

Comparing Public Housing and Housing Voucher Tenants With Bayesian Propensity Scores

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Abstract

The U.S. Department of Housing and Urban Development (HUD) currently has no administrative data to compare housing quality of public housing units with that of Housing Choice Voucher Program (HCVP) units. The American Housing Survey (AHS) provides the only data available to compare subjective housing and neighborhood quality assessments in HUD's largest rental assistance programs.

Quality comparisons based on AHS data are problematic because the AHS overrepresents public housing and underrepresents the HCVP.

HUD administrative data, however, are an excellent source of prior information for the expected proportion of households in public housing. In this study, I explore Bayesian methods using prior information on variables such as income and rents to estimate propensity scores for program participation. I then use the Bayesian propensity scores to improve the reliability of AHS-based quality comparisons. Results indicate that, after adjusting for program participation propensities, little difference exists in AHS household and neighborhood quality ratings between public housing and voucher households.

Introduction

Today, the U.S. Department of Housing and Urban Development (HUD) provides rental assistance to about 1 million households in public housing (PH) projects and about 2.1 million households through the Housing Choice Voucher Program (HCVP).^{1,2} PH units are owned and operated by public housing agencies (PHAs). In sharp contrast, the HCVP provides subsidies to low-income households to seek safe and sanitary privately owned rental units.

Numerous arguments are made for providing rental assistance in privately owned buildings instead of providing PH. The primary motivation for increasing private-sector housing choices has been expanding social and economic opportunities for low-income households receiving rental assistance. Another argument is that private owners might have better incentives for operational efficiency, thus lowering program costs.

An argument against private-sector choices is that private landlords may have more incentive to control costs by reducing housing quality. To ensure all HCVP units meet a minimum-quality threshold, HUD requires compliance with Housing Quality Standards regulations. PHAs must preinspect units before tenants occupy a unit and PHAs enter into assistance contracts. Annual reinspections are also required for all units. Samples of units must be selected for quality control inspections, and PHAs and landlords must ensure that housing-quality problems are promptly rectified.

Measuring living conditions of assisted households is integral to evaluating the performance of HUD rental assistance programs. Currently, HUD has no administrative data to compare the housing quality of PH units with that of HCVP units.

In addition to providing quality housing, HUD rental assistance programs are also intended to promote access to good neighborhoods. Geocoding of HUD administrative records allows for comparison of census measures of neighborhood quality such as median income, poverty rates, and minority concentration. Buron and Pantrabansh (2007), however, report that census measures do not correlate well with HCVP households' subjective opinions of their neighborhoods.

The American Housing Survey (AHS) data are the only data available for comparing both subjective housing quality assessments and subjective neighborhood quality assessments in HUD's largest rental assistance programs. Quality comparisons based on AHS data are problematic because the AHS overrepresents PH and underrepresents the HCVP. The 2009 sum of weights was about 1.65 million households for either program. Apparently, many AHS HCVP tenants respond that they are PH tenants (Casey, 1992; HUD, 2008; Rucinski and Athey, 1995; Shroder, 2002).

¹ Throughout this paper, the public housing program will be referred to as PH, and participants in the program will be referred to as PH tenants. The Housing Choice Voucher Program will be referred to as HCVP, and participants in HCVP will be referred to as HCVP tenants.

² HUD provides rental assistance to another 1.4 million households in the project-based Section 8 program, and the Internal Revenue Service subsidizes approximately 1.8 million low-income tenants via the Low-Income Household Tax Credit (LIHTC) Program. Because the American Housing Survey identifies only PH and HCVP tenants, this study is limited to these two programs.

In 2011, the Census Bureau began using HUD administrative data to sample renters known to receive rental assistance through various HUD programs. This new information could substantially improve the analysis of assisted housing tenants, assuming the data are made available on the public use file.

One method for dealing with the AHS overrepresentation of PH is to use HUD administrative data to establish prior distributions. Specifically, in this study, I explore Bayesian methods for using prior information from variables such as income and rents to estimate propensity scores for program participation. I then use the Bayesian propensity scores to improve the reliability of AHS-based quality comparisons. Results indicate that, after adjusting for program participation propensities, no statistical difference exists in AHS household and neighborhood quality ratings between PH and HCVP households.

The remainder of the article is organized into six additional sections. The next section reviews relevant literature. The section Data Sources discusses and summarizes the data employed. The section AHS Reporting of Rental Assistance Programs addresses AHS response error and is followed by a section that compares characteristics of tenants in both programs. The next section, which discusses Bayesian propensity scores, is followed by a comparison of home and neighborhood quality. The final section summarizes results.

Review of Past Studies

This section reviews relevant literature on two topics: comparing PH tenants with HCVP tenants and measurement error in the reporting of assistance and assistance type.

Comparing Public Housing and Vouchers

Because rent burdens tend to be lower in PH compared with the HCVP, one might question whether PH tenants are better off than HCVP tenants with similar incomes. The voucher program is designed to foster choices outside areas with high concentrations of poverty. Therefore, HCVP tenants with higher burdens might be compensated with higher housing quality or better neighborhoods.

Numerous studies have compared outcomes between PH and HCVP tenants. Some programs, such as the Gautreaux program in Chicago, have compared outcomes for HCVP families that move out of PH. The Moving to Opportunity (MTO) program compares outcomes for PH residents in five cities randomly assigned to three groups. The first group, referred to as the MTO treatment group, is made up of households that received a voucher that could be used only to move to low-poverty neighborhoods. Along with the voucher, families in this group received special counseling and assistance in locating rental units. The second group, referred to as the Section 8 comparison group, received regular vouchers with no geographic restrictions and no special counseling beyond assistance PHAs normally provide in locating housing. The final group, referred to as the in-place control group, received no voucher but continued to receive PH assistance.

