Using the Census to Evaluate Administrative Records and Vice Versa

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Proceedings of the 2015 Federal Committee on Statistical Methodology (FCSM) Research Conference

1. Introduction

An ideal way of evaluating the accuracy and coverage of administrative records for use in census enumeration would be through a comparison to the actual occupancy and number of residents in each housing unit on April 1, 2010. While the 2010 Census provides information about this, not all Census enumerations are equally reliable. Censuses, like surveys, have some level of unit and item nonresponse as well as measurement error.

A common way to evaluate the quality of survey response data is by comparing it to information from administrative records on the same people. Meyer and Goerge (2011), for example, compare responses on food stamp receipt from both the American Community Survey (ACS) and the Current Population Survey (CPS) to administrative data on food stamps. With such an approach, however, one must determine the direction of quality comparison. Is comparing the two sources a measure of administrative record quality, survey or census response quality, both, or neither?

Sources of error in survey data collection have been well documented in the literature (see Groves et al., 2009). More recently, researchers have started documenting systematic errors within administrative records sources as well (Groen, 2012). At the Census Bureau, researchers have been using administrative records as a research tool to assess survey responses, allowing for the possibility that neither the census nor the records are perfect (Mulry et al., 2006). This paper follows that vein.

This paper posits that some census responses are likely of higher quality than a given administrative record, and others may be of worse quality. By exploring characteristics of census responses that we hypothesize are related to accuracy, we can make inferences about how the census data compare to administrative record data with regard to accuracy.

Our specific problem - how can we evaluate the quality of administrative records for census enumeration when the main comparison source (the decennial census) is likely imperfect? - illustrates a general problem: how can researchers evaluate data quality when each source is likely imperfect?

To address this problem, we evaluate the quality, or fitness of use, of administrative records for decennial census enumeration purposes by comparing them to census responses. We segregate what we believe are the most trustworthy enumerations for comparison. Recognizing that administrative record quality varies both within and across sources, we assign quality scores that vary with characteristics within and across sources. We then evaluate the soundness of our "trustworthy" approach by comparing census counts in housing units captured in the independent Census Coverage Measurement (CCM) evaluation.

We aim to develop quality scores for administrative records and survey enumerations. The quality scoring can support decisions on when and how to use administrative records data in operations for the decennial census or surveys. Though there are many interesting aspects of data quality, this study focuses on the number of persons residing in a housing unit. For the decennial census, the housing unit population count is the foundation upon which higher-level population aggregates are built. Errors in a housing unit's population count are associated with errors in other important data items, such as age, gender, race, and Hispanic origin. Section 2 describes the data, Section 3 describes the methodology and results, and Section 4 concludes.

2. Data

The study employs data from three sources: (1) the 2010 decennial census person and housing unit response files, (2) administrative records sources, and (3) the 2010 Census Coverage Measurement (CCM) post-enumeration survey. The 2010 decennial census files include data on names, relationships, sex, age, Hispanic origin, race, and usual residence elsewhere, how many people lived or stay in the house on April 1, whether there are additional people not included in the count, housing tenure, whether there are people included in the count who sometimes live elsewhere, telephone number, the enumeration mode, and whether a USPS Undeliverable As Addressed (UAA) notice was received.

Table 1. Administrative Records Data Used in This Study

Person-Address Sources	Years
IRS individual income tax returns (Form 1040)[1]	2008-2009
IRS information returns (Form 1099/W2)	2008-2009
Department of Housing and Urban Development Computerized Homes Underwriting Management System (HUD CHUMS)	2000-2010
Housing and Urban Development Public and Indian Housing Information Center (HUD PIC)	2009-2010
Housing and Urban Development Tenant Rental Assistance Certification System (TRACS)	2009-2010
Selective Service System (SSS) registration records	2009-2010
Medicare Enrollment records	2009-2010
Indian Health Service (IHS) Patient Registration System records	2009-2010
United States Postal Service National Change of Address (NCOA) records	2009-2010
New York Supplemental Nutrition Assistance Program (New York SNAP) records	2009-March 2010
Supplemental Security Record (SSR) data	2010
Experian End-Dated Records (Experian-EDR)	2010
Experian-Insource Records	2010
InfoUSA Records	2010
Melissa Data Records	2010
Targus-Consumer Records	2010
Targus-Wireless Records	2010
Veteran Service Group of Illinois Name and Address Resource Consumer file (VSGI-NAR) Records	2010
Veteran Service Group of Illinois TrackerPlus (VSGI-TRK) Records	2010
Address-Only Sources	
Texas Supplemental Nutrition Assistance Program (Texas SNAP) records	2009
Targus National Address File (Targus NAF) Data	
Corelogic Records	2010

The administrative record sources vary in content. Some include marital status, household income, housing tenure, length of residence, home value, mortgage information, investment property indicators, types of tax filing, and the extent of household roster turnover in the previous year.

For this analysis, we use the CCM population (P) sample.[2] The CCM survey was conducted to assess the quality of the 2010 decennial census, producing measures of net coverage, the components of coverage (erroneous

[1] We incorporate information from the 2009 electronic filings, which contain dependents beyond the four included in the main 2009 file.

[2] The P sample is a housing unit and person sample obtained independently from the Census for a sample of block clusters. See Mule (2008) for details about the survey design. The entire P-sample universe contains 178,696 observations. The analysis excludes observations from Puerto Rico (7,479 observations), living quarters classified as group quarters in the Census (nine observations), observations that could not be matched to the Census (6,154 observations), those with an unresolved P-sample housing unit status (39 observations), those with an unresolved P-sample match status (eight observations), those not interviewed in CCM (5,118 observations), those with a blank P-

enumerations and omissions), and coverage for demographic groups, geographic areas, and for key census operations. CCM operations make extra efforts to determine each person's Census Day address by asking detailed follow-up questions and conducting additional interviews. It was conducted 4-5 months after Census Day, however, introducing error from recall bias and people moving in and out of housing units. Being a survey, it may suffer from some of the same issues as the census itself. The primary purpose of the CCM was not to determine the housing unit population count, rather focusing on whether individuals were census day residents in the block or not.[3] The CCM Census Day population count in this analysis is calculated by summing the counts of people reported as living in the selected housing units.[4]

For all three data sources, the addresses are linked using the Census Bureau's address identifier called the Master Address File ID, or MAFID. Person records in the decennial census, the CCM, and all the administrative record sources except Corelogic, Targus NAF, and Texas SNAP have also been assigned a common person ID, called a Protected Identification Key (PIK), by the Census Bureau's Person Identification Validation System (PVS), so we can link the person records within and across sources.[5] We merge in demographic information (age, gender, race, and Hispanic origin) from a demographic file created by the Census Bureau's Center for Administrative Records Research and Application (CARRA) using the most reliable demographics for each person based on pre-2010 Census Bureau data, Social Security Administration (SSA) data, and other government sources. Information on deaths and citizenship status come from SSA.

3. Methodology and Results

This paper aims to evaluate quality in both administrative records and the census. We first divide 2010 census responses into more and less reliable groups based on potential observable enumeration errors. Next, we measure administrative records data quality using logistic regressions to predict whether the record and more reliable census enumerations place a person at the same housing unit. Using various federal, state, and commercial data sources, we construct a composite file of persons at the housing unit where he or she has the highest propensity score to reside. We sum the number of persons assigned to the housing unit, forming the administrative record population count for each address. We assign each housing unit's administrative records a quality score.

We then evaluate the quality of census responses with potential observable errors by comparing them to administrative records in a set of housing units that both have potential errors and high estimated administrative record quality scores, using administrative record characteristics as predictors. Once each census enumeration has been assigned a quality score, we use the score as a dependent variable in models predicting census enumeration quality, separately estimated by enumeration mode. As a final evaluation of this methodology, we study correlations between estimated administrative record quality score, predicted census quality, and agreement rates among the CCM, the census, and administrative records.

3.1 Classifying Census Enumerations by Reliability

We have developed a list of "potential observable errors", or POEs, in census enumerations based on research conducted for the 2010 Census Program for Evaluations and Experiments and 2020 Research and Testing Program. The existence of a POE casts doubt on the validity of an enumeration.[6] We assume that enumerations without POEs are more reliable and use them as the comparison for administrative records. Table 2 contains our list of POEs. Note

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sample Census Day housing unit status (5,997 observations), those with unclassified persons (i.e., it could not be determined if the person lives at the housing unit on Census Day or not – 5,317 observations), and three errant records identified in microsimulation research. The usable P-sample universe for this project contains 148,572 observations.

[3] As a result, obtaining the Census Day address for persons who moved from one housing unit to another within the same block since Census Day was given a lower priority.

[4] This is calculated as the sum of nonmovers, P-sample outmovers, non-P-sample outmovers, and unclassified outmovers. The CCM results are weighted using the unbiased P-sample weights. These have not been adjusted for the exclusion of some observations from the analysis.

[5] See Wagner and Layne (2013) for details about the PVS system.

[6] We recognize that enumerations without POEs may nonetheless be inaccurate, and those with POEs may actually be correct. We are assuming that those without POEs are more likely to be accurate.

that administrative data help identify several of these POEs. The identification of unvalidated persons and duplicates uses the PVS process for assigning PIKs to person records, and the PVS system uses data from SSA, the IRS, and other federal government sources thought to be of high quality. Identification of movers is based on NCOA data. Persons filling out change of address forms for NCOA have an incentive to do it correctly in order to receive their mail at their place of residence.

Table 2. Potential Observable Census Errors (POEs)

Not Alive: at least one individual in the response is not alive on Census Day.
Duplicate: at least one individual in the response is found elsewhere in the Census.
Count Imputation: the housing unit's status and/or household count was count imputed.
Occupied Proxy: the housing unit has a proxy response, and the status is occupied.
Unvalidated Persons: at least one individual in the response is not validated.
Conflicting Responses: the housing unit status or household count differs across responses for this housing unit.
Moved In Before Census Day, Not Counted: at least one person moved in during December 2009-March 2010 with no move out by this person from this unit before April 2010, according to the U.S. Postal Service's National Change of Address File (NCOA), and the housing unit was classified as unoccupied in the decennial.
Moved In After Census Day, Counted: at least one person in the decennial response moved in during April 2010-July 2010 with no move out of this unit by the person between April and the move in, according to NCOA.
Moved Out Before Census Day, Counted: at least one person in the decennial response moved out in December 2009-March 2010 (with no subsequent move back in by this person before April 2010), according to NCOA.
Moved Out After Census Day, Not Counted: at least one person moved out in April 2010-July 2010 (with no move in by this person to this unit between April 2010 and the move out), according to NCOA, and the housing unit was classified as unoccupied in the decennial.
Count ≠ Number of Persons, CFU: the response household count (the number provided by the respondent) differs from the number of listed persons (the number of persons with data captured) in at least one of this housing unit's responses. In other words the household count screener question at the beginning and the content filled are different. The case was sent to Coverage Follow-Up (CFU).
Count ≠ Number of Persons, Non-CFU: the response household count (the number provided by the respondent) differs from the number of listed persons (the number of persons with data captured) in at least one of this housing unit's responses. In other words the household count screener question at the beginning and the content filled are different. The case was not sent to CFU.
Yes to Undercount Question, CFU: at least one of this housing unit's responses contains a yes answer to an Undercount question. The case was sent to CFU.
Yes to Undercount Question, Non-CFU: at least one of this housing unit's responses contains a yes answer to an Undercount question. The case was not sent to CFU.
Yes to Overcount Question, CFU: at least one of this housing unit's responses contains a yes answer to an Overcount question. The case was sent to CFU.
Yes to Overcount Question, Non-CFU: at least one of this housing unit's responses contains a yes answer to an Overcount question. The case was not sent to CFU.

