

Are Utility Subsidies Accurately Predicting Assisted Households' Actual Utility Expenditures?: A Methodological Examination

Davia Spado¹, Lee Harding¹, Ronaldo Iachan¹
¹ICF, 530 Gaither Road Suite 500, Rockville, MD 20850

Abstract

Households receiving rental subsidies through the U.S. Department of Housing and Urban Development's (HUD) assisted housing programs receive a reduction in their monthly rent, or a utility allowance (UA), for out-of-pocket utility costs. UA amounts are estimated by housing sites and are not necessarily equal to a household's actual monthly utility expenses. They are derived using a variety of methods, including the HUD Utility Schedule Model (HUSM). The Utility Allowance Comparison study, sponsored by HUD, seeks to ascertain whether the HUSM UA method is better or worse at predicting actual out-of-pocket utility expenses than a comparison UA calculated via other methods. We use data collected from a nationally representative sample and mean square errors (MSEs) to assess the accuracy of the two UA methods in predicting the actual utility expenditure. The analysis uses jackknife replication to produce standard errors and confidence intervals of the two MSEs, and a determination of prediction performance between the methods is made. Results may inform policies and methods by which UAs are calculated to mitigate both under- and over-subsidizing for out-of-pocket utility costs.

Key Words: mean square error, jackknife replication

1. Introduction

The U.S. Department of Housing and Urban Development (HUD) provides housing subsidies to Multifamily project owners and Public Housing Authorities (PHAs) to administer housing assistance primarily to low-income households. The Office of Public and Indian Housing (PIH) and the Office of Housing provide funding for rental subsidies and utility allowances (UAs) through Public Housing, PHA-administered Section 8 Housing Choice Voucher and Moderate Rehabilitation programs (PHA-administered Section 8), and the Owner-administered Section 8 project-based programs. Collectively, these programs are part of HUD's Rental Housing Assistance Programs (RHAP). They are administered by more than 4,000 intermediary agencies and provide affordable housing for approximately 4.97 million households (i.e., 1.1 million through Public Housing, 2.2 million through the PHA-administered Section 8 program, and 1.6 million through project-based programs).¹

¹ U.S. Department of Housing and Urban Development. Annual Report: FY 2015 Agency Financial Report. Washington, DC: U.S. Department of Housing and Urban Development, 2015. pg. 12

Eligible tenants enrolled in HUD's RHAP receive a UA, in the form of a tenant rent reduction, to offset utility costs for which the household is financially responsible. PHAs/Projects (i.e., local housing sites) set UAs using a variety of models and are required to update them when utility rates increase by at least 10 percent. Allowances consider unit characteristics and are equal to an estimate of utility costs for reasonable, energy-conservative use to sustain a healthy living environment. The estimate is not determined on a household by household basis and is not intended to equal a given household's actual out-of-pocket costs. However, the UA estimate, on average, should reasonably compensate for tenant-paid costs across households.

An estimated 3.43 million households that were enrolled in HUD's RHAP in Federal Fiscal Year (FY) 2015 received a UA. Approximately, 2.05 million of these households received assistance through PHA-administered Section 8, and 0.48 million and 0.90 million received assistance through Public Housing and Owner-administered programs, respectively.

ICF International (ICF) was contracted to perform the Utility Allowance Comparison (UAC) Study in conjunction with the Quality Control (HUDQC) Study.² The UAC Study seeks to determine the accuracy of the HUD Utility Schedule Model (HUSM) in setting UA amounts, as well as ascertain whether UAs that were provided to households receiving assistance through PHA-administered (i.e., Public Housing, Section 8 Housing Choice Voucher, and Section 8 Moderate Rehabilitation) and Owner-administered programs in FY 2015 were reasonably accurate relative to actual tenant-paid utility costs. To fulfill these objectives, we collected complex survey data from a nationally representative sample of assisted households to determine and compare the three main metrics defined in Table 1.