MTO is considered an improvement from previous programs, such as Gautreaux, in which families that used vouchers to move out of PH were self-selected. The most appropriate MTO groups for general comparison of PH and HCVP are the in-place and Section 8 groups. Interim results

indicate that both the MTO treatment group and Section 8 group had significant increases in neighborhood quality and satisfaction, but the effects were about twice as large for the MTO treatment group (HUD, 2003). Because of dangerous conditions in PH developments, both the MTO and Section 8 group “mentioned safety as the most valuable aspect of their current neighborhoods” (HUD, 2003: 67).

Other studies more relevant to this study have made cross-sectional comparisons. Newman and Schnare (1997) compared neighborhood quality using census tract measures such as the poverty rate and minority concentration from the 1990 Census. They found that, compared with PH residents, HCVP households are less likely to be located in extremely high-poverty neighborhoods. They found little evidence, however, that vouchers “encourage moves into middle- and upper-income areas to any significant degree” (Newman and Schnare, 1997: 728).

To expand on Newman and Schnare’s analysis, exhibit 1 compares tract measures for PH and HCVP tenants using more recent data from the 2000 Census. Household means are reported for tract measures of minority concentration, median income, the poverty rate, and a binary indicator for tracts with poverty rates of at least 40 percent.

Compared with PH tenants, HCVP tenants tend to live in census tracts with lower percentages of minorities. The average tract minority percentage is 57.5 percent for PH tenants, versus 47.8 percent for HCVP tenants. HCVP tenants also tend to live in higher median income tracts with lower poverty rates. The average tract poverty rate is 30.3 percent for PH tenants versus 19.0 percent for HCVP tenants. More than 22 percent of PH tenants live in tracts with poverty rates at or above 40 percent. The corresponding percentage for HCVP tenants is 6.7 percent.

The results in exhibit 1 are consistent with Newman and Schnare’s (1997) findings that, compared with other rental assistance programs, the HCVP tends to lower “the probability that families live in the most economically and socially distressed areas” (Newman and Schnare, 1997: 728).

HUD’s *Picture of Subsidized Households* reports census measures of tract poverty rates, minority concentration, and percentage of households that are owner occupied for HUD-assisted tenants.³ Although HUD administrative data on rental assistance programs are available annually, tract data

Exhibit 1

Census Measures of Neighborhood Quality

Variable	Public Housing (PH)		Housing Choice Voucher Program (HCVP)	
	Mean	Standard Deviation	Mean	Standard Deviation
Percent minority	57.5	35.5	47.8	33.4
Median income	\$25,135	\$12,412	\$35,160	\$13,708
Poverty rate	30.3	16.6	19.0	12.3
Poverty rate ≥ 40 percent	0.226	0.418	0.067	0.250

N = 1,031,855 for PH and 1,961,593 for HCVP.

Sources: Public and Indian Housing Information Center (PIC), 2009; U.S. Census Bureau, 2000 Census

³ <http://www.huduser.org/portal/datasets/assthsg.html>.

are available only from the decennial census or the American Community Survey averaged over 5 years. Thus census data are limited in their ability to measure current neighborhood conditions.

Furthermore, Buron and Pantrabansh (2007) report that census measures do not correlate well with HCVP households' subjective opinions of their neighborhoods. Mast (2010), however, reports that Buron and Pantrabansh's findings may be driven by use of household data. When household opinions are aggregated at the tract level, Mast (2010) reports fairly strong correlation with census variables.

AHS data are the only data available for comparing subjective housing and neighborhood quality assessments in HUD's largest rental assistance programs. The survey asks respondents if they live in PHA-owned housing or if they use a voucher to subsidize their rent. Numerous studies have measured housing and neighborhood quality with AHS data (Chapman and Lombard, 2006; Dilulio, 1994; Goodman, 2005; Hipp, 2007; Mast, 2010; Thibodeau, 1995). Yet, before this symposium (see Ross, Shlay, and Picon, 2012), no studies have used AHS data to compare housing or neighborhood quality in HUD rental assistance programs, which is perhaps due to reporting error regarding assistance status.

Reporting Assistance

Numerous studies have examined the reporting of housing assistance and type of assistance (Casey, 1992; HUD, 2008; Rucinski and Athey, 1995; Shroder, 2002). According to Shroder (2002),

...researchers should expect difficulties in using and interpreting survey data when they are interested in identifying households receiving housing assistance and the type of assistance received. The fact and type of housing assistance are widely misreported (Shroder, 2002: 411–412).

In general, PH tenants tend to report assistance much more accurately than HCVP tenants. Casey (1992) compared known HUD-assisted addresses with addresses of AHS respondents. More than 90 percent of PH tenants correctly identified their type of assistance. One-third of HCVP tenants incorrectly identified themselves as PH tenants.

This study attempts to extend this literature by using Bayesian methods to more accurately predict type of assistance for AHS households reporting rental assistance. Although the method is not as accurate as address matching (Casey, 1992; HUD, 2008; Rucinski and Athey, 1995), the propensity score method I employ is a useful alternative for researchers using public use AHS data.

I do not calculate propensity scores for receipt of assistance. The method I employ could be adopted to predict both receipt of assistance and type of assistance, however.

Data Sources

I analyze data from two main sources: HUD's Public and Indian Housing Information Center (PIC) data system and the AHS.