We study how well POEs predict disagreement between the census and the CCM and how this varies by the mode of data collection (self-responses via the mailout/mailback (MOMB) operation and Nonresponse Follow-up (NRFU) fieldwork). Table 3 shows that all cases that were flagged as potential sources of error have lower levels of agreement than cases that have no flags, both for MOMB and NRFU enumerations. The number of flags identified is also negatively correlated with percent agreement. Not surprisingly, levels of agreement are lowest for housing units that are "count imputed" due to nonresponse in the census. The second lowest agreement rate is for households that moved out before census day, but were counted there in error.

Table 3. Percent Agreement between CCM and Census Household Population Counts by Potential Observable Error (POE) Type.

Error Type	All Housing Units		Mailout/Mailback		Nonresponse Follow-up	
	Percent Agreement	No. Obs.	Percent Agreement	No. Obs.	Percent Agreement	No. Obs.
All Observations	82.7	148,572	86.2	85,755	75.6	47,195
No POEs	90.3	105,913	91.3	66,745	87.4	28,459
At Least One POE	62.2	42,659	67.1	19,010	56.7	18,736
One POE	70.9	26,741	73.8	13,761	66.5	9,764
Two POEs	51.6	11,615	52.7	4,204	51.0	6,043
Three POEs	37.1	3,568	38.0	830	36.9	2,451
Four or More POEs	23.6	735	21.9	215	24.6	478
Not Alive	75.6	1,036	81.7	675	57.3	217
Duplicate	52.6	12,449	52.4	6,332	52.9	4,785
Count Imputation	16.6	523	N.A.	N.A.	16.7	332
Occupied Proxy	53.3	6,856	N.A.	N.A.	53.2	6,486
Unvalidated Persons	53.8	16,011	63.4	4,144	48.9	9,631
Conflicting Responses	44.1	2,528	46.3	155	43.9	2,121
Moved In Before 4/1, Not Counted	67.0	1,646	70.6	859	62.3	729
Moved In After 4/1, Counted	66.9	561	75.0	283	57.1	261
Moved Out Before 4/1, Counted	27.1	168	23.3	111	30.0	51
Moved Out After 4/1, Not Counted	55.4	1,779	56.5	709	54.8	1,009
Count ≠ Number of Persons, CFU	61.5	1,116	62.9	845	56.2	167
Count ≠ Number of Persons, Non-CFU	56.5	6,951	66.9	1,507	52.5	4,381
Yes to Undercount Question, CFU	67.2	1,628	68.9	1,277	58.4	225
Yes to Undercount Question, Non-CFU	54.4	1,549	59.4	990	42.8	398
Yes to Overcount Question, CFU	69.1	1,910	69.5	1,655	67.1	72
Yes to Overcount Question, Non-CFU	62.8	6,993	63.1	5,995	61.2	308

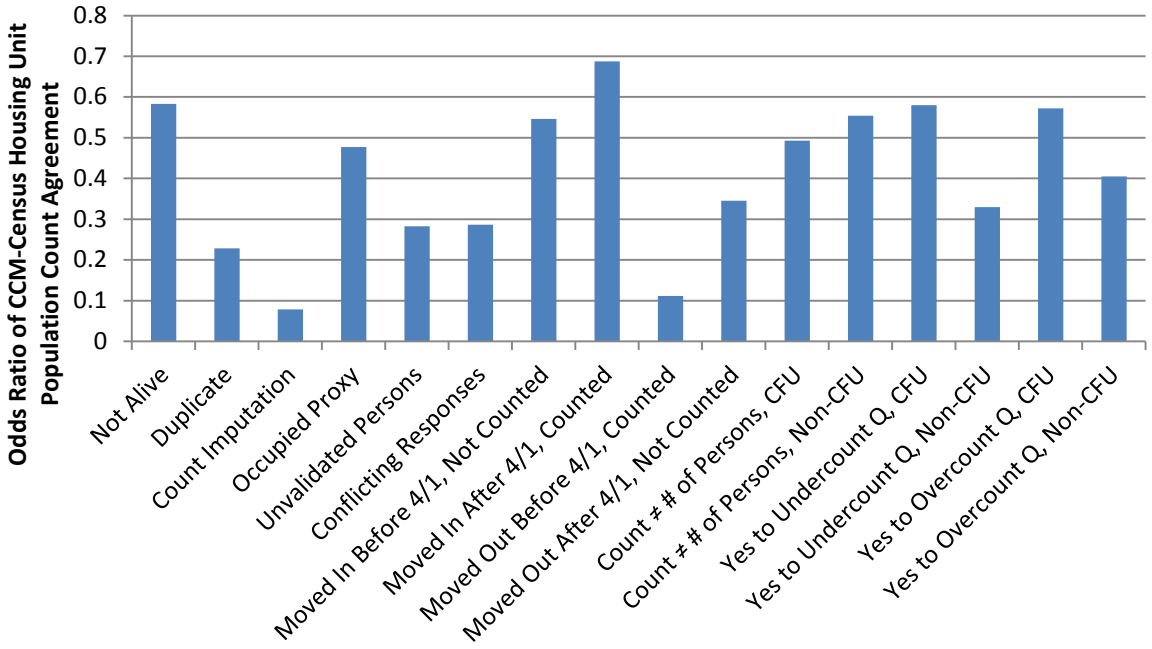
Sources: the 2010 Census Decennial Response File (DRF), the 2010 Census Unedited File (CUF), and the 2010 Census Coverage Measurement survey (CCM).

Some potential errors are associated with each other. For example, proxy responses often result in duplicate enumerations and conflict with NCOA move dates. Neighbors on both sides of a household move may report the household, and they may not remember names and birthdates, resulting in unvalidated persons and conflicts between the count of persons and the number of person records.

To see which potential errors have independent predictive power for CCM-Census agreement, we estimate a logistic model predicting agreement in the household count between the census and the CCM, including each of the potential errors as explanatory variables. Figure 1 shows the odds ratios. Every discrepancy category is a significant negative predictor of agreement in the population count between the census and CCM. Count imputation and being counted despite moving out before Census Day are most negatively associated with agreement. Duplicate

enumerations, unvalidated persons, and conflicting responses are also strongly negatively associated with agreement.

Figure 1. Using Potential Error Scenarios to Predict CCM and Census Household Population Count Agreement



Sources: the 2010 Census Decennial Response File (DRF), the 2010 Census Unedited File (CUF), and the 2010 Census Coverage Measurement survey (CCM). The oods ratios come from a logistic regression with a dependent variable equal to one when the census and the CCM have the same population count for a housing unit and zero otherwise.

We conduct sensitivity analysis involving the move-in/move-out potential error scenarios using the NCOA data. We examine the relative incidence of NCOA household moves near Census Day to assess whether enumeration errors are more likely to occur in conjunction with moves. These results are shown in Appendix A. We find that outmovers have a heightened incidence of potential errors, consistent with there being outmovers just before Census Day that neighbors report having lived there on Census Day in proxy responses, while the outmovers themselves or their subsequent neighbors also report them living at their destination address. Analogously, inmovers just after Census Day may have new neighbors reporting them as having lived there on Census Day, while the inmovers or their former neighbors report them living at their previous address. Such patterns provide support for the accuracy of the NCOA data and reasonableness of the potential error flags.

3.2 Estimating Administrative Record Quality Scores

Next, we produce administrative record quality scores. We drop records that fail to receive a PIK in the PVS process to include validated persons and avoid duplication in the administrative record enumeration. Unduplicating persons across administrative record sources is critically important as new sources are added, because there is considerable overlap in coverage (e.g., same person may be in IRS 1040 and Experian data). It is also necessary to unduplicate within sources, as many sources retain historical records in the data.[7] In addition, persons not alive on Census Day

[7] There are two drawbacks to the PVS validation constraint. The first is that some U.S. residents cannot be validated, because they do not have an SSN or ITIN. Alternatively, they have such an I.D. but do not appear in any of the federal administrative sources used as reference files in the PVS process. A second drawback is that the PVS process

are removed from the pool of eligible records. Dates of birth and death are checked by linking the PIKs to SSA's Death Master File and Numident data. The one exception is Individual Taxpayer Identification Numbers (ITINs), which are not found in SSA data: a being alive requirement is not imposed on ITINs here.

Taking the unduplicated set of PIKs alive on Census Day, we assess administrative records quality using the record's probability of placing the person at the same address as a decennial census enumeration without POEs. Focusing on housing units enumerated during NRFU with none of the POEs,[8] we execute this via two stages of person-place logistic regressions.[9] The first-stage regressions predict quality variation within individual administrative record sources. A separate first-stage regression is run for each administrative record source, using the subset of addresses both in the source and which meet the above sample restrictions. The dependent variable is equal to one if the administrative record source places the person at the same address as the decennial census, and it is zero otherwise. Explanatory variables vary across source regressions depending on availability. All sources except Texas SNAP, Targus NAF, and Corelogic contain person-address data, allowing us to include the following as explanatory variables: the shares of the persons with different demographic characteristics (deceased, gender, age categories, race categories, Hispanic origin, citizenship status, number of validated persons, and number of unvalidated persons). Most regressions include variables indicating the data vintage. Some include marital status, household income, owner vs. renter, length of residence, home value, mortgage information, investment property indicators, types of tax filing, and the extent of household roster turnover in the previous year (IRS 1040).

Table 4 shows selected results from the first-stage person-place regressions for the IRS 1040, NCOA, and VSGI-TRK sources; full results for these sources are in Appendix Tables B1, B2, and B3.[10] The results suggest that administrative records addresses for males and minorities are less likely to match the Census address, while those of young children, persons found in 2008 and 2009 IRS 1040 returns at this address, persons on married-filing-jointly returns, and those with higher income, owner-occupancy, and longer-term residence are more likely to match. NCOA records with a destination address just before Census Day have a very high probability of being a match, while a departure address before Census Day and a destination address after Census Day has an extremely low probability of being a match, as expected. Scores capturing the reliability of the PVS process identifying the right person generally increases the probability that the administrative record's address matches the Census address.[11]

Table 4. First-Stage Person-Place Regression Findings for Selected Administrative Records Sources

Variable	Odds Ratio	Standard Error
IRS 1040 Male	0.812	0.004
IRS 1040 Age 0-2	2.870	0.039
IRS 1040 Age 3-17	2.884	0.029
IRS 1040 Age 18-24	0.731	0.005
IRS 1040 Age 45-64	1.096	0.007
IRS 1040 Age 65-74	0.677	0.008
IRS 1040 Age 75+	0.450	0.006
IRS 1040 Hispanic	0.800	0.006
IRS 1040 African-American	0.592	0.003
IRS 1040 American Indian/Alaska Native	0.787	0.015
IRS 1040 Asian	0.967	0.013
IRS 1040 Native Hawaiian/Pacific Islander	0.885	0.047
IRS 1040 Some Other Race	1.020	0.013

can sometimes assign multiple persons the same PIK, resulting in the erroneous removal of records when unduplicating by PIK.

[8] We limit the sample to NRFU housing units, because we are particularly interested in evaluating administrative record fitness for enumerating non-responding housing units.

[9] Theoretically, this could be done in a single regression, but this is not feasible due to computer processing constraints.

[10] Results for the other sources are available upon request. Note that some caution is warranted in interpreting the results, since the regressions contain many variables and may thus have some multicollinearity. The purpose of the regressions is prediction rather than interpretation of the factors affecting match rates.