Table 1: Definition of Main Utility Metrics Relevant to the UAC Study

<i>Utility Metric</i>	<i>Definition</i>
HUSM Utility Allowance (HUA)	The monthly UA amount estimated by the HUSM
Actual Utility Allowance (AUA)	The monthly UA amount on Forms HUD-50058/50059 ³
Utility Expenditure (UE)	The average monthly utility cost incurred by the household

This paper examines one of the UAC Study's five main research questions, which is of interest to both technical (e.g., researchers, statisticians, and economists) and non-technical (e.g., policy-makers and housing administrators) audiences; for each program separately and in combination, does either method of UA determination (either HUA or AUA) produce allowances that are statistically significantly closer to the UE than the other?

2. Methods

To evaluate the predictive performance of the HUA and AUA relative to the UE, we used data from responding households of a nationally representative sample. Data were

² HUD's Quality Control (HUDQC) Study provides national estimates of the extent, severity, costs, and sources of errors in tenant subsidies for the largest housing programs administered by the Office of Housing and the Office of PIH.

³ Form HUD-50058 and Form HUD-50059 are official forms completed for each assisted household by HUD's RHAP to record information used in the annual income and rent certification process.

collected from a variety of sources, including a Web-survey, file record abstraction, computer-assisted personal interviewing (CAPI), and third-party data, and were used to calculate average monthly amounts for each of the three utility metrics.

2.1 Key Terms

In order to calculate and compare utility metrics consistently, we defined three key concepts—utilities, unit of interest, and financial responsibility.

2.1.1 Utilities

Utility components included in the definition of utilities are: electric, natural gas, fuel oil, propane/bottled gas, kerosene, coal, wood/wood pellets, water, sewer, and trash. Components not included in the definition are cable television, satellite television, subscription streaming services (e.g., Netflix, Hulu), Internet connection, and wireless cell phone costs. Other specialized components included the renting or financing of a range, microwave, or refrigerator, and other fees determined to be covered by UAs (e.g., city fees). Utility elements that were used when determining the average monthly allowance and expenditure for each utility include consumption, per unit consumed or flat cost rates, monthly/service fees, extra/surcharges, and taxes. Elements assessed on a household-specific level—such as late fees and activation fees—were not included; only those fees that apply to all households serviced by the utility company were included.

2.1.2 Unit of Interest

UAs and utility expenses are tied to the characteristics of the rented unit. The level of subsidy and out-of-pocket costs may depend on the unit's geographic location; the structure type of the unit's building; the number of bedrooms in the unit; and the energy-efficiency of the unit on the basis of age, structural features, and appliances. The physical unit of interest was defined as the property occupied by the household according to the Forms HUD-50058/50059 selected for the HUDQC Study.⁴

2.1.3 Financial Responsibility

Financial responsibility was defined as the utility component expenses incurred by the unit that either the household or someone outside of the household pays for, including the Low Income Energy Assistance Program (known as LIEAP) and/or Federal- and State-based utility assistance programs, but excluding the PHA/Project.

2.2 Sample and Subgroup

The UAC Study households were a subgroup of the HUDQC Study sample and included only those HUDQC Study households that had financial responsibility to pay for utilities in their unit. Households were considered as respondents or nonrespondents depending on whether the data that were needed to calculate the three utility metrics of interest (HUA, AUA, and UE) were complete or missing.

2.2.1 Project Sampling

The universe from which study headquarters drew the HUDQC Study sample included all assisted housing projects and households located in the continental United States, Alaska, Hawaii, and Puerto Rico. The sampling design required approximately equal allocations

⁴ For more information about the selection of the HUDQC Study Forms HUD-50058/50059 action, see the *Final FY 2015 HUDQC Study Data Collection Standards*, an ICF International unpublished report to HUD dated September 18, 2015.

for the following three major program types and we sampled 200 projects from each:⁵ Public Housing, PHA-administered Section 8 (Vouchers and Moderate Rehabilitation), and Owner-administered Section 8 (including Section 202 Project Rental Assistance Contracts [PRAC], Section 202/162 Project Assistance Contracts [PAC], and Section 811 PRAC). We selected projects with probabilities proportional to size, but more households were selected from larger projects whose size exceeded the sampling interval; these were counted as more than one project for the purpose of determining the sample size.