PIC Data

The PIC system has quarterly entries for each family receiving HUD rental assistance starting in 1995.⁴ Data are available on income, rent, and a large number of other household and PHA characteristics. I use PIC data for HUD's two largest rental assistance programs: the HCVP (including project-based vouchers and excluding homeownership vouchers subsidizing mortgages), and PH.

The PIC data system is transaction based. The most common transactions are (1) admissions, (2) annual reexams, (3) interim reexams due to changes in eligibility factors such as income or family size, (4) moves, and (5) exits from the program. The system captures the most recent transaction at the end of each quarter. If multiple transactions for a household occur during a quarter, only the most recent is available. If no transaction occurs during a quarter, the family's entry is a duplicate of the entry for the previous quarter.

Rent contracts are effective for 1 year and most households have only one transaction per year. Therefore, most changes are made annually, not quarterly. For this study, I employ a longitudinal file that captures the most recent PIC transaction at the end of 2009. The data provide a consistent end-of-year snapshot for each family. In total, I analyze PIC data on 1,967,865 HCVP households and 1,032,239 PH households.

Eligibility for HUD rental assistance programs is based on adjusted household income. Adjusted income is calculated by subtracting off certain expenses from total household income.⁵ Accounting for known eligibility restrictions, I drop some outlier observations with suspect data.

I exclude HCVP households if their (1) adjusted annual income is negative or more than \$42,000; (2) total household income is negative, more than \$44,000, or less than adjusted income; or (3) household rent burden [(household rent + utility allowance)/adjusted monthly income] is less than 28 percent or more than 100 percent of adjusted monthly income.

I exclude PH tenants if their (1) adjusted annual income is negative or more than \$62,000; (2) total household income is negative, more than \$64,000, or less than adjusted income; or (3) rent burden is less than 10 percent or more than 100 percent of adjusted monthly income. The upper income cutoffs for both programs are approximately the 99th percentiles; lower rent burden cutoffs are less than the 1st percentiles. Households with missing incomes are dropped. Rent burden is not defined for households with \$0 adjusted income; these cases are not dropped.

AHS Data

Although PIC data provide a large amount of information, it is not possible to measure housing quality or subjective neighborhood quality with PIC data. To compare HCVP and PH housing and neighborhood quality, I use AHS data. The AHS includes both national and metro surveys; I employ national AHS data, primarily for 2009.

⁴ http://portal.hud.gov/hudportal/HUD?src=/program_offices/public_indian_housing/systems/pic.

⁵ Details of adjusted income calculation are reported on HUD form 50058: http://portal.hud.gov/hudportal/HUD?src=/program_offices/public_indian_housing/systems/pic/50058.

I limit my AHS sample to households that self-report receiving voucher or PH rental assistance. The AHS voucher question asks, “Did a public housing authority, or some similar agency, give you a CERTIFICATE or VOUCHER to help pay the rent for this housing unit?” (HUD, 2006: 529). The PH question asks, “Is the building owned by a public housing authority?” (HUD, 2006: 404). Neither question asks if the subsidy program is HUD funded, so it is possible that a respondent could have participated in a local- or state-funded program.

In addition, the sum of weights for 2009 AHS voucher respondents is about 1.64 million, while the count of occupied HCVP units is around 2.1 million. The 2009 AHS sum of weights for PH is greater than the actual number of households in HUD PH. One possible explanation for the discrepancy is that some HCVP tenants respond that they are PH tenants. I study these discrepancies in more detail in the next section.

AHS Reporting of Rental Assistance Programs

To measure housing and neighborhood quality, I use data from the national AHS, which is weighted to be nationally representative. As noted in the previous section on data sources, the AHS overrepresents PH households and underrepresents HCVP households. Exhibit 2 reports responses, weighted household frequencies, and proportion of households in PH from the 2005, 2007, and 2009 national AHS. Of course, AHS overrepresentation of PH in any given year could be due to random sampling variance. Yet the overrepresentation occurs each year.

For comparison with AHS estimates, exhibit 3 reports HUD counts and ratios for the same years, along with 95-percent confidence intervals. Uneven PIC reporting in the HCVP Moving to Work

Exhibit 2

AHS Counts of Voucher and Public Housing Households

Year	Number of Responses	Number of Weighted HCVP Households	Number of Weighted PH Households	Weighted Proportion in PH
2005	1,125	898,895	1,850,512	0.673
2007	1,119	1,266,161	1,900,533	0.600
2009	1,422	1,642,867	1,656,488	0.502

AHS = American Housing Survey. HCVP = Housing Choice Voucher Program. PH = public housing.

Sources: AHS data for 2005, 2007, and 2009

Exhibit 3

HUD Counts of Voucher and Public Housing Households

Year	Number of HCVP Households	Number of PH Households	PH As a Proportion of Total Households	Lower 95% CI	Upper 95% CI
2005	1,994,827	1,072,730	0.350	0.325	0.379
2007	1,993,524	1,090,901	0.354	0.330	0.384
2009	2,105,004	1,053,481	0.334	0.312	0.359

CI = confidence interval. HCVP = Housing Choice Voucher Program. HUD = U.S. Department of Housing and Urban Development. PH = public housing.

Notes: Confidence intervals are bootstrap estimates with 1,000 samples. Bootstrap sample size is 1,125 for 2005, 1,119 for 2007, and 1,422 for 2009.

