studies find a strong negative relationship between female head of household and tenure. That is, households headed by women are much less likely to leave assisted housing programs than households headed by men. Second, both studies find a negative relationship between elderly households and tenure in assisted housing with households headed by the elderly being much less likely to leave assisted housing. Finally, both studies find an unexpected positive and significant relationship between unemployment rates and assisted housing tenure. Hungerford (1996) speculates that this positive relationship may reflect the tendency for households to leave areas with higher unemployment rates for areas with greater employment opportunities. The primary difference between the Hungerford (1996) study and this analysis is in the incorporation of neighborhood factors and time-varying economic factors in this study.

Summary and Policy Implications

This study sought to estimate a proportional hazard model of leaving versus staying in an assisted housing program. I frame the analysis around four questions regarding factors that might lead to differences in assisted housing tenure. The first question is to what extent individual demographic characteristics affect the stay or leave decision. The results indicate that individual characteristics do play a significant role in assisted housing tenure and that significant differences in individual characteristics exist across the three primary housing programs. For example, the estimated coefficients indicate that households headed by a disabled individual at origination are significantly less likely to leave assisted housing programs. Furthermore, comparing the marginal effects across the three assisted housing programs shows that the sensitivity to this factor is about the same. Significant differences across the programs, however, occur in the responsiveness of households to changes in income (as a percent of area median). For instance, the results indicate that a one-point increase in household income relative to area median income greatly increases the odds that a household will leave a tenant-based assisted housing unit or a public housing unit. The marginal effects indicate that a one-point increase in household income relative to area median increases the probability of leaving public housing by 20 percent, while the same increase in income results in a 72 percent greater likelihood of leaving the tenant-based housing program. In addition, the results clearly indicate that households in public housing with income from wage or salary have a significantly higher probability of leaving public housing. The interesting finding across programs is that the wage effect is not present in households residing in tenant-based or project-based programs.

The second question considers whether housing program characteristics affect assisted housing tenure. Looking at the project-based programs, the results indicate that differences exist in the housing tenure of households depending on the type of assistance attached to the unit. For example, households living in units receiving assistance under Section 236 have a higher probability of leaving the assisted housing program.

The third question examines the effect of location and neighborhood factors on tenure in assisted housing programs. Here, the results consistently indicate that neighborhood characteristics (measured at the census tract level) do have an effect on the probability that a household will leave the tenant-based assisted housing program, but the results are less clear for the public housing and project-based assisted housing programs. One factor, *pct_isolated,* appears to be significant in all three models. This factor represents the percentage of the population in a census tract that is language isolated, which is a rough proxy for the proportion of recent immigrants living in the census tract. The significantly negative coefficients in the three models indicate that households living in census tracts with high proportions of people who do not speak English are significantly less likely to leave assisted housing. All else being equal, this result suggests that programs focused on reducing language isolation may help reduce the tenure in assisted housing. In addition, the results from this study suggest that neighborhood education level is an important factor, all else being equal, in determining whether a household stays or leaves the tenant-based assisted housing program.

Finally, the fourth question examines the effect that changes in local economic conditions have on assisted housing tenure. Again, the results show that local economic factors play a significant role in determining whether a household stays or leaves assisted housing. As expected, the results show that households are more likely to leave assisted housing during periods of economic expansion and less likely to leave during periods of economic uncertainty. Furthermore, significant differences exist in the sensitivity of households in the various housing programs to changes in economic conditions. For example, households residing in public housing units are significantly less sensitive to changes in local economic conditions than households receiving tenant-based housing assistance.

To conclude, this analysis has examined the hazard rates of termination from the three primary housing assistance programs. The results indicate that the baseline hazard rate differs significantly across the three programs. I also analyzed the effect of demographic, location, program-specific, and economic factors. The results indicate that these factors do play a role in determining the probability that a household will either leave or stay in an assisted housing program.

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Notes

1. *Questions and Answers About HUD* (http://www.hud.gov/about/qaintro.cfm).

2. *HUD's Public Housing Program Fact Sheet* (www.hud.gov/renting/phprog.cfm).

3. See Shroder (2002) for a discussion of poverty concentration by tenant and project-based subsidies.

4. An additional 200,204 (2 percent) households reside in units under the modified rehabilitation program. Because this program is significantly smaller than the other programs and program participation does not cover the complete analysis period, I eliminate these households from the analysis.

5. Effectively, this restriction eliminates from the analysis households that entered assisted housing in the 1990s if current information about their status is not available.

6. Analysis of the population of households residing in assisted housing between 1994 and 2001 indicates that the cleaned random sample roughly matches the overall population. For example, 15.2 percent of the random sample entered assisted housing in 1999, while 13.6 percent of the overall population entered assisted housing in 1999.

7. See Kiefer (1988) for an overview of duration models applied to economic data.

8. See Greene (1990) for a brief discussion of models of duration data with references to the extended literature.

9. See Allison (1995).

10. Pair-wise comparisons of the program hazard rates produced the following log-rank and Wilcoxon statistics:

Statistic	Tenant-based vs. Project-based	Tenant-based vs. Public Housing	Project-based vs. Public Housing
Log-rank	48.4	48.7	493.4
Wilcoxon	34.0	83.9	225.8

All statistics are significant at the 1-percent level.

11. See Cox (1972).

12. The neighborhood is broadly defined as the census tract where the household is located. Thus, for example, an African-American household is coded as being in the majority (*in_majority* = 1) if African Americans make up the largest population segment within that census tract.

13. During an economic expansion, inflation is a major concern, and the Federal Reserve has followed a policy of increasing interest rates in an effort to prevent inflation.

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Additional Reading

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