2.2.2 Household Sampling

The initial HUDQC sampling design called for a nationally representative sample with 4 households randomly selected from each of the 600 projects, equaling 2,400 households. We selected households using HUD-provided PIH Information Center/Tenant Rental Assistance Certification System (PIC/TRACS) data. Where reliable PIC/TRACS data did not exist for a project (e.g., Moving to Work projects with biennial or triennial recertification cycles), we collected a tenant roster from the individual project and selected the sample using simple random sampling techniques. A random sample of 4 households was selected from most projects, with some larger Voucher projects having a selection of multiples of 4 households (8, 12, or more households). An equal number of “replacement” households were identified at each selected project as potential substitutes, in the event that a selected household did not meet the study requirements or was unavailable to be interviewed.

2.2.3 Study Subgroup

Households in the HUDQC Study sample were assessed on two conditions to determine whether they should be a part of the UAC Study subgroup. These two conditions were:

1. Flat rent status
2. Verified status of tenant-furnished utilities

Tenants in the Public Housing program that pay flat rent⁶ do not receive an UA on Form HUD-50058, and the HUDQC Study methodology does not require household interviews with flat rent households (preventing the collection of out-of-pocket utility cost information). Because these households were in the HUDQC Study sample but were not relevant to the UAC Study, we neither replaced these households nor collected additional data from other households solely for use in the UAC Study. Public Housing households paying a flat rent were not included in the UAC Study subgroup.

In addition to a household’s flat rent status, households that did not pay for utilities out of pocket and did not receive a UA were excluded from the UAC Study subgroup. We established three criteria to identify these households:

1. The household selected in the HUDQC Study did not receive a UA on Forms HUD-50058/50059, and where missing on the form, an allowance amount could not be identified from other sources in the household file;

⁵ For the purpose of this study, a “project” for the Section 8 Voucher program was defined as the administration of the program in one county/township. Therefore, if a PHA administered vouchers in more than one county/township, the PHA could be represented in this study by more than one “project.”

⁶ The monthly rent contribution of those tenants electing flat rent is not based on the family’s income. Rather, their rent is based on the market rent charged for comparable units in the private unassisted rental market and is equal to the amount for which the PHA could promptly lease the unit.

2. UA determination documents found in the household file (including Form HUD-52667: Allowances for Tenant-Furnished Utilities; Form HUD-52641: Housing Assistance Payment Contract; Form HUD-52517: Request for Tenancy Approval; and other UA worksheets or lease agreements) indicated that the household was not responsible for utilities and an allowance should not be assessed; and
3. The household indicated that it was not financially responsible for utility consumption and costs during the household interview.

If all three criteria were met, then the household was excluded from the UAC Study subgroup. Otherwise, the household was included (i.e., if none, one, or two of the criteria were met). Among the HUDQC Study households, 1,628 (68%) were included in the UAC Study subgroup.

2.2.4 Nonresponse

The UAC Study's main objectives required that the three utility metrics of interest be compared for subgroup households. We designated each subgroup household as respondent or nonrespondent on the basis of whether the data needed to calculate all three utility metrics of interest were complete. To ensure consistent findings across all study objectives, we analyzed only the data of respondent households.

In order to make a nonresponse designation, we evaluated the category of the data for each of the three utility metrics, which are presented in Table 2.

Table 2: Utility Metrics' Categories

<i>HUA</i>	<i>AUA</i>	<i>UE</i>
Amount equal to \$0	Amount equal to \$0	Amount equal to \$0
Amount greater than \$0 and could be calculated	Amount greater than \$0	Amount greater than \$0 and could be calculated
Amount greater than \$0 and could not be calculated		Amount greater than \$0 and could not be calculated

Given the two categories for AUA and three categories for UE and HUA, a household had one of 18 possible combinations of data across the three utility metrics. Households where all three utility metrics are equal to \$0, as discussed previously under 2.2.3 *Study Subgroup*, were excluded from the UAC Study subgroup.