Sources: HUD Voucher Management System data; Public and Indian Housing Information Center (PIC) data

demonstration program could result in undercounting of vouchers. To more accurately estimate the proportion of households in PH, HCVP data in exhibit 3 are based on HUD financial data on counts of occupied units by PHA.⁶

The confidence intervals in exhibit 3 are nonparametric estimates based on a simulation with 1,000 random samples with replacement. I simulate data for each year, with total households and proportions in PH according to HUD official counts reported in exhibit 3. I then take 1,000 repeated random samples with replacement, generating a new estimate of the PH proportion for each sample. The sample size for the repeated samples in a given year is the number of AHS respondents who reported receiving rental assistance that year. This process, referred to as bootstrapping, provides a method for computing confidence intervals directly from the distribution of sample means or, in this case, sample proportions (Lohr, 2007). I compute 95-percent confidence intervals based on the 2.5th and 97.5th percentiles.

The confidence intervals measure the probability that a random sample of assisted households of the same sample size as the AHS will have a PH proportion equal to the AHS estimate. None of the confidence intervals contain the AHS estimate. Not reported, the same is true for wider 99-percent confidence intervals. It is highly unlikely that the AHS systematic overcounting of PH is the result of random sampling variability.

Numerous studies (see Shroder, 2002, for a review) find that tenants receiving rental assistance often misreport their type of assistance. For example, Casey (1992) compared known HUD-assisted addresses with addresses of AHS respondents. More than 90 percent of PH tenants correctly identified their type of assistance. One-third of HCVP tenants incorrectly identified themselves as PH tenants.

The overrepresentation of PH raises serious questions regarding our ability to compare PH and HCVP tenants with AHS data. HUD administrative data, however, are an excellent source of prior information for the expected proportion of households in PH. I will now explore Bayesian methods for using this prior information to improve the reliability of AHS-based comparisons.

Comparing Tenant Characteristics

The Bayesian technique employed in this study depends on differences in characteristics between PH and HCVP tenants. In this section, I explore differences in incomes and rents of HCVP and PH tenants, using 2009 PIC data. I use these differences in the next section to estimate program participation probabilities.

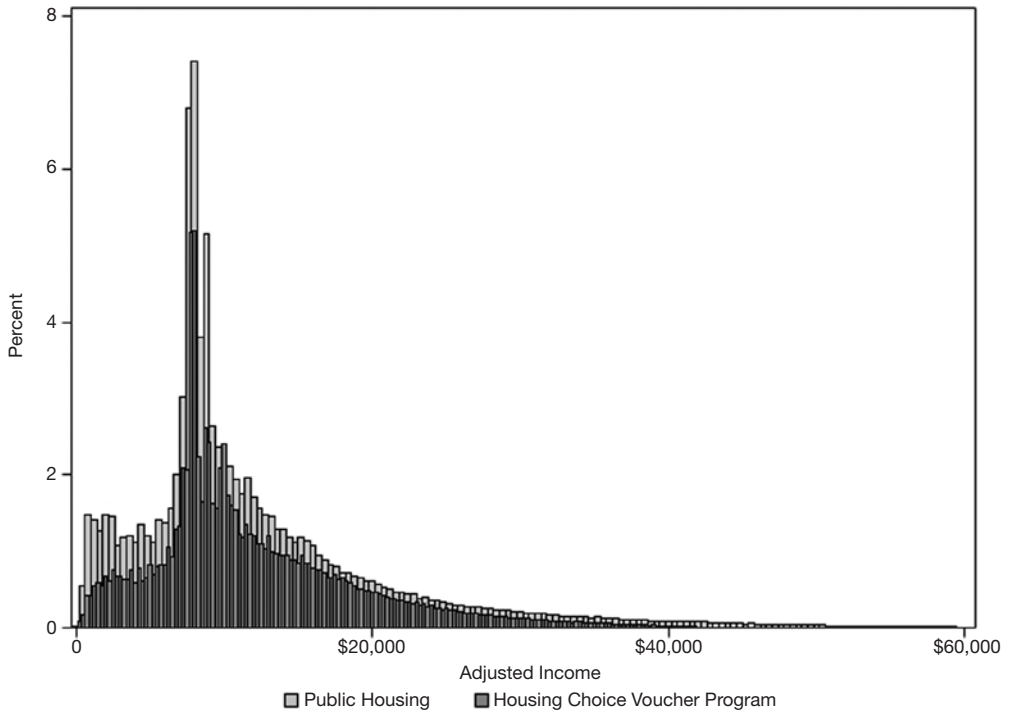
Because income limits are higher for PH, incomes can be larger for PH tenants compared with HCVP tenants. Exhibit 4 depicts distributions for adjusted annual income in both programs. Although the distributions are similar, the PH distribution has a much longer upper tail. Exhibit 5

⁶ Exhibit 3 data on HCVP occupied units are from HUD's Voucher Management System. The system does not report separately on homeownership vouchers. For exhibit 3, I subtracted PIC homeownership voucher counts from VMS counts of total vouchers. Homeownership vouchers are a tiny fraction of total vouchers, totaling 8,496 vouchers in 2009 according to PIC.

reports means and percentiles (10th, 25th, median, 75th, 90th) for adjusted and total annual household income. For both programs, adjusted income is about 92 percent of total income at the mean.