[11] The PVS process involves seven different attempts (called passes) to link person records, and the NCOA file includes the pass number used for linking each particular record. The table shows results separately by pass.

IRS 1040 Multi-Race	1.035	0.016
IRS 1040 Married Filing Jointly	2.792	0.020
IRS 1040 Married Filing Separately	1.092	0.016
IRS 1040 Filing as Household Head	1.121	0.008
IRS 1040 Filing as Widow	2.304	0.177
IRS 1040 Both 2008 & 2009 1040 Return Here	2.289	0.011
NCOA Destination Address in May 2009	0.939	0.006
NCOA Destination Address in June 2009	1.001	0.007
NCOA Destination Address in July 2009	1.037	0.007
NCOA Destination Address in August 2009	1.054	0.007
NCOA Destination Address in September 2009	1.069	0.007
NCOA Destination Address in October 2009	1.099	0.008
NCOA Destination Address in November 2009	1.150	0.008
NCOA Destination Address in December 2009	6.171	0.072
NCOA Destination Address in January 2010	6.209	0.072
NCOA Destination Address in February 2010	6.400	0.077
NCOA Destination Address in March 2010	6.792	0.072
NCOA Destination Address in April 2010	0.033	0.0004
NCOA Departure Address in April 2009	0.019	0.0003
NCOA Departure Address in May 2009	0.017	0.0002
NCOA Departure Address in June 2009	0.015	0.0002
NCOA Departure Address in July 2009	0.015	0.0002
NCOA Departure Address in August 2009	0.014	0.0002
NCOA Departure Address in September 2009	0.015	0.0002
NCOA Departure Address in October 2009	0.015	0.0002
NCOA Departure Address in November 2009	0.014	0.0002
NCOA Departure Address in December 2009	0.009	0.0002
NCOA Departure Address in January 2010	0.010	0.0002
NCOA Departure Address in February 2010	0.009	0.0001
NCOA Departure Address in March 2010	0.006	0.0001
NCOA Departure Address in April 2010	0.510	0.006
NCOA PVS Pass 1	2.097	0.073
NCOA PVS Pass 1*PVS Score	0.983	0.001
NCOA PVS Pass 2	0.577	0.448
NCOA PVS Pass 2*PVS Score	1.055	0.041
NCOA PVS Pass 3	1.286	0.049
NCOA PVS Pass 3*PVS Score	1.012	0.002
NCOA PVS Pass 4	1.076	0.036
NCOA PVS Pass 4*PVS Score	1.008	0.001
NCOA PVS Pass 5	0.858	0.159
NCOA PVS Pass 5*PVS Score	1.021	0.008
NCOA PVS Pass 6	0.281	0.035
NCOA PVS Pass 6*PVS Score	1.045	0.005
NCOA PVS Pass 7	0.056	0.187
NCOA PVS Pass 7*PVS Score	1.145	0.190
VSGI-NAR Owner	1.510	0.003
VSGI-NAR Renter	0.583	0.002
VSGI-NAR Log Length of Residence	1.206	0.0008
VSGI-NAR Income <$20,000	0.531	0.002
VSGI-NAR Income $20,000-29,999	0.585	0.002
VSGI-NAR Income $30,000-39,999	0.648	0.002
VSGI-NAR Income $40,000-49,999	0.705	0.002
VSGI-NAR Income $50,000-74,999	0.788	0.002
VSGI-NAR Income $75,000-99,999	0.907	0.003
VSGI-NAR Income $100,000-124,999	0.963	0.003
VSGI-NAR Income $125,000-149,999	0.918	0.004

Notes: Sources include 2008-2009 IRS 1040 records, 2009-2010 USPS NCOA records, and 2010 Veteran Service Group of Illinois TrackerPlus (VSGI-TRK) Records. The odds ratios and robust standard errors are from logistic regressions with a dependent variable equal to one if the administrative record address is the same as the census address, and it is zero otherwise. The base categories are 25-44 for IRS 1040 age, white for IRS 1040 race, single filer for IRS 1040 filing status, destination address in April 2010 for NCOA address, $150,000 and above for VSGI-NAR income, and missing tenure for VSGI-NAR tenure.

A second-stage regression predicts the person-place match propensity for each person-address pair found in at least one of the sources used in the first-stage regressions. The regression incorporates information from the first-stage regressions by including variables indicating whether the person record is in each particular administrative record source at this address or a different one, plus interactions between these dummy variables and the individual match propensities obtained from the first-stage regression corresponding to the variable source for the particular person-place pair.[12] In addition, the regression contains variables regarding the housing structure and decennial census paradata. Selected findings are presented in Table 5 below; full results are presented in Appendix Table B4.

Table 5. Second-Stage Person-Place Match Logistic Regression Findings

Variable	Odds Ratio	Standard Error
Mobile or Other Housing Structure	1.030	0.013
2-4-Unit Housing Structure	0.863	0.014
5-9-Unit Housing Structure	1.055	0.020
10-19-Unit Housing Structure	1.101	0.018
20-49-Unit Housing Structure	1.070	0.017
50+-Unit Housing Structure	1.066	0.015
Residential, Excluded from Delivery Statistics	0.472	0.021
In 2000 Census Here	1.168	0.010
In 2000 Census Elsewhere	1.280	0.007
Same Race for All Persons in Housing Unit	1.079	0.007
Same Hispanic Origin for All Persons in Housing Unit	1.022	0.009
Two Adrec PIKs in Housing Unit	0.891	0.009
Three Adrec PIKs in Housing Unit	0.646	0.007
Four Adrec PIKs in Housing Unit	0.608	0.007
Five Adrec PIKs in Housing Unit	0.570	0.007
Six Adrec PIKs in Housing Unit	0.514	0.006
Seven Adrec PIKs in Housing Unit	0.466	0.006
Eight Adrec PIKs in Housing Unit	0.439	0.007
Nine Adrec PIKs in Housing Unit	0.391	0.007
Ten or More Adrec PIKs in Housing Unit	0.271	0.007
IRS1040 Here	1.751	0.014
IRS 1040 Here*1st-Stage Match Propensity	3.522	0.036
IRS 1040 Elsewhere	0.537	0.004
IRS 1040 Elsewhere*1st-Stage Match Propensity	0.421	0.004
NCOA Here	0.102	0.002
NCOA Here*1st-Stage Match Propensity	90.056	2.736
NCOA Elsewhere	1.454	0.013
NCOA Elsewhere*1st-Stage Match Propensity	0.143	0.003
VSGI-NAR Here	1.511	0.056
VSGI-NAR Here*1st-Stage Match Propensity	0.850	0.047
VSGI-NAR Elsewhere	1.136	0.043
VSGI-NAR Elsewhere*1st-Stage Match Propensity	0.844	0.048

[12] The rationale for the interactions is that the location where a source lists a person should carry more weight if the first-stage match propensity is high. For the three sources without person information in 2010, dummy variables are included for whether the source has at least one record for the housing unit and interactions between those dummy variables and their first-stage occupancy probability from a housing unit status multinomial logit model.

Notes: Sources include all those listed in Table 1, the 2010 Census Unedited File (CUF), and the January 2011 Master Address File (MAF). This is a logistic regression with a dependent variable equal to one if the administrative record address is the same as the census address for the person, and it is zero otherwise. The base categories include single-unit structure for housing structure type and not in the 2000 Census for 2000 Census person categories. The first-stage occupancy propensities for Texas SNAP, Targus National Address File, and Corelogic come from the occupancy models described in footnote 16. The first-stage match propensity is the person-place pair's predicted value from the first-stage regression corresponding to the source the propensity is being interacted with. A 10 percent random sample of person-place pairs is drawn, and the ones that are at addresses with no U.S. Postal Service Undeliverable As Addressed (UAA) received after the questionnaire mailing and with 2010 NRFU fieldwork with no POEs are used in the regression. A random sample is taken due to computer processing constraints. The standard errors are cluster-adjusted at the housing-unit level.

Characteristics predicting a discrepancy between a person being at the administrative record address versus the census address include being in a small, multi-unit housing structure, an address excluded from the USPS Delivery Sequence File (DSF) delivery statistics, reporting mixed races or Hispanic origins across persons assigned to the housing unit by administrative records, persons not found in the 2000 Census, and large numbers of persons with this address in administrative records.

For most administrative record sources for a person, having a record from that source at this address is a more powerful predictor of an administrative record-census person-place match when this person-place's match propensity from that source's first-stage regression is high. In addition, if the person has a record from the source at a different address from the one being examined, and the person-place match propensity at the other address is high (low), then the person's match propensity at the examined address is reduced (raised). The fact that these results for individual sources remain highly significant even when controlling for other sources suggests that agreement among the sources improves the probability that the person is enumerated at that address. Each source contributes predictive power despite the large number of sources with heterogeneous perceived quality ex ante.[13]

Using out-of-sample predictions, the second-stage regression produces a propensity for the person to be at a particular address for all PIKs alive on Census Day and at an address in the census.[14] We use these results to create an administrative records composite, selecting the address with the highest propensity for each person's PIK.[15] We sum these records to construct the administrative record population count for each housing unit. We use the minimum propensity among persons assigned to the housing unit as the housing unit's administrative records quality score.[16]

3.3 Predicting Census Enumeration Quality

With these preparations complete – POEs flagged on the census records and quality scores on the administrative records – we can calculate a quality score for each census enumeration. The score is set to one if the enumeration has no POEs. For enumerations with POEs, the score equals the mean agreement rate between the census and high-quality administrative records[17] for the particular combination of POEs the housing unit has in 2010.[18]

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[13] For example, one might assume prior to study that tax records are more reliable than commercial records.

[14] This implicitly assumes that the administrative record characteristics predicting the address match propensity at addresses where the census enumeration has no potential errors are the same as the ones predicting the propensity for the administrative records to place the person at the correct Census Day address in cases where the census enumeration has potential errors and/or had a self-response.

[15] Each person is assigned a single address, because the decennial census aims to count each person once in a single residence. For datasets with multiple implicates, such as the Longitudinal Employer-Household Dynamics (LEHD) program, one could consider assigning fractions of persons to each of the addresses found for the person in administrative records, with weights based on the relative propensities to match to the census.

[16] We have also tried using the mean propensity among persons assigned to the housing unit to rank housing units, and that ranking is highly correlated with the minimum propensity score ranking.

[17] High-quality administrative records are defined as follows. High-quality USPS Undeliverable As Addressed (UAA) for vacancy reasons (UAA-vacant) and non-UAA housing units have an occupancy probability of two percent or less or a likelihood that the administrative record population count matches the census count of 90 percent or more, while high-quality UAA for other reasons (UAA-other) housing units have an occupancy probability of

We then use these enumeration quality scores as the dependent variable in models predicting the quality of census enumerations by mode (self-response or NRFU fieldwork).[19] We employ a quasi-likelihood function, using a binomial family variance with a logistic link, since the dependent variable takes on values in the 0-1 interval.[20] Housing units with a self-response in 2010 are eligible to be included in the self-response logistic regression models for this dependent variable. The explanatory variables are aggregated to the housing unit level, using shares of individuals having each characteristic (e.g., in a particular age category). The coefficients are applied to all housing units. Analogously, NRFU housing units are eligible to be in the NRFU logistic regression models. As is the case in the person-place models above, the second-stage models include dummy variables for whether each source has any records for the housing unit, plus interactions between those variables and the first-stage propensities from those sources.