Subgroup households with complete data for all three utility metrics were designated as respondents and were included in the analyses. Households that had an amount equal to \$0 category on one or two of the utility metrics were still included as respondents, if the other utility metric(s) had a category of amount greater than \$0 and could be calculated. Among the UAC Study subgroup, 436 (27%) were respondent households and were included in the analyses.

2.3 Data Collection

This study used a multistage data collection process to obtain information from projects, tenants and utility companies. Information obtained from projects included a Web-based survey and administrative file record abstractions. Tenants provided information via CAPI. Upon request, data related to utility rates and consumption were provided from third-party utility companies. To support this data collection process, both field interviewers and study headquarters staff were trained in the appropriate methods and policies to ensure consistency of procedures and accuracy of data. All information was collected using HUD-

sanctioned data collection procedures, and quality control and assurance procedures were put in place to review obtained data.

2.3.1 Web-based Survey

We obtained initial PHA/Project contact names from HUD headquarters staff and emailed PHA/Project contacts to notify them of the study and request participation. Each project in the study was sent a Web survey, the Project Specific Information (PSI) questionnaire, requesting background information essential to the data collection process. The survey also asked for data on how projects determined their UA schedule and other key pieces of information related to UAs, including: the method used to determine UA amounts in FY 2015; the document that the field interviewer should review to determine the utilities for which the household is responsible; the structure type of the project's building(s) and the ENERGY STAR[®] certification status of their units (for project-based program types only).

2.3.2 File Record Abstraction

While at the project site, field interviewers used computer-assisted data collection technology to review and extract information contained in each household's file. The main focus of the review was to identify and collect documents⁷ from the tenant file which were related to UAs. The documents were photocopied and mailed to study headquarters, where staff used these documents to determine characteristics of the unit (e.g., bedroom size, ENERGY STAR[®] certification status, and fuel sources for heating, cooking, and water heating), and the specific utilities for which the household received a UA.

2.3.3 CAPI

An adult household member (preferably the head of household) participated in a detailed interview that investigated all potential utility costs incurred by the household, including those that may not have been stated in the household's file record. Field interviewers used CAPI software to obtain the information and transfer the data electronically to study headquarters. The CAPI software instructed the field interviewer to request and review any documentation of out-of-pocket utility costs, such as utility bills. Documents that contained the same address as the unit of interest were scanned and electronically transferred to study headquarters.

Adult household members were asked to sign standardized release authorization forms that permitted study headquarters staff to obtain additional information from relevant third-party utility companies for all utility items. The hard-copy version of these forms were returned to study headquarters via FedEx, and were scanned and transferred electronically to study headquarters for processing.

2.3.4 Third-party Data

When adequate historical utility consumption and/or rate information was not available from documentation provided during the household interview, additional information and verification from third-party utility companies was requested. Data requests referenced the specific time period, property address, and account number for which data were needed. Utility companies were asked to provide detailed data reports containing historical monthly utility consumption, as well as historical rates.

⁷ Documents identified and collected included Form HUD-52667 (Allowances for Tenant-Furnished Utilities), Form HUD-52641 (Housing Assistance Payment Contract), Form HUD-52517 (Request for Tenancy Approval), lease agreements, and other UA schedule/worksheet documents.

2.4 Utility Metric Calculations

To respond to UAC Study objectives, ICF calculated monthly amounts for responding households for each of the following metrics: HUA, AUA, and UE. Monthly amounts represented allowances received or costs incurred in FY 2015.

2.4.1 HUSM Utility Allowance (HUA)

The HUA was the sum of HUSM estimated itemized, monthly allowances associated with the utility components for which the household was financially responsible. The HUSM is a Microsoft Excel workbook designed to produce consistent UA schedules (or Form HUD-52667 Allowances for Tenant-Furnished Utilities and Other Services) for PHAs/Projects relative to energy-conservative households of modest circumstances consistent with the requirements of a safe, sanitary, and healthful living environment. This workbook required data entry of the location of the project to populate climate data and rates/charges for a range of utilities to generate a UA schedule.