Exhibit 4

Histogram for Adjusted Annual Household Income



N = 1,032,239 for public housing and 1,967,865 for the Housing Choice Voucher Program.
 Source: 2009 Public and Indian Housing Information Center (PIC) data

Exhibit 5

Summary Statistics for Household Adjusted and Total Annual Income

Program	10th Percentile (\$)	25th Percentile (\$)	Median (\$)	Mean (\$)	75th Percentile (\$)	90th Percentile (\$)
Household adjusted annual income						
HCVP	4,524	7,688	10,040	12,058	15,506	22,068
PH	3,420	7,332	9,233	12,192	15,060	23,870
Household total annual income						
HCVP	5,424	8,256	10,901	13,132	16,812	23,669
PH	4,225	8,088	10,192	13,213	16,456	25,341

HCVP = Housing Choice Voucher Program. PH = public housing.
N = 1,032,239 for PH and 1,967,865 for the HCVP.
 Source: 2009 Public and Indian Housing Information Center (PIC) data

Median income is slightly higher in the HCVP. Adjusted (total) median income is \$10,040 (\$10,901) in the HCVP, compared with \$9,233 (\$10,192) in PH. Mean income, however, is slightly higher in PH. Adjusted (total) mean income is \$12,058 (\$13,132) in the HCVP, compared with \$12,192 (\$13,213) in PH. One-tenth of voucher households have adjusted incomes below \$4,524, and only 10 percent have adjusted incomes above \$22,068. For PH, the 10th percentile adjusted income is \$3,420 and the 90th percentile is \$23,870.

Compared with income differences, rent burden differences between programs are much greater. PH tenants have an option to pay a flat rent that does not vary with income. Although gross rent, as a percentage of adjusted income, is not supposed to fall below 30 percent in the HCVP, the flat rent option makes rent burdens well below 30 percent possible in PH.

Exhibit 6 reports percentages of households by program in six rent burden categories: (1) missing, (2) 10 to 19 percent, (3) 20 to 27 percent, (4) 28 to 31 percent, (5) 32 to 40 percent, and (6) 41 percent or more. The missing category is for households with \$0 adjusted income for which rent burden is undefined. Of HCVP tenants, 10.8 percent have undefined rent burden, as do 11.6 percent of PH tenants.

About 6 percent of PH tenants have rent burdens of less than 20 percent, and 6.1 percent have rent burdens between 20 and 27 percent. Because of the 30-percent minimum, no HCVP tenants fall in these categories. Of PH tenants, 58.2 percent have rent burdens between 28 and 31 percent, as do 72.7 percent of HCVP tenants. More than 20 percent of HCVP tenants have rent burdens between 32 and 40 percent, and 10.5 percent have rent burdens greater than 40 percent. In sharp contrast, less than 4 percent of PH tenants have rent burdens above 31 percent.

Exhibit 6

Rent Burden Frequency Distributions

Rent Burden Category	Percent of HCVP Households	Percent of PH Households
Missing	10.8	11.6
10 to 19 percent	0.0	6.3
20 to 27 percent	0.0	6.1
28 to 31 percent	58.2	72.7
32 to 40 percent	20.5	0.9
41 percent and above	10.5	2.3

HCVP = Housing Choice Voucher Program. PH = public housing.

Notes: N = 1,032,239 for PH and 1,967,865 for the HCVP. Rent burden = (rent + utility allowance)/adjusted income.

Source: 2009 Public and Indian Housing Information Center (PIC) data

Bayesian Propensity Scores

In this section, I compute prior distributions for the propensity of an AHS-assisted household residing in public housing based on HUD administrative data and compute Bayesian posterior distributions based on HUD and AHS data.

Prior Distributions

As discussed in the previous section comparing tenant characteristics, incomes and rent burdens vary across programs; I use this information to help predict whether a given AHS rental-assisted household participates in PH or the HCVP. I start by constructing 21 categories based on income and rent burden reported in exhibit 7. The first category is for households with \$0 income for which rent burden cannot be computed. The remaining categories are based on four rent burden ranges and five income ranges. The upper limits for the rent burden categories are roughly the 25th, 50th, 75th, and 100th percentiles for the 2009 PIC combined programs. The upper income limits are approximately the 20th, 40th, 60th, 80th, and 100th percentiles.

Although HUD program regulations are based on adjusted income, it is not possible to construct a comparable income measure with AHS data. As such, the income and rent burden categories in exhibit 7 are based on total income.

Also reported in exhibit 7 is the number of PIC HCVP and PH households in each category, the number of PH households, and the proportion of households in each category living in PH (μ). For example, in 2009 112,024 PIC households (category 8) had incomes ranging from \$7,033

Exhibit 7

PIC Income and Rent Burden Categories

Category	Household Annual Income (\$)	Rent Burden (%)	Total Number of HCVP and PH Households	Number of PH Households	Proportion of Total Households in PH (μ)
1	0	Missing	308,030	114,132	0.371
2	1–7,032	0.0–26.6	175,484	61,001	0.348
3	1–7,032	26.7–28.5	61,027	26,803	0.439
4	1–7,032	28.6–30.0	39,045	15,244	0.390
5	1–7,032	30.1–100.0	120,104	29,208	0.243
6	7,033–9,012	0.0–26.6	97,219	40,964	0.421
7	7,033–9,012	26.7–28.5	247,419	118,144	0.478
8	7,033–9,012	28.6–30.0	112,024	50,605	0.452
9	7,033–9,012	30.1–100.0	115,176	3,182	0.028
10	9,013–12,168	0.0–26.6	103,352	45,700	0.442
11	9,013–12,168	26.7–28.5	81,902	31,381	0.383
12	9,013–12,168	28.6–30.0	275,946	108,090	0.392
13	9,013–12,168	30.1–100.0	112,499	2,874	0.026
14	12,169–18,108	0.0–26.6	125,960	66,252	0.526
15	12,169–18,108	26.7–28.5	170,175	61,040	0.359
16	12,169–18,108	28.6–30.0	158,164	55,490	0.351
17	12,169–18,108	30.1–100.0	118,947	1,592	0.013
18	18,109 and above	0.0–26.6	170,607	126,591	0.742
19	18,109 and above	26.7–28.5	116,009	34,545	0.298
20	18,109 and above	28.6–30.0	167,034	38,043	0.228
21	18,109 and above	30.1–100.0	117,325	974	0.008
Total			2,993,448	1,031,855	0.345

HCVP = Housing Choice Voucher Program. PH = public housing. PIC = Public and Indian Housing Information Center.