Full results are shown in Appendix C. In the first-stage self-response enumeration quality regressions for IRS 1040, NCOA, and VSGI-NAR, we find the following variables are positively associated with a high-quality census enumeration via self-response:

- Persons aged 65-74,
- Married couples,
- High stability of the household roster across the 2008 and 2009 IRS 1040 filings, and
- Middle income.

The following variables are associated with low-quality census enumeration via self-response:

- Deceased individuals,
- Males,
- Persons aged 18-24,
- Minorities,
- Persons with Schedule C filings,
- Persons on an IRS 1040 return as a dependent at one address and on another return as a non-dependent at a second address,
- Unvalidated records,
- Frequent moves, and
- particularly moves near Census Day.

Results for the second-stage regression are shown in Appendix Table C4. The following characteristics are associated with poor-quality self-responses:

- mobile homes and small multi-unit structures,
- addresses deleted or with imputed responses in the 2000 Census,

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five percent or less or a population count match likelihood of 80 percent or more. The values are less strict for UAA-other, because too few UAA-other housing units meet the more strict criteria to be able to produce reliable estimates. Occupancy probabilities come from a series of multinomial logit regression models using occupied vs. vacant vs. delete in the Census as the dependent variable, focusing on housing units without potential errors. As with the person-place models, we first run separate occupancy regressions by administrative record source to obtain propensities for each source-address pair, then run a second-stage regression using dummies for present at this address, present interacted with the vacant propensity from the first-stage regression, and present interacted with the delete propensity from the first-stage regression as explanatory variables, along with various characteristics from the MAF.

[18] We calculate means for each pairwise combination of potential errors, provided they have at least 100 observations. For housing units with more than two potential errors, we use the minimum value from among their pairwise potential error combinations' means.

[19] Not reported here, we have also estimated separate models by NRFU fieldwork contact attempt number and for proxy responses. The NRFU results shown here are for all NRFU contact attempt numbers, and they include household member and proxy responses.

[20] Wedderburn (1974) was the first to suggest this model for such dependent variables. Hardin and Hilbe (2007) show how to implement it in Stata.

- excluded from DSF delivery statistics,
- 2010 address canvassing or otherwise added addresses,
- addresses with an additional questionnaire sent,
- bilingual questionnaires, and
- low first-stage response quality propensities.

Appendix D displays regression results for fieldwork enumeration quality. Unlike with self-response quality, deceased persons and addresses not in the DSF delivery statistics are highly positively associated with fieldwork quality. People may self-respond in March, then pass away before Census Day, leading to an enumeration error. In contrast, NRFU fieldwork occurs after the person's death, and neighbors are likely to know about the person's passing. Persons 75 or over are more strongly positively associated with fieldwork quality than self-response quality, possibly because they are more homebound than other age groups. Higher-income and owner-occupied households are also more strongly positively associated with fieldwork quality than self-response quality. Otherwise, the patterns are similar to those for self-response quality.

3.4 Comparing Administrative Record and Enumeration Quality Predictions Against a Post-Enumeration Survey

We calculate agreement rates among the administrative record count, census count, and the CCM count for housing units grouped by potential errors, focusing on housing units with high-quality administrative records. These results, displayed in Table 6, exhibit higher CCM-census agreement rates than those in Table 3 that also include housing units with lower-quality administrative records, suggesting that survey-style enumeration quality is positively correlated with administrative record quality. As is the case in Table 3, these results show that all cases flagged as potential sources of error have lower levels of agreement across sources than cases that have no flags. The number of potential errors is also negatively correlated with percent agreement.[21] Of special interest is that addresses with household moves have lower agreement rates between either the CCM or the census and administrative records than between the CCM and the census. The CCM and the census, which are both survey-style sources, may well suffer from the same measurement error; the CCM appears to have particular difficulty handling moves, possibly due to the several month lag between Census Day and the fieldwork.

Application of the average CCM-census agreement rates for each POE or combination of POEs to non-CCM housing units with those POEs could be considered as an alternative approach to assessing housing unit-level census enumeration quality. The CCM is a relatively small survey, however, resulting in a small number of observations for each particular type of POE and thus estimates with a low level of confidence. And the apparent correlation in census and CCM enumeration difficulties may make administrative records with high predicted quality a preferable benchmark.

[21] Agreement here means the two sources have the same housing unit population count.

Table 6. Percent Agreement between CCM, Census, and Administrative Record Household Counts by Potential Observable Error (POE) Type, High-Quality Administrative Records Sample

Error Type	CCM-Administrative Record Agreement Rate	Census-Administrative Record Agreement Rate	CCM-Census Agreement Rate	Number of Observations
All Observations	93.6	94.9	94.9	15,743
No POEs	95.6	97.7	97.2	13,773
At Least One POE	78.6	74.6	79.0	1,970
One POE	81.6	81.8	86.3	1,451
Two or More POEs	69.2	52.4	56.6	519
Not Alive	90.7	86.7	83.5	124
Duplicate	68.0	55.2	65.1	410
Occupied Proxy	77.1	69.2	69.4	293
Unvalidated Persons	70.4	52.8	66.5	481
Conflicting Responses	66.4	60.9	60.8	79
Moved In Before 4/1, Not Counted	47.0	56.7	73.5	78
Moved Out After 4/1, Not Counted	73.6	79.3	81.8	50
Count ≠ Number of Persons, CFU	85.7	71.2	72.0	61
Count ≠ Number of Persons, Non-CFU	85.0	79.6	79.2	264
Yes to Undercount Question, CFU	71.3	66.5	78.8	84
Yes to Overcount Question, CFU	86.9	71.9	69.8	90
Yes to Overcount Question, Non-CFU	82.4	84.8	82.8	512

Sources: all person-address administrative record sources in Table 1, the 2010 Census Decennial Response File (DRF), the 2010 Census Unedited File (CUF), and the 2010 Census Coverage Measurement survey (CCM). These are weighted using CCM weights. Only housing units with high-quality administrative records and in the CCM are included here.

Finally, we examine the usefulness of our administrative record quality scores for predicting agreement among administrative records, Census, and CCM housing unit population counts. We do this by sorting housing units by their predicted administrative record-census agreement rates. Here the predicted administrative record-census agreement rate is the mean agreement between administrative records and Census enumerations without POEs separately for 100 administrative record quality score one percentage point bins, using all housing units with at least one administrative record and no POEs for these calculations.[22] For 17 groups of these predicted agreement rates (0-9.99, 10-19.99, 20-24.99,…, 85-89.99, 90-100),[23] we calculate the actual agreement rates among administrative record counts, census counts, and CCM counts for the housing units in our CCM sample, and we display them in Figures 2-4. The X-axis represents the 17 predicted administrative record-census agreement rate groups in ascending order (each value on the X-axis is displayed at the upper value of the range for each group). The Y-axis is the percent of the housing units with the same population count across the two or three sources. In addition to pair-wise

[22] These agreement rates are monotonically increasing in the quality score.

[23] We use five-percentage-point groups here, as single-percentage-point bins have too few observations. Values in the tails are particularly scarce, so we group together 0-9.99, as well as 90-100.

and three-way agreement among the administrative record composite, the CCM, and the census, we also display predicted Census enumeration quality produced by the model in the previous subsection.[24]

Figure 2, which includes housing units both with and without census POEs, shows that the agreement rates involving administrative records range from the teens to the 90's, increasing monotonically with the administrative record quality score. The CCM-census agreement rate also increases with administrative record quality, with a variation of over 30 percentage points across the administrative record quality score distribution.

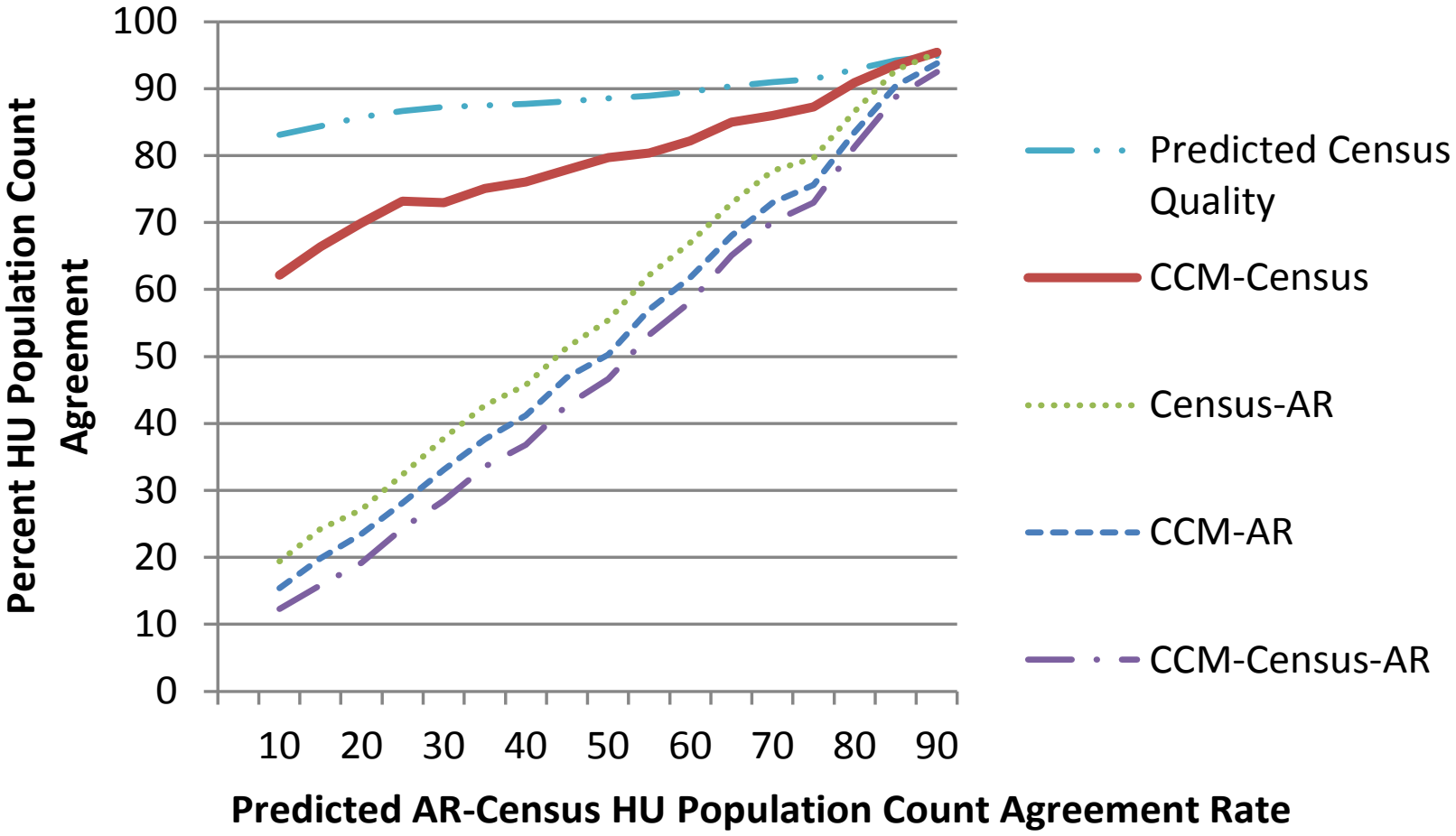
Predicted census enumeration quality is also monotonically increasing in administrative record quality scores, again suggesting that census enumeration and administrative record enumeration both tend to be more difficult in the same housing units. The census quality line has a much more gradual slope than that of the CCM-census agreement rate, reflecting the difficulty the models have at predicting which housing units are likely to have poor-quality census enumerations. The gap between the two lines is roughly half the distance between the CCM-census agreement rate and 100 percent in the lower part of the administrative record quality range. If one were to assume that when the CCM and the census disagree, each is "correct" half the time (rather than both being "incorrect"), then this gap is about right.