Study headquarters calculated HUAs using version 13 of the HUSM (revised as of August 27, 2013). The procedures outlined in HUD's HUSM Instruction document were followed to complete the data entry of the "Location," "Tariffs," and "Utility Allowance Computation" tabs.

Data that were entered into the model were identified from various sources. The selection of utility component rates/charges, including range/microwave, refrigerator, and other fees, (for the "Tariffs" tab) and the utility and fuel source (for the "Utility Allowance Computation" worksheet) for each household was based on the review of tenant file records and allowance documentation provided by the project during the Web survey. The specific utility rates, fees, and taxes data entered into the "Tariffs" tab were based on the data from tenant-provided documentation of out-of-pocket utility costs, such as utility bills, returned data from third-party utility company requests, or information supplied in project-provided allowance documentation. Other required data were identified as follows:

- Unit Type: The structure type of the unit's building was determined from the Form HUD-50058 (for PHA-administered Section 8 households), project responses to the PSI questionnaire, or review of tenant file documents.
- ENERGY STAR® Status: The ENERGY STAR® certification status of the unit was determined from project responses to the PSI questionnaire and the review of tenant file documents.
- Unit Size: The number of bedrooms in the unit was determined from the review of tenant file documents, the Forms HUD-50058/50059, or based on HUD occupancy standards.

2.4.2 Actual Utility Allowance (AUA)

If the cost of utilities for an assisted unit is not included in the tenant rent but is the responsibility of the family occupying the unit, a UA is provided to the household. This allowance is approved by the PHA/Project to be an estimate of the monthly cost of reasonable consumption of utilities for the unit by an energy-conservative household of modest circumstances, consistent with the requirements of a safe, sanitary, and healthful living environment.

The AUA used for analysis was the monthly UA amount on Forms HUD-50058/50059, or if missing from the form, the amount of UA found on other sources in the household's file.

This amount was the official monthly household UA for the year, following the most recent (re)certification of rent selected for use in the HUDQC Study. The AUA was determined by projects via all other methods that were not the HUSM and represented the comparison UA to the HUA. These methods included approximations of average utility costs from local utility companies, engineering/consumption modeling, average tenant costs/usage based on actual utility bills, and collection of average costs using a phone survey of local area tenants.

2.4.3 Utility Expenditure (UE)

UE was the average monthly utility cost incurred by the household in the unit of interest during FY 2015, or the sum of the monthly costs among each utility component. This average was determined by first selecting the utility components, then calculating consumption and utility rate, fees, and taxes.

The selection of utility components that were considered for the UE was based on financial responsibility according to the household, as stated verbally during the household interview or as listed on tenant-provided documentation of out-of-pocket utility costs, such as utility bills.

Each selected utility component's consumption was based on tenant-provided utility bills, or similar documentation, and data returned from third-party utility company requests. We reviewed these data sources for monthly consumption data from October 2014 to May 2016 and an average monthly consumption amount was then calculated. This average monthly consumption was weighted to account for differential utility use in winter and summer months; it was the average of the average winter consumption and the average summer consumption. Winter and summer month designations were defined by the utility company's policy, if available. If not available, winter months were November through April, and summer was May through October.

The selected utility components' specific charges, including rates, fees, and taxes, were based on the returned data from third-party utility company requests; information supplied in project-provided allowance documentation data; or from tenant-provided documentation of out-of-pocket utility costs, such as utility bills. An average monthly rate was also calculated based on a weighted average to account for seasonal variations in cost, using the same winter and summer month designations as used for consumption. A weighted average rate was calculated for each rate block, where applicable. Other total charges/fees and total taxes were also assessed.

In general, the average monthly cost of each utility component was calculated by:

1. Multiplying the weighted average consumption by each of following, where applicable:
 - a. The weighted average rate for each rate block
 - b. The total charges/fees assessed based on consumption
 - c. The total tax rate assessed based on consumption
2. Summing the products of (1) and any flat rates or charges/fees
3. Assessing any flat tax rates

For each household, the UE was then calculated as the sum of their utility components' average monthly costs.