Note: Rent burden = (rent + utility allowance)/total household monthly income.

Source: 2009 PIC data

to \$9,012 and burdens ranging from 28.6 to 30.0 percent. Of these households, 50,605, or 45.2 percent, resided in PH. The final row presents data for all households. In total, 34.5 percent of total tenants resided in PH.

I use the proportion μ for each of the 21 categories as the prior probability that an AHS household in the same category resides in PH. Although PIC underreporting of voucher households in Moving to Work PHAs may slightly bias the percentages, they are almost certainly closer to actual values than AHS estimates.

AHS Distributions

Exhibit 8 reports 2009 AHS responses in each of the 21 categories, total weighted households, weighted households in PH, and the weighted proportion in PH (p). The standard error of the proportion (s) is also reported. In total, 50.4 percent of AHS-weighted HCVP and PH households report living in PH; this estimate is much larger than the PIC estimate of 34.5 percent. I assume that the AHS proportion in each category follows a Normal distribution with mean p and standard deviation estimated by s.

Exhibit 8

AHS Income and Rent Burden Categories

Category	Total Household Annual Income (\$)	Rent Burden (%)	(N)	Weighted Households	Weighted PH Households	Weighted Proportion in PH (p)	Standard Error of the Proportion (s)
1	0	Missing	269	637,350	320,595	0.503	0.033
2	1–7,032	0.0–26.6	18	49,468	23,496	0.475	0.123
3	1–7,032	26.7–28.5	5	15,714	5,003	0.318	0.201
4	1–7,032	28.6–30.0	3	5,885	4,599	0.782	0.214
5	1–7,032	30.1–100.0	65	151,804	84,971	0.560	0.065
6	7,033–9,012	0.0–26.6	26	58,475	33,161	0.567	0.105
7	7,033–9,012	26.7–28.5	20	48,049	31,625	0.658	0.115
8	7,033–9,012	28.6–30.0	14	35,084	23,754	0.677	0.124
9	7,033–9,012	30.1–100.0	114	263,543	122,978	0.467	0.050
10	9,013–12,168	0.0–26.6	57	122,603	74,871	0.611	0.069
11	9,013–12,168	26.7–28.5	28	62,535	29,336	0.469	0.101
12	9,013–12,168	28.6–30.0	16	40,257	27,122	0.674	0.121
13	9,013–12,168	30.1–100.0	81	191,740	72,522	0.378	0.057
14	12,169–18,108	0.0–26.6	67	153,256	67,949	0.443	0.064
15	12,169–18,108	26.7–28.5	17	30,007	14,742	0.491	0.131
16	12,169–18,108	28.6–30.0	17	42,215	23,839	0.565	0.128
17	12,169–18,108	30.1–100.0	103	231,933	102,997	0.444	0.053
18	18,109 and above	0.0–26.6	157	377,579	228,974	0.606	0.042
19	18,109 and above	26.7–28.5	14	34,938	21,184	0.606	0.143
20	18,109 and above	28.6–30.0	16	36,930	13,053	0.353	0.121
21	18,109 and above	30.1–100.0	89	206,298	82,736	0.401	0.055
Total			1,196	2,795,662	1,409,507	0.504	

AHS = American Housing Survey. N = total number in a category. PH = public housing.

Note: Rent burden = (rent + utility allowance)/total household monthly income.

Source: 2009 AHS data

I drop 226 AHS responses: 202 responses with burdens above 100 percent and 24 responses with household incomes above \$64,000. My remaining sample consists of 1,196 responses, of which 269 cases have missing burdens due to missing rent data or \$0 income; these cases are relegated to the first category for missing data.

Bayesian Posterior Distributions

The Bayesian Posterior distribution for each category is Normal with mean p^* and standard deviation s^* ; exhibit 9 reports p^* and s^* . s^* equals the square root of $1/[\frac{1}{\sigma^2} + \frac{n}{s^2}]$, where n is the AHS number of responses and σ is the prior standard deviation. I set σ equal to $1/\sqrt{4n/s^2}$. p^* equals $[\frac{\mu}{\sigma^2} + \frac{np}{s^2}]/s^{*2}$, where μ is the PIC mean proportion reported in exhibit 7. For comparison, n , μ , p , σ , and s are also reported in exhibit 9.

We can define an alternative equation for p^* as a weighted average of the prior mean and AHS sample mean (Laskey, 2009). Let r be the precision (inverse variance) of the AHS data; and λ be the prior precision: $r = 1/s^2$, and $\lambda = 1/\sigma^2 = 4n/s^2 = 4nr$. λ^* is the posterior precision: $\lambda^* = \lambda + nr = 5nr$. The posterior mean $p^* = (\lambda\mu + nrp)/\lambda^*$. The prior mean μ receives weight $\lambda/\lambda^* = 4/5$, and the AHS mean p receives weight $nr/\lambda^* = 1/5$.