Predicted census enumeration quality and especially the CCM-census agreement rate are much lower when the census enumeration has at least one POE (Figure 3) than it is for those with none (Figure 4). The actual administrative record agreement rates are less strongly associated with predicted administrative record-census agreement when the census enumeration has at least one POE. At the 90 percent predicted administrative record-census agreement level, the CCM-administrative record agreement rate is 96 percent without POEs in the census enumeration, but it is only 80 percent when there is at least one potential error in the Census. This again suggests that the census and the CCM tend to have enumeration difficulties in the same housing units.

Note, however, that the models are estimated using census enumerations without POEs, so the predictions in Figure 3 are all out of sample. A potential weakness of our application of non-POE housing units to study associations between various characteristics and census-administrative record agreement to POE housing units is that there may be unobservable systematic differences between POE and non-POE housing units (e.g., POE housing units may have a higher rate of household moves not captured in administrative records than non-POE housing units do). The fact that all the agreement rates in Figure 3 are monotonically increasing in administrative record quality suggests that the models' administrative record-census predicted agreement rates are still highly relevant for POE housing units.

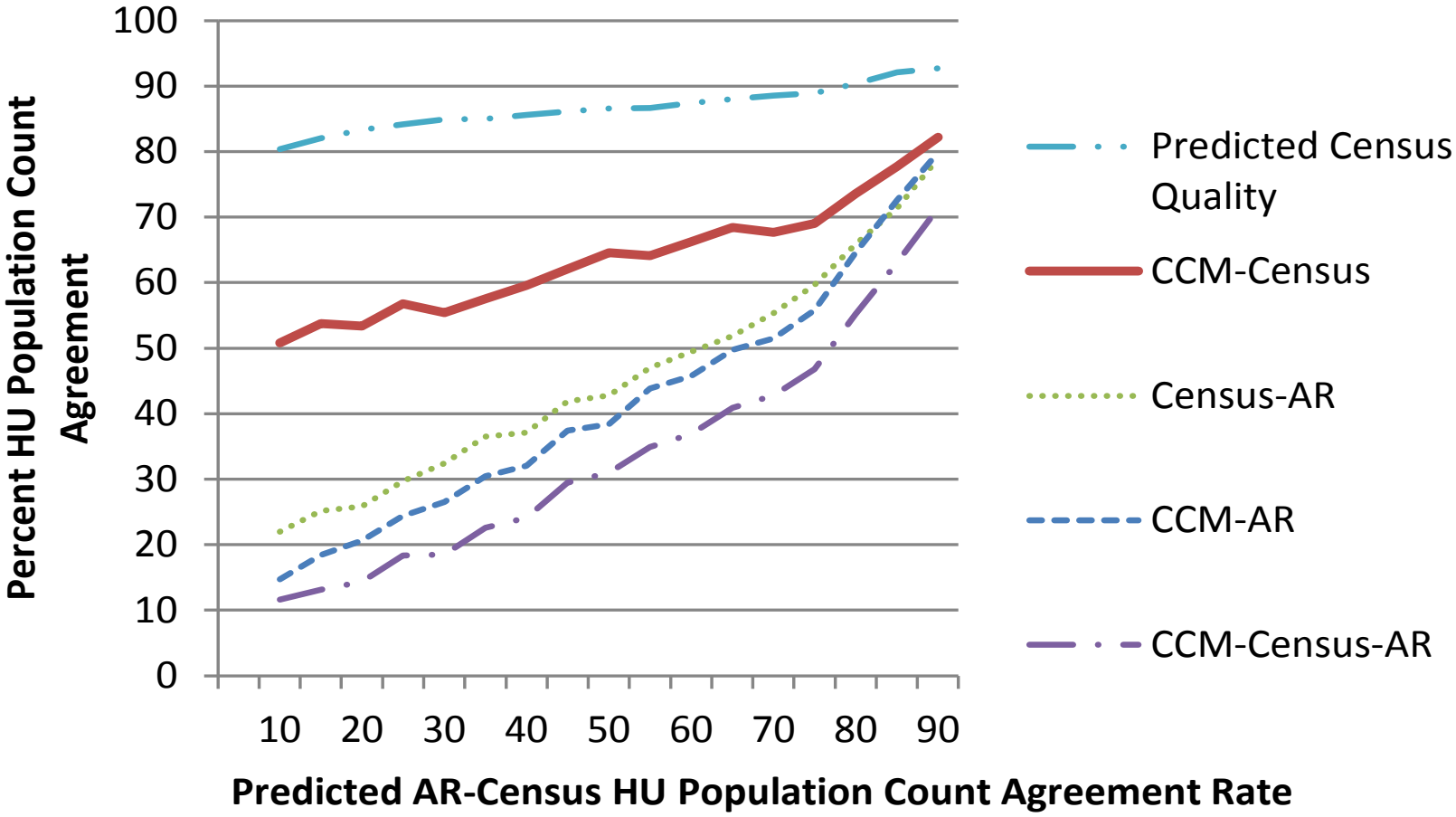
[24] This is predicted self-response quality for housing units with a self-response in 2010 and predicted fieldwork quality for all other housing units.

Figure 2. Variation in Housing Unit Population Count Agreement by Administrative Record Quality: Housing Units with Persons in Administrative Record Sources, Census Enumerations with or without POEs



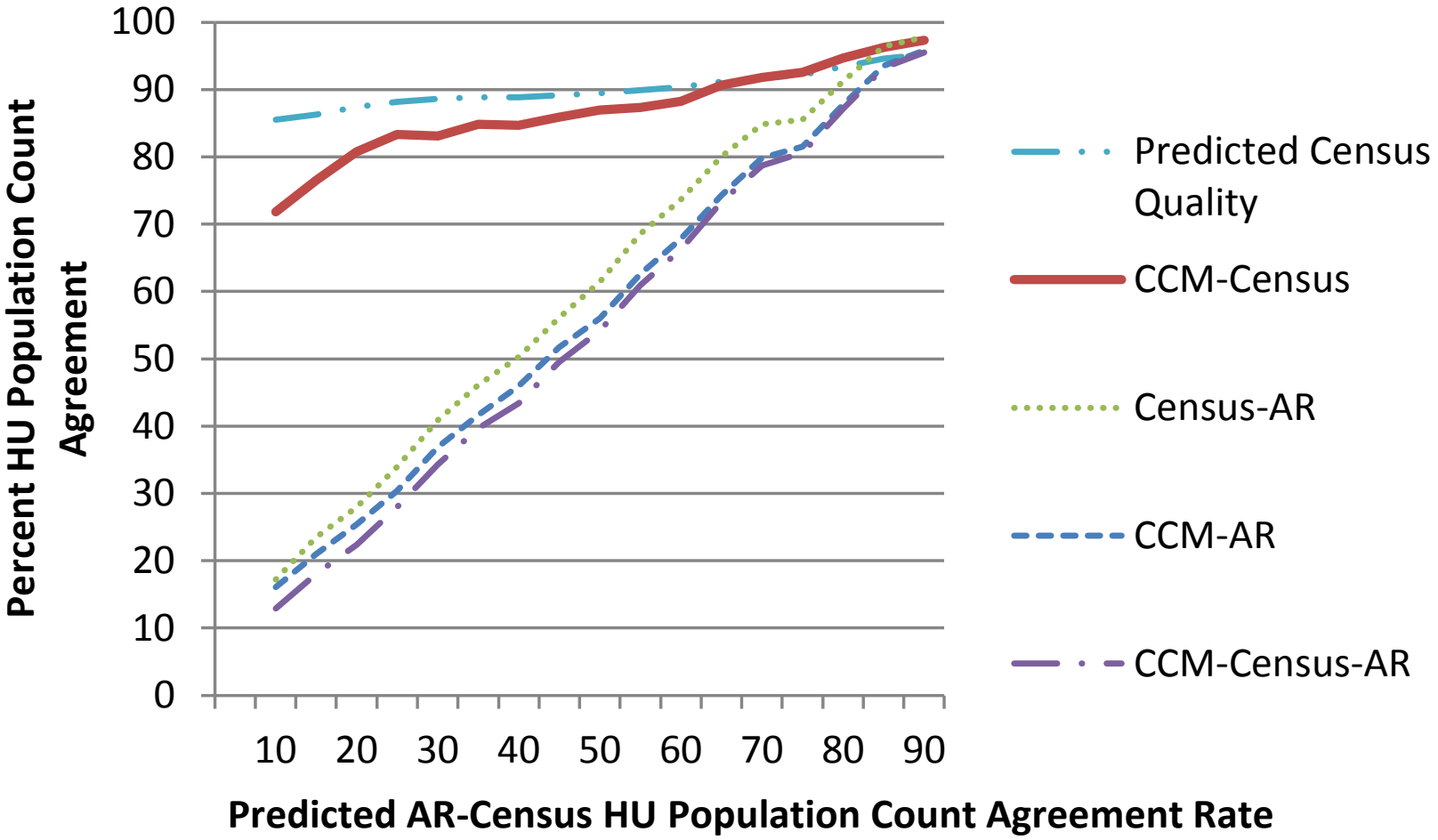
Notes: Sources include the 2010 Census Unedited File (CUF), the 2010 Census Coverage Measurement survey (CCM), all administrative record sources listed in Table 1, and the January 2011 Census Master Address File (MAF). These numbers exclude USPS Undeliverable As Addressed (UAA) housing units, as many of them are unoccupied.

Figure 3. Variation in Housing Unit Population Count Agreement by Administrative Record Quality: Housing Units with Persons in Administrative Records, Census Enumerations with At Least One POE



Notes: Sources include the 2010 Census Unedited File (CUF), the 2010 Census Coverage Measurement survey (CCM), all administrative record sources listed in Table 1, and the January 2011 Census Master Address File (MAF). These numbers exclude USPS Undeliverable As Addressed (UAA) housing units, as many of them are unoccupied.

Figure 4. Variation in Housing Unit Population Count Agreement by Administrative Record Quality: Housing Units with Persons in Administrative Records, Census Enumerations with No POEs



Notes: Sources include the 2010 Census Unedited File (CUF), the 2010 Census Coverage Measurement survey (CCM), all administrative record sources listed in Table 1, and the January 2011 Census Master Address File (MAF). These numbers exclude USPS Undeliverable As Addressed (UAA) housing units, as many of them are unoccupied.

4. Conclusion

This paper demonstrates multiple methods to assess data quality and to explore the accuracy of respondent-provided data, proxy-provided data, and administrative records. Our findings focus on the decennial census, but our processes can be applied to other surveys or evaluations.[25] Future research may extend our study of potential observable errors, particularly for the timing of enumerations. Potential errors associated with move timing can help understand whether respondents (or administrative records) engage in a de jure vs. de facto census. Our administrative record quality scores can serve as housing-unit-level hard-to-count scores. These scores may inform decisions about whether to use administrative records or fieldwork to enumerate individual housing units. Finally, our approach to forming an administrative record composite can assist research and planning for decennial census and adaptive design applications, providing a rigorous, repeatable process to compile multiple sources.

[25] Note that our evaluation of these methods is limited to housing unit population count, while surveys collect many other types of data as well. We leave analysis of how well administrative records can help with collection of other data items to future research.