2.4 Assessment of Utility Allowances

Comparisons of the three key utility metrics were used to answer UAC Study research question of interest. To assess whether one method of UA—either HUA or AUA—outperformed the other in predicting the UE, we first had to assess how accurately the individual UA metrics predicted the UE. We adapted the mean square error (MSE) metric, as indicated in the formula below, where the individual UA metrics were treated as the estimate and the UE was treated as true value.

$$MSE = \frac{\sum_{i=1}^n (Allowance - Expenditure)^2}{n}$$

Ideally, the MSE would be zero, indicating that the UA predicted the UE exactly. The smaller the MSE, the closer the UA metric is to the actual utility costs incurred by the household.

Standard errors for the two MSEs were then obtained separately using a delete-a-group Jackknife procedure. This was implemented by using 20 replicate groups and creating 20 separate sets of MSEs, allowing us to produce confidence intervals around each MSE. The confidence intervals were compared for overlap and two-tailed *t*-tests were performed to determine whether one method statistically significantly outperformed the other in predicting the UE.

3. Results

Data are presented by the three program types that were the basis for the sampling design: PHA-administered Public Housing; PHA-administered Section 8 Housing Choice Voucher and Moderate Rehabilitation programs (PHA-administered Section 8); and Office of Housing-administered Section 8, Section 202 PRAC, Section 811 PRAC, and Section 202/162 PAC programs (Owner-administered). Analyses were conducted using sample data for the 436 responding households.

Table 3 presents the unweighted MSE for the HUA when compared to the UE and the AUA (i.e., the comparison UA determined via all other methods) when compared to the UE for each program separately and in combination. On a household by household basis, UAs via any method did not entirely subsidize households for their UE, as indicated by MSE values much greater than 0. Owner-administered had the smallest MSEs, indicating that allowances provided to households in this program type—either AUA or HUA—are closest to the UE. Conversely, Public Housing had the largest MSEs, indicating that allowances determined via any method and provided to households in this program type are furthest from the UE.

Table 3. MSEs Between Utility Allowance Metrics and Utility Expenditure

<i>Administration Type</i>	<i>HUA vs. UE</i>		<i>AUA vs. UE</i>		<i>t</i>
	<i>MSE</i>	<i>95% C.I.</i>	<i>MSE</i>	<i>95% C.I.</i>	
Public Housing	5,851	±7,235	7,654	±10,823	-0.289
PHA-administered Section 8	4,553	±1,914	4,585	±2,024	-0.024
Owner-administered	1,558	±417	1,430	±582	0.375
Total	3,654	±1,364	3,954	±1,986	-0.260

When comparing confidence intervals for overlap and assessing *t*-values, no statistically significant results were found between the HUA MSE and the AUA MSE for each program

type separately and in combination. Neither form of UA produced subsidies closer to households' out-of-pocket costs than the other.

4. Conclusion

UAs are provided to eligible tenants enrolled in HUD's RHAP, in the form of a tenant rent reduction, to offset utility costs for which the household is financially responsible. PHAs/Projects set UAs using a variety of models to estimate utility costs for reasonable, energy-conservative use to sustain a healthy living environment, including the HUSM, approximations of average utility costs from local utility companies, engineering/consumption modeling, average tenant costs/usage based on actual utility bills, and collection of average costs using a phone survey of local area tenants.

The UA estimate is not determined by PHAs/Projects on a household by household basis and is not intended to equal a given household's actual out-of-pocket costs. Therefore, it was expected that the MSEs obtained when comparing the HUA and AUA to the UE were not close to 0, which would have indicated that the UA perfectly predicts the UE.

Analytical findings suggest that PHAs/Projects would not be providing significantly better allowances to assisted households if they elected to use the HUSM over other comparison methods to set UA amounts. However, UAs and out-of-pocket utility costs depend on unit characteristics, such as the unit's geographic location; the structure type of the unit's building; the number of bedrooms in the unit; and the energy-efficiency of the unit on the basis of age, structural features, and appliances. Future research includes subdomain analyses to determine whether the predictive performance between the HUA and AUA is statistically significant for specific classifications of unit characteristics.