Exhibit 9

Bayesian Posterior Statistics

Category	AHS Responses (N)	Prior Proportion (μ)	AHS Proportion (p)	Bayesian Posterior Proportion (p^*)	Prior Standard Deviation (σ)	AHS Standard Deviation (s)	Bayesian Posterior Standard Deviation (s^*)
1	269	0.371	0.503	0.397	0.001	0.033	0.001
2	18	0.348	0.475	0.373	0.014	0.123	0.013
3	5	0.439	0.318	0.415	0.045	0.201	0.040
4	3	0.390	0.782	0.469	0.062	0.214	0.055
5	65	0.243	0.560	0.307	0.004	0.065	0.004
6	26	0.421	0.567	0.451	0.010	0.105	0.009
7	20	0.478	0.658	0.514	0.013	0.115	0.012
8	14	0.452	0.677	0.497	0.017	0.124	0.015
9	114	0.028	0.467	0.115	0.002	0.050	0.002
10	57	0.442	0.611	0.476	0.005	0.069	0.004
11	28	0.383	0.469	0.400	0.010	0.101	0.009
12	16	0.392	0.674	0.448	0.015	0.121	0.013
13	81	0.026	0.378	0.096	0.003	0.057	0.003
14	67	0.526	0.443	0.509	0.004	0.064	0.004
15	17	0.359	0.491	0.385	0.016	0.131	0.014
16	17	0.351	0.565	0.394	0.016	0.128	0.014
17	103	0.013	0.444	0.100	0.003	0.053	0.002
18	157	0.742	0.606	0.715	0.002	0.042	0.001
19	14	0.298	0.606	0.359	0.019	0.143	0.017
20	16	0.228	0.353	0.253	0.015	0.121	0.014
21	89	0.008	0.401	0.087	0.003	0.055	0.003

AHS = American Housing Survey.

Sources: 2009 Public and Indian Housing Information Center (PIC) data; 2009 AHS data

I chose $4n$ for the prior precision so that the prior mean would have 4 times the influence as the AHS mean on the posterior mean. I gave the PIC-based prior much greater weight because I believe it to be a much more reliable data source than the AHS.

For example, consider category 6; this category has the median number of AHS responses equal to 26. The prior mean $\mu = 0.0421$, and the AHS mean $p = 0.567$. The posterior mean $p^* = 0.451$ is a weighted average of 0.421 and 0.567, with 0.421 receiving weight $4/5$ and 0.567 receiving weight $1/5$.

I use the Bayesian Posterior proportion p^* as a propensity score for an AHS assisted household residing in PH, conditional on their income and rent burden. Using propensity score weighting, the probability of an AHS assisted household residing in PH is 0.352, which is much closer to the PIC estimate of 0.345 than the unadjusted AHS estimate of 0.504.

Note that the normal-normal conjugate model I employ adjusts only the propensity of residing in PH for households reporting receipt of rental assistance; it does not adjust the propensity of receiving rental assistance, incomes, or rent burdens. Additional variables could be adjusted with a Dirichlet-multinomial conjugate model.

Housing and Neighborhood Quality Comparisons

In this section, I compare AHS housing and neighborhood quality responses of HCVP tenants with PH respondents. I measure housing quality with responses to a question asking households to rate their home on a scale of 1 to 10. I measure neighborhood quality with a neighborhood rating on a scale of 1 to 10 and with a question asking if any serious neighborhood crimes occurred in the past year. I compare both unadjusted estimates and estimates adjusted by the propensity scores computed in the previous section.

Exhibits 10 and 11 report weighted 2009 AHS home and neighborhood ratings, respectively, along with ratings adjusted by propensity scores. I compute the adjusted PH ratings by multiplying the survey weight by the propensity score for residing in PH. I compute the adjusted HCVP ratings by multiplying the survey weight by 1 minus the propensity score.

Exhibit 12 reports sample means for binary home, neighborhood, and crime indicators. For home and neighborhood ratings, three binary indicators are constructed for ratings of at least 7, 8, and 9. H7 through H9 are the binary home indicators, and N7 through N9 are the binary neighborhood indicators. The crime indicator equals 1 for households that responded “yes” when asked if serious neighborhood crimes occurred in the past year; “no” and “don’t know” responses are set to 0. Nonresponses for all indicators are set to missing.

Little difference in home ratings exists across programs, either for the adjusted or unadjusted ratings. Neighborhood ratings indicate more pronounced differences. For the proportions adjusted by propensity scores, 55.1 percent of HCVP tenants rated their neighborhoods 8 or greater on a scale of 1 to 10; the corresponding percentage for PH tenants is 51.8 percent. About 36 percent of adjusted HCVP tenants rated their neighborhoods 9 or greater, compared with 32.8 percent of adjusted PH households.

Exhibit 10

Home Ratings

Home Rating	Unadjusted AHS Estimates		Adjusted Estimates	
	Percent of PH Tenants	Percent of HCVP Tenants	Percent of PH Tenants	Percent of HCVP Tenants
1	1.5	1.8	1.6	1.7
2	1.1	0.8	1.5	0.7
3	1.2	1.9	1.9	1.4
4	1.7	1.7	1.7	1.7
5	9.0	8.6	8.6	8.9
6	7.1	6.9	6.8	7.1
7	17.0	16.1	15.5	17.2
8	23.9	23.4	24.7	23.1
9	8.9	10.5	10.9	9.0
10	28.5	28.2	26.7	29.2

AHS = American Housing Survey. HCVP = Housing Choice Voucher Program. PH = public housing.

Notes: N = 1,196. Adjusted data are adjusted by propensity scores for program participation.