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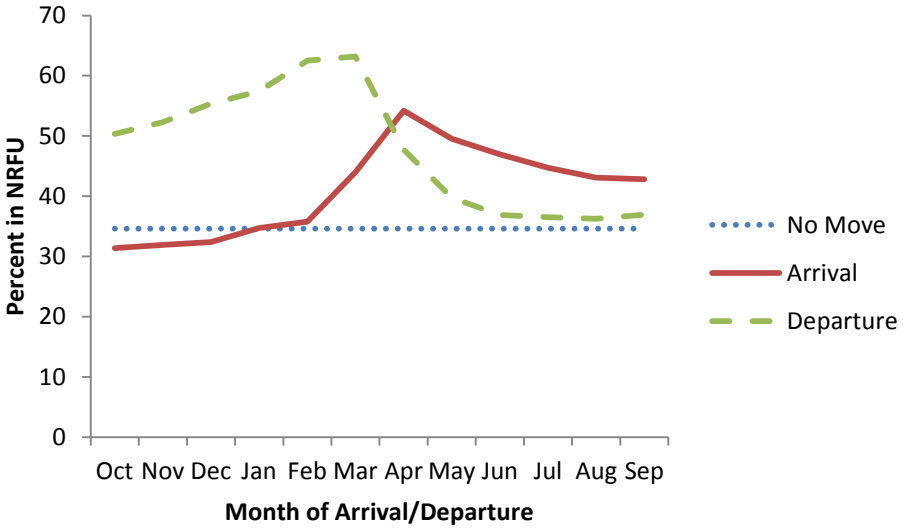
Appendix A: Associations Between Potential Observable Errors (POEs) and NCOA Moves

One would expect enumeration to be more difficult when household moves occur near Census Day. If the NCOA data accurately record moves, and if our list of potential observable enumeration errors (POEs) capture actual enumeration problems, then NCOA moves near Census Day should be associated higher rates of potential errors. We examine these correlations both as a way to judge the quality of the NCOA data and for further exploration of the reasonableness of the potential observable enumeration error flags. Figure A1 shows the variation in the share of nonresponding housing units by moving activity as recorded in the NCOA, focusing on housing units classified as occupied in the decennial census. Housing units containing people moving out just prior to Census Day and moving in soon after Census Day are in the NRFU universe more often than other units. Such housing units should have high rates of enumeration error; if the NCOA data are accurate, these housing units are particularly likely to have been vacant on Census Day (and hence the nonresponse), while they are classified as occupied in the Census. In contrast, housing units with inmover before Census Day or post-Census-Day outmovers experience similar nonresponse rates to nonmovers, which is to be expected given that those housing units were apparently occupied on Census Day.

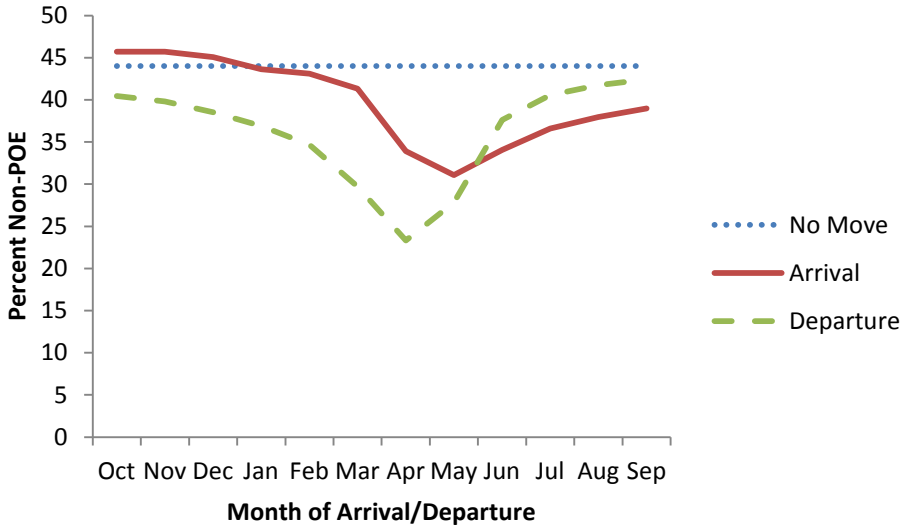
Figure A1. Percent of Housing Units in NRFU by Month of Arrival/Departure



Sources: 2009-2010 USPS NCOA records and the 2010 Census Decennial Response File (DRF).

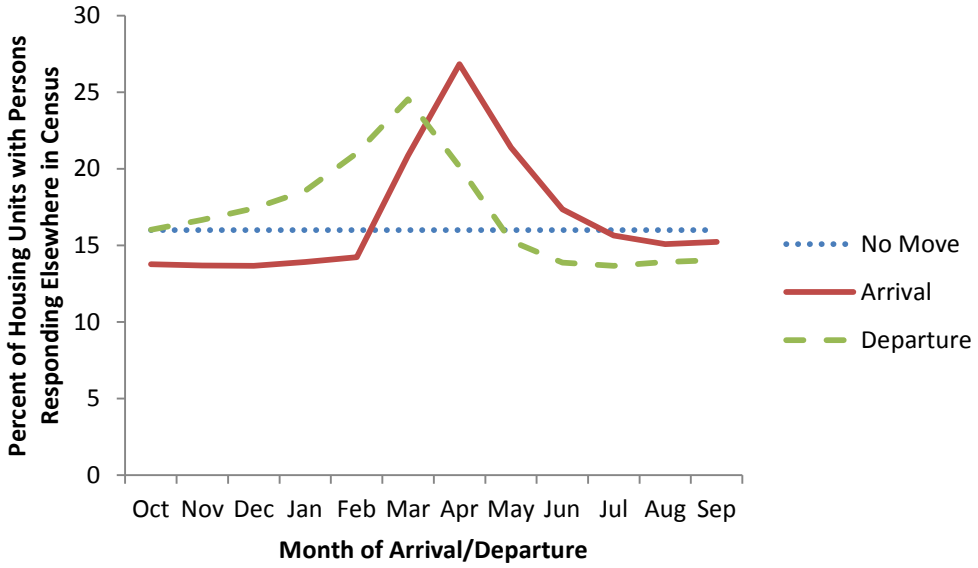
The percentage of non-POE enumerations among occupied NRFU housing units by NCOA move status is shown in Figure A2. Departures are associated with higher rates of potential errors than non-mover housing units, especially when they occur in the months straddling Census Day, with similar rates for departures before and after Census Day. Post-Census-Day arrivals experience more potential errors than non-movers do, while pre-Census-Day arrivals do not, consistent with the hypothesis that the housing units with post-Census-Day arrivals are particularly likely to be vacant on Census Day, despite being classified as occupied in the Census. The associations between NCOA move timing and individual POEs exhibit similar patterns, with POE rates peaking for March or April NCOA departures and May-June NCOA arrivals, as shown in Figures A3-A7.

Figure A2. Percent of Non-POE NRFU Housing Units by Move Type and Month



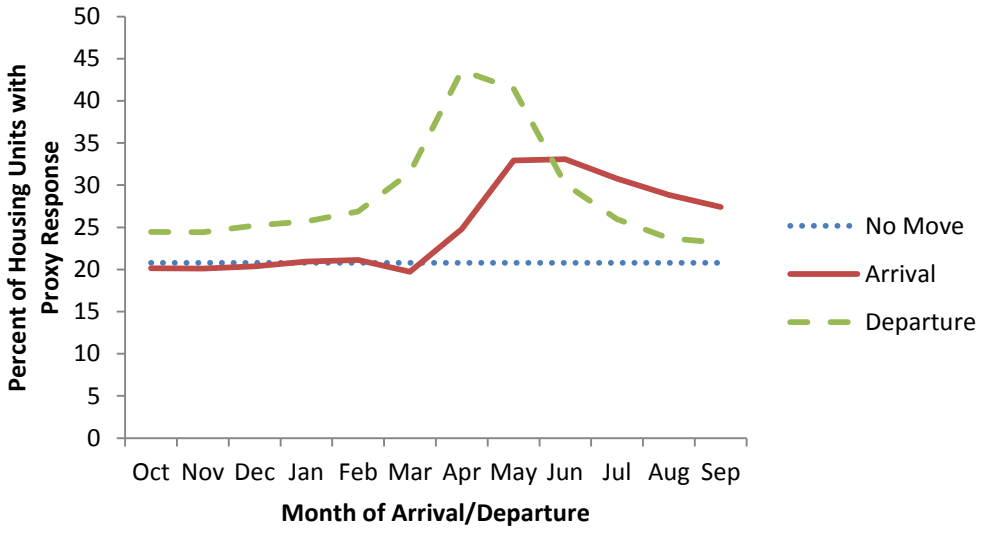
Sources: 2009-2010 USPS NCOA records and the 2010 Census Decennial Response File (DRF).

Figure A3. Percent of NRFU Housing Units with Persons Duplicated Elsewhere by Move Type and Month



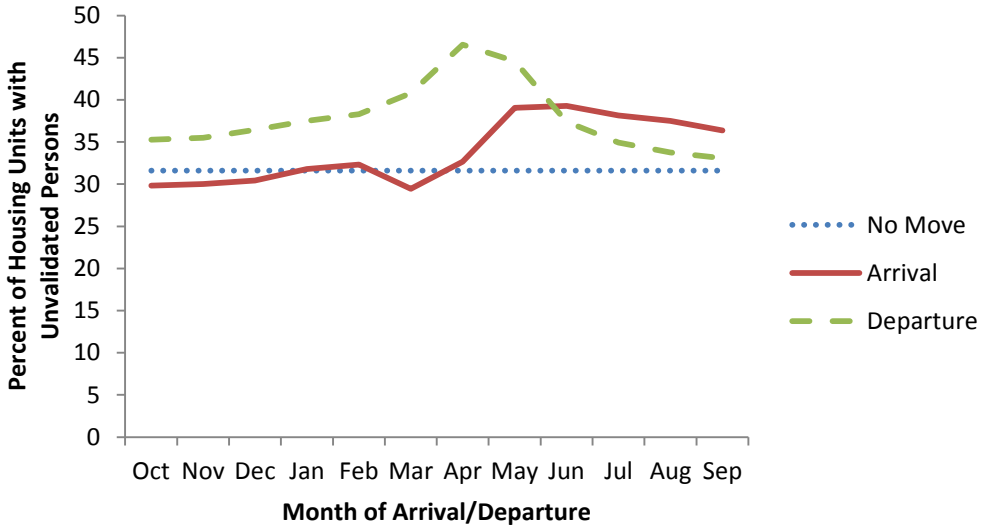
Sources: 2009-2010 USPS NCOA records, the 2010 Census Decennial Response File (DRF), and the 2010 Census Unedited File (CUF).