Sources: 2009 AHS data; Public and Indian Housing Information Center (PIC) data

Exhibit 11

Neighborhood Ratings

Neighborhood Rating	Unadjusted AHS Estimates		Adjusted Estimates	
	Percent of PH Tenants	Percent of HCVP Tenants	Percent of PH Tenants	Percent of HCVP Tenants
1	2.5	4.1	3.8	3.1
2	2.4	2.6	2.9	2.3
3	2.2	2.3	2.4	2.2
4	3.4	2.6	2.8	3.1
5	13.2	13.2	12.6	13.5
6	9.1	8.3	9.7	8.2
7	10.7	14.0	13.2	11.8
8	19.3	20.3	19.8	19.8
9	11.2	8.1	9.3	9.8
10	25.9	24.5	23.5	26.1

AHS = American Housing Survey. HCVP = Housing Choice Voucher Program. PH = public housing.

Notes: N = 1,196. Adjusted data are adjusted by propensity scores for program participation.

Sources: 2009 AHS data; Public and Indian Housing Information Center (PIC) data

The unadjusted crime indicator is considerably lower for PH tenants (0.257) compared with HCVP tenants (0.293). Adjusted crime indicators indicate little difference between programs; 27.1 percent of HCVP tenants report major crime problems in the past year, as did 28.2 percent of PH tenants.

Exhibit 13 reports Rao-Scott Chi-square test statistics and probability values for each binary indicator. The null hypothesis is that the sample proportions are equal for both the HCVP and PH samples. Only one unadjusted test statistic is significant at the 0.05 level—the unadjusted crime indicator is significantly lower for PH tenants compared with HCVP tenants. None of the test statistics are statistically significant for data adjusted by propensity scores.

On the whole, little statistical evidence indicates that any of the indicators vary significantly across programs. This lack of statistical evidence raises equity concerns, because rent burdens tend to be much higher in the HCVP compared with PH.

Exhibit 12

Binary Indicators of Home and Neighborhood Quality

Variable	Unadjusted AHS Estimates				Adjusted Estimates			
	PH		HCVP		PH		HCVP	
	Mean	Standard Error	Mean	Standard Error	Mean	Standard Error	Mean	Standard Error
H7	0.782	0.019	0.784	0.019	0.779	0.016	0.785	0.014
H8	0.615	0.021	0.608	0.022	0.617	0.018	0.608	0.016
H9	0.387	0.021	0.374	0.021	0.377	0.017	0.383	0.016
N7	0.668	0.021	0.671	0.021	0.659	0.018	0.676	0.015
N8	0.520	0.022	0.559	0.022	0.518	0.018	0.551	0.016
N9	0.325	0.020	0.372	0.022	0.328	0.017	0.359	0.016
Crime	0.257	0.019	0.293	0.020	0.282	0.016	0.271	0.014

AHS = American Housing Survey. HCVP = Housing Choice Voucher Program. PH = public housing.
 Notes: N = 1,196. H7 = home rating ≥ 7. H8 = home rating ≥ 8. H9 = home rating ≥ 9. N7 = neighborhood rating ≥ 7. N8 = neighborhood rating ≥ 8. N9 = neighborhood rating ≥ 9. Crime is a binary indicator for serious crime in the past year. Adjusted data are adjusted by propensity scores for program participation.
 Source: 2009 AHS data

Exhibit 13

Rao-Scott Chi-Square Test Statistics

Variable	Unadjusted AHS Estimates		Adjusted Estimates	
	Chi-Square Test Statistic	Probability Value	Chi-Square Test Statistic	Probability Value
H7	0.004	0.952	0.108	0.742
H8	0.054	0.817	0.159	0.690
H9	0.184	0.668	0.064	0.801
N7	0.007	0.931	0.542	0.462
N8	1.638	0.201	1.863	0.172
N9	2.477	0.116	1.850	0.174
Crime	6.563	0.038	0.235	0.628

AHS = American Housing Survey.
 Notes: N = 1,196. H7 = home rating ≥ 7. H8 = home rating ≥ 8. H9 = home rating ≥ 9. N7 = neighborhood rating ≥ 7. N8 = neighborhood rating ≥ 8. N9 = neighborhood rating ≥ 9. Crime is a binary indicator for serious crime in the past year. Adjusted data are adjusted by propensity scores for program participation.
 Sources: 2009 AHS data; 2009 Public and Indian Housing Information Center (PIC) data

Conclusion

Unfortunately, HUD has no administrative data to compare participants’ perception of housing quality or objective measures specific to the dwelling they occupy. AHS data are the only data available to compare subjective housing quality and subjective neighborhood quality assessments in HUD’s largest rental assistance programs.

Quality comparisons based on AHS data are problematic because the AHS overrepresents PH households and underrepresents HCVP households. Apparently, many AHS households in the HCVP respond that they live in PH.

HUD administrative data, however, are an excellent source of prior information for the expected proportion of households in PH. In this study, I explore Bayesian methods for using prior information on variables such as income and rents to estimate propensity scores for program participation. I then use the Bayesian propensity scores to improve the reliability of AHS-based quality comparisons.

Results indicate that, after adjusting for program participation propensities, neighborhood quality indicators are higher on average for HCVP tenants compared with those for PH tenants. The differences are not statistically significant, however. Thus, the AHS provides little evidence that HCVP tenants are living in better neighborhoods compared with PH tenants. My estimates raise equity concerns, because rent burdens tend to be much higher in the HCVP compared with PH.

The AHS sample of assisted households is very small relative to the population receiving HUD rental assistance, however. The small sample size limits the usefulness of the AHS for comparing HUD programs.

In 2011, the Census Bureau will begin using HUD administrative data to sample renters known to receive rental assistance through various HUD programs. This new information could substantially improve analysis of assisted housing tenants, assuming the data are made available on the public use file.

Acknowledgments

This article was first prepared as a Selected Paper for presentation at the American Housing Survey User Conference, Washington, D.C., March 8, 2011. The author thanks Shawn Bucholtz for his helpful comments.

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