Figure A4. Percent of NRFU Housing Units with Occupied Proxy Response by Move Type and Month



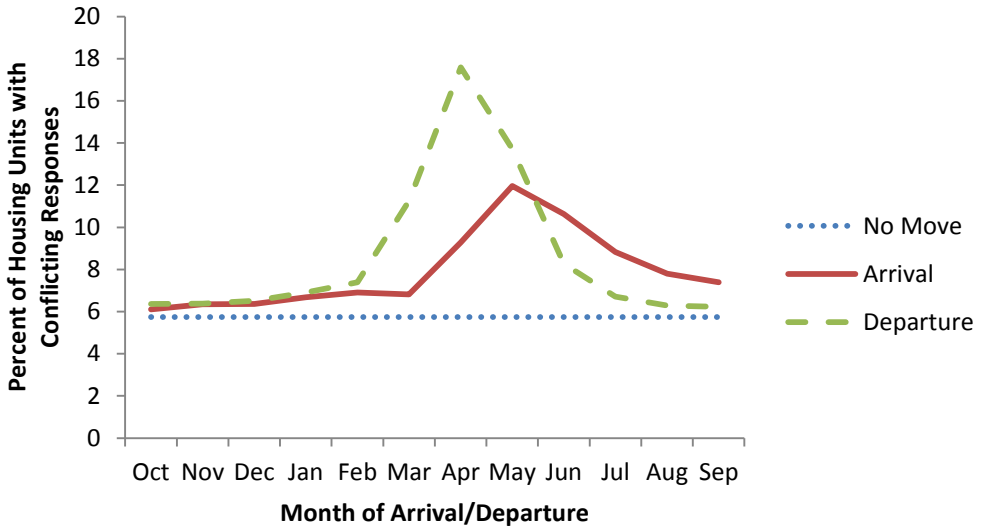
Sources: 2009-2010 USPS NCOA records, the 2010 Census Decennial Response File (DRF), and the 2010 Census Unedited File (CUF).

Figure A5. Percent of NRFU Housing Units with Unvalidated Persons by Move Type and Month



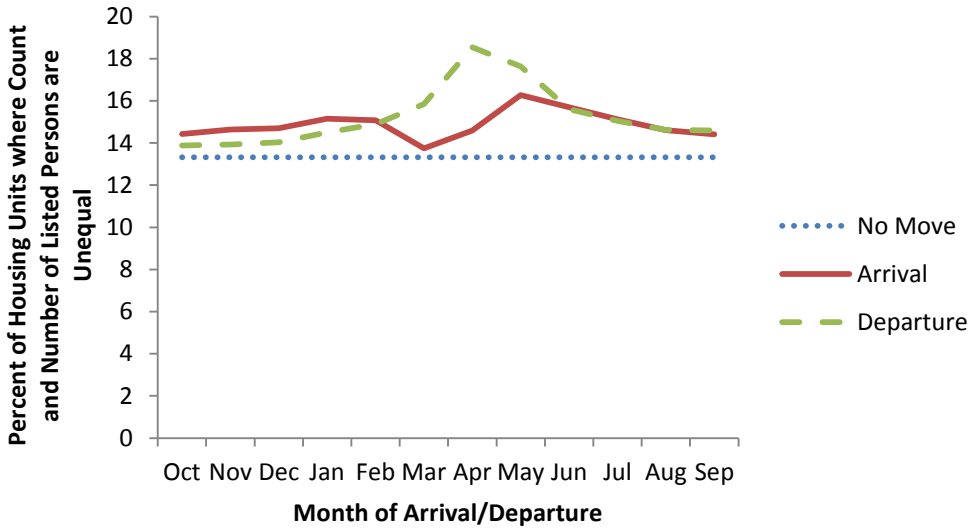
Sources: 2009-2010 USPS NCOA records, the 2010 Census Decennial Response File (DRF), and the 2010 Census Unedited File (CUF).

Figure A6. Percent of NRFU Housing Units with Conflicting Responses by Move Type and Month



Sources: 2009-2010 USPS NCOA records and the 2010 Census Decennial Response File (DRF).

Figure A7. Percent of NRFU Housing Units with Different Household Count and Number of Listed Persons by Move Type and Month



Sources: 2009-2010 USPS NCOA records, the 2010 Census Decennial Response File (DRF), and the 2010 Census Unedited File (CUF).

Appendix B: Person-Place Logistic Regressions

Table B1. Person-Place Logistic Regression with IRS 1040 Data

Variable	Odds Ratio	Standard Error
Male	0.812	0.004
Age 0-2	2.870	0.039
Age 3-17	2.884	0.029
Age 18-24	0.731	0.005
Age 45-64	1.096	0.007
Age 65-74	0.677	0.008
Age 75+	0.450	0.006
Hispanic	0.800	0.006
African-American	0.592	0.003
American Indian/Alaska Native	0.787	0.015
Asian	0.967	0.013
Native Hawaiian/Pacific Islander	0.885	0.047
Some Other Race	1.020	0.013
Multi-Race	1.035	0.016
Married Filing Jointly	2.792	0.020
Married Filing Separately	1.092	0.016
Filing as Household Head	1.121	0.008
Filing as Widow	2.304	0.177
Return has Secondary Filer	0.692	0.008
Return has At Least One Dependent	1.606	0.015
Is Secondary Filer	0.735	0.005
Is Dependent	0.423	0.004
Return has Child Away	0.766	0.026
Is Dependent*Return has Child Away	0.262	0.014
Return Contains Schedule C	1.023	0.009
Return Contains Schedule D	1.028	0.009
Return Contains Schedule E	0.901	0.008
Return Contains Schedule F	0.859	0.018
Return Contains Schedule SE	0.848	0.008
U.S. Citizen	0.866	0.007
Legal Alien, Authorized to Work	0.760	0.014
Legal Alien, Not Authorized to Work	0.534	0.021
Other Alien	0.225	0.012
Alien Student, Restricted Work Authorized	0.951	0.067
Conditionally Legalized Alien	0.645	0.044
Ever Alien	0.885	0.013
ITIN	1.448	0.764
Both 2008 & 2009 1040 Return Here	2.289	0.011
Electronic Filer	0.974	0.007
IRS Processing Week 4	0.519	0.006
IRS Processing Week 5	0.610	0.006
IRS Processing Week 6	0.693	0.006
IRS Processing Week 7	0.759	0.007
IRS Processing Week 8	0.820	0.010
IRS Processing Week 9	0.879	0.011
IRS Processing Week 10	0.909	0.012
IRS Processing Week 11	0.958	0.014
IRS Processing Week 12	1.030	0.016
IRS Processing Week 13	1.067	0.018
IRS Processing Week 14	1.087	0.018
IRS Processing Week 15	1.084	0.018
IRS Processing Week 16	1.164	0.015

IRS Processing Week 17	1.153	0.017
IRS Processing Week 18	1.198	0.019
IRS Processing Week 19	1.136	0.018
IRS Processing Week 20	1.144	0.020
IRS Processing Week 21	1.112	0.024
IRS Processing Week 22	1.111	0.027
IRS Processing Week 23	1.145	0.033
IRS Processing Week 24	1.122	0.029
IRS Processing Week 25	1.061	0.029
IRS Processing Week 26	0.859	0.032
IRS Processing Week 27	0.813	0.033
IRS Processing Week 28	0.851	0.039
IRS Processing Week 29	0.815	0.036
IRS Processing Week 30	0.822	0.037
IRS Processing Week 31	0.805	0.039
IRS Processing Week 32	0.743	0.037
IRS Processing Week 33	0.821	0.044
IRS Processing Week 34	0.821	0.043
IRS Processing Week 35	0.766	0.040
IRS Processing Week 36	0.749	0.040
IRS Processing Week 37	0.686	0.046
IRS Processing Week 38	0.782	0.046
IRS Processing Week 39	0.708	0.041
IRS Processing Week 40	0.784	0.043
IRS Processing Week 41	0.784	0.038
IRS Processing Week 42	0.791	0.033
IRS Processing Week 43	0.870	0.027
IRS Processing Week 44	0.932	0.026
IRS Processing Week 45	0.956	0.025
IRS Processing Week 46	0.808	0.035
IRS Processing Week 47	0.792	0.052
IRS Processing Week 48	0.867	0.066
IRS Processing Week 49	0.827	0.058
IRS Processing Week 50	0.833	0.058
IRS Processing Week 51	0.806	0.061
IRS Processing Week 52	0.802	0.067
Pseudo-R^2	0.101	
Number of Observations	1,927,105	

Notes: Sources include 2008-2009 IRS 1040 records and the 2010 Census Unedited File (CUF). The base categories are 25-44 for age, white for race, missing citizenship for citizenship, single filer for filing status, and missing for Internal Revenue Service (IRS) processing week. Dummy variables for missing gender, Hispanic origin, and race are also included. A 10 percent random sample of 2009 IRS 1040 person-place pairs is drawn, and the ones at addresses with 2010 NRFU fieldwork with no POEs are used in the regression. Predicted values are applied to all 2009 IRS 1040 person-place pairs. A random sample is taken due to computer processing constraints. The standard errors are robust.

Table B2. Person-Place Logistic Regression with NCOA Data

Variable	Odds Ratio	Standard Error
Male	0.889	0.003
Age 0-2	2.124	0.030
Age 3-17	1.858	0.015
Age 18-24	0.728	0.003
Age 45-64	1.034	0.004
Age 65-74	0.995	0.009
Age 75+	0.852	0.010
Hispanic	0.914	0.005

African-American	0.850	0.004
American Indian/Alaska Native	0.850	0.011
Asian	1.080	0.010
Native Hawaiian/Pacific Islander	1.189	0.040
Some Other Race	1.028	0.010
Multi-Race	1.071	0.011
Destination Address in May 2009	0.939	0.006
Destination Address in June 2009	1.001	0.007
Destination Address in July 2009	1.037	0.007
Destination Address in August 2009	1.054	0.007
Destination Address in September 2009	1.069	0.007
Destination Address in October 2009	1.099	0.008
Destination Address in November 2009	1.150	0.008
Destination Address in December 2009	6.171	0.072
Destination Address in January 2010	6.209	0.072
Destination Address in February 2010	6.400	0.077
Destination Address in March 2010	6.792	0.072
Destination Address in April 2010	0.033	0.0004
Departure Address in April 2009	0.019	0.0003
Departure Address in May 2009	0.017	0.0002
Departure Address in June 2009	0.015	0.0002
Departure Address in July 2009	0.015	0.0002
Departure Address in August 2009	0.014	0.0002
Departure Address in September 2009	0.015	0.0002
Departure Address in October 2009	0.015	0.0002
Departure Address in November 2009	0.014	0.0002
Departure Address in December 2009	0.009	0.0002
Departure Address in January 2010	0.010	0.0002
Departure Address in February 2010	0.009	0.0001
Departure Address in March 2010	0.006	0.0001
Departure Address in April 2010	0.510	0.006
U.S. Citizen	0.884	0.005
Legal Alien, Authorized to Work	0.915	0.011
Legal Alien, Not Authorized to Work	0.714	0.024
Other Alien	0.479	0.035
Alien Student, Restricted Work Authorized	0.914	0.035
Conditionally Legalized Alien	0.783	0.049
Ever Alien	1.116	0.012
ITIN	0.874	0.258
Family Move	1.234	0.004
Undeliverable Flag F	0.137	0.028
Undeliverable Flag G	0.119	0.016
Undeliverable Flag K	0.814	0.011
Changed Address (vs. Added Address)	0.259	0.0008
PVS Pass 1	2.097	0.073
PVS Pass 1*PVS Score	0.983	0.001
PVS Pass 2	0.577	0.448
PVS Pass 2*PVS Score	1.055	0.041
PVS Pass 3	1.286	0.049
PVS Pass 3*PVS Score	1.012	0.002
PVS Pass 4	1.076	0.036
PVS Pass 4*PVS Score	1.008	0.001
PVS Pass 5	0.858	0.159
PVS Pass 5*PVS Score	1.021	0.008
PVS Pass 6	0.281	0.035
PVS Pass 6*PVS Score	1.045	0.005

PVS Pass 7	0.056	0.187
PVS Pass 7*PVS Score	1.145	0.190
IRS Family Member	4.141	0.041
CHUMS Family Member	1.358	0.021
HUD PIC Family Member	1.590	0.027
HUD TRACS Family Member	1.708	0.067
Medicare Family Member	0.867	0.019
SSR Family Member	0.624	0.017
Experian-EDR Family Member	0.747	0.008
Experian-Insource Family Member	0.971	0.010
InfoUSA Family Member	0.604	0.007
Targus-Consumer Family Member	1.060	0.011
VSGI-NAR Family Member	1.029	0.011
Pseudo-R^2	0.5447	
Number of Observations	6,653,884	

Notes: Sources include 2009-2010 NCOA records and the 2010 Census Unedited File (CUF). The base categories are 25-44 for age, white for race, missing citizenship for citizenship, destination address in April 2010 for address, and added address for changed vs. added address. Dummy variables for missing gender, Hispanic origin, and race are also included. Person-place pairs in 2009-2010 National Change of Address (NCOA) data at addresses with 2010 NRFU fieldwork with no POEs are used in the regression. Predicted values are applied to all person-place pairs in 2009-2010 NCOA data. The standard errors are robust.

Table B3. Person-Place Logistic Regression with VSGI-NAR Data

Variable	Odds Ratio	Standard Error
Male	0.889	0.001
Age 0-17	1.781	0.022
Age 18-24	0.588	0.003
Age 45-64	1.275	0.002
Age 65-74	0.957	0.003
Age 75+	0.609	0.002
Hispanic	0.978	0.003
African-American	0.864	0.002
American Indian/Alaska Native	0.940	0.007
Asian	0.996	0.005
Native Hawaiian/Pacific Islander	1.020	0.022
Some Other Race	1.036	0.005
Multi-Race	1.022	0.006
Missing Race	0.786	0.004
Owner	1.510	0.003
Renter	0.583	0.002
Number of Persons	0.835	0.0007
Log Length of Residence	1.206	0.0008
Income <$20,000	0.531	0.002
Income $20,000-29,999	0.585	0.002
Income $30,000-39,999	0.648	0.002
Income $40,000-49,999	0.705	0.002
Income $50,000-74,999	0.788	0.002
Income $75,000-99,999	0.907	0.003
Income $100,000-124,999	0.963	0.003
Income $125,000-149,999	0.918	0.004
U.S. Citizen	0.891	0.002
Legal Alien, Authorized to Work	0.976	0.006
Legal Alien, Not Authorized to Work	0.592	0.010
Other Alien	0.483	0.017
Alien Student, Restricted Work Authorized	0.853	0.019
Conditionally Legalized Alien	0.864	0.024

Ever Alien	1.017	0.006
ITIN	0.967	0.018
Pseudo-R^2	0.0480	
Number of Observations	9,388,414	

Notes: Sources include 2010 Veteran Service Group of Illinois Name and Address Resource Consumer file (VSGI-NAR) records and the 2010 Census Unedited File (CUF). The base categories are 25-44 for age, white for race, missing citizenship for citizenship, $150,000 and above for income, and missing tenure for tenure. Dummy variables for missing race and length of residence are also included. Person-place pairs in VSGI-NAR records at addresses with 2010 NRFU fieldwork with no POEs are used in the regression. Predicted values are applied to all person-place pairs in 2010 VSGI-NAR records. The standard errors are robust.

Table B4. Second-Stage Person-Place Match Logistic Regression

Variable	Odds Ratio	Standard Error
Update/Leave	0.845	0.015
Military	1.032	0.081
Urban Update/Leave	0.781	0.018
City-Style, No DSF	0.363	0.102
City-Style, Some DSF	0.394	0.108
City-Style, All DSF	0.421	0.116
City-Style and Noncity-Style, no DSF	0.229	0.061
City-Style (95-99.99%) and Noncity-Style, some DSF	0.408	0.112
City-Style (90-94.99%) and Noncity-Style, some DSF	0.388	0.106
City-Style (85-89.99%) and Noncity-Style, some DSF	0.379	0.103
City-Style (80-84.99%) and Noncity-Style, some DSF	0.358	0.097
City-Style (75-79.99%) and Noncity-Style, some DSF	0.338	0.092
City-Style (70-74.99%) and Noncity-Style, some DSF	0.348	0.094
City-Style (<70%) and Noncity-Style, some DSF	0.282	0.075
Assorted Noncity-Style, No DSF	0.232	0.062
Mobile or Other Housing Structure	1.030	0.013
2-4-Unit Housing Structure	0.863	0.014
5-9-Unit Housing Structure	1.055	0.020
10-19-Unit Housing Structure	1.101	0.018
20-49-Unit Housing Structure	1.070	0.017
50+-Unit Housing Structure	1.066	0.015
Housing Unit Not in 2000 Decennial	1.031	0.009
Housing Unit Unoccupied in 2000 Decennial	0.979	0.020
Spring 2010 DSF Deliverable Flag	1.267	0.142
Spring 2010 DSF X Flag	1.368	0.190
6-Month Periods Since Last DSF Deliverable Flag	1.011	0.005
Never Had DSF Deliverable Flags	1.012	0.067
Had DSF Deliverable Flag Every Time Since Fall 2008	0.793	0.014
2000 LUCA Address	1.059	0.022
Post-2000 LUCA Address	1.035	0.070
2010 Address Canvassing Address	1.930	0.066
2010 Decennial Added Address	1.180	0.155
Targeted Block, Additional Form Sent	0.933	0.008
Targeted Block, Additional Form Not Sent	1.075	0.010
Block Blanketed with Second Forms	0.879	0.007
Bilingual Form	0.959	0.009
Business Address	1.029	0.204
Residential, Excluded from Delivery Statistics	0.472	0.021
Built After 2000	1.199	0.097
Has Location Description in MAF	0.934	0.018
Missing DSF Route	1.193	0.110
MAF Valid Unit Status	3.940	0.215
Texas SNAP Here	0.731	0.172

Texas SNAP Here*Occupancy Propensity	1.570	0.573
Targus National Address File Here	0.530	0.018
Targus National Address File Here*Occupancy Propensity	0.911	0.044
Corelogic Here	0.804	0.013
Corelogic Here*Occupancy Propensity	1.112	0.032
In 2000 Census Here	1.168	0.010
In 2000 Census Elsewhere	1.280	0.007
Same Race for All Persons in Housing Unit	1.079	0.007
Same Hispanic Origin for All Persons in Housing Unit	1.022	0.009
Two Adrec PIKs in Housing Unit	0.891	0.009
Three Adrec PIKs in Housing Unit	0.646	0.007
Four Adrec PIKs in Housing Unit	0.608	0.007
Five Adrec PIKs in Housing Unit	0.570	0.007
Six Adrec PIKs in Housing Unit	0.514	0.006
Seven Adrec PIKs in Housing Unit	0.466	0.006
Eight Adrec PIKs in Housing Unit	0.439	0.007
Nine Adrec PIKs in Housing Unit	0.391	0.007
Ten or More Adrec PIKs in Housing Unit	0.271	0.007
IRS1040 Here	1.751	0.014
IRS 1040 Here*1st-Stage Match Propensity	3.522	0.036
IRS 1040 Elsewhere	0.537	0.004
IRS 1040 Elsewhere*1st-Stage Match Propensity	0.421	0.004
IRS 1099 Here	0.724	0.010
IRS 1099 Here*1st-Stage Match Propensity	2.028	0.048
IRS 1099 Elsewhere	0.562	0.007
IRS 1099 Elsewhere*1st-Stage Match Propensity	1.133	0.027
HUD CHUMS Here	0.232	0.010
HUD CHUMS Here*1st-Stage Match Propensity	24.905	1.893
HUD CHUMS Elsewhere	1.785	0.076
HUD CHUMS Elsewhere*1st-Stage Match Propensity	0.200	0.015
HUD PIC Here	0.584	0.220
HUD PIC Here*1st-Stage Match Propensity	11.670	5.701
HUD PIC Elsewhere	32.105	13.124
HUD PIC Elsewhere*1st-Stage Match Propensity	0.002	0.001
HUD TRACS Here	0.736	0.154
HUD TRACS Here*1st-Stage Match Propensity	7.892	2.509
HUD TRACS Elsewhere	1.287	0.432
HUD TRACS Elsewhere*1st-Stage Match Propensity	0.134	0.057
SSS Here	0.156	0.004
SSS Here*1st-Stage Match Propensity	15.850	1.043
SSS Elsewhere	0.813	0.025
SSS Elsewhere*1st-Stage Match Propensity	1.144	0.107
Medicare Here	0.363	0.024
Medicare Here*1st-Stage Match Propensity	10.525	0.971
Medicare Elsewhere	0.406	0.059
Medicare Elsewhere*1st-Stage Match Propensity	1.415	0.265
IHS Here	0.283	0.027
IHS Here*1st-Stage Match Propensity	16.094	4.979
IHS Elsewhere	1.009	0.116
IHS Elsewhere*1st-Stage Match Propensity	0.333	0.141
NCOA Here	0.102	0.002
NCOA Here*1st-Stage Match Propensity	90.056	2.736
NCOA Elsewhere	1.454	0.013
NCOA Elsewhere*1st-Stage Match Propensity	0.143	0.003
NY SNAP Here	0.212	0.053
NY SNAP Here*1st-Stage Match Propensity	10.636	4.029

NY SNAP Elsewhere	0.736	0.143
NY SNAP Elsewhere*1st-Stage Match Propensity	0.368	0.117
SSR Here	0.392	0.035
SSR Here*1st-Stage Match Propensity	13.139	1.867
SSR Elsewhere	0.562	0.071
SSR Elsewhere*1st-Stage Match Propensity	0.323	0.073
Experian-EDR Here	0.428	0.012
Experian-EDR Here*1st-Stage Match Propensity	8.806	0.926
Experian-EDR Elsewhere	0.907	0.023
Experian-EDR Elsewhere*1st-Stage Match Propensity	1.342	0.133
Experian-Insource Here	0.636	0.017
Experian-Insource Here*1st-Stage Match Propensity	2.760	0.113
Experian-Insource Elsewhere	0.881	0.018
Experian-Insource Elsewhere*1st-Stage Match Propensity	0.767	0.024
InfoUSA Here	0.339	0.004
InfoUSA Here*1st-Stage Match Propensity	6.932	0.129
InfoUSA Elsewhere	0.876	0.007
InfoUSA Elsewhere*1st-Stage Match Propensity	0.588	0.010
Melissa Here	0.424	0.007
Melissa Here*1st-Stage Match Propensity	4.618	0.133
Melissa Elsewhere	0.817	0.011
Melissa Elsewhere*1st-Stage Match Propensity	1.227	0.033
Targus-Consumer Here	2.200	0.078
Targus-Consumer Here*1st-Stage Match Propensity	0.966	0.050
Targus-Consumer Elsewhere	0.640	0.018
Targus-Consumer Elsewhere*1st-Stage Match Propensity	1.592	0.070
Targus-Wireless Here	0.614	0.025
Targus-Wireless Here*1st-Stage Match Propensity	1.794	0.146
Targus-Wireless Elsewhere	1.329	0.057
Targus-Wireless Elsewhere*1st-Stage Match Propensity	0.653	0.057
VSGI-NAR Here	1.511	0.056
VSGI-NAR Here*1st-Stage Match Propensity	0.850	0.047
VSGI-NAR Elsewhere	1.136	0.043
VSGI-NAR Elsewhere*1st-Stage Match Propensity	0.844	0.048
VSGI-TRK Here	0.571	0.012
VSGI-TRK Here*1st-Stage Match Propensity	0.904	0.042
VSGI-TRK Elsewhere	0.974	0.023
VSGI-TRK Elsewhere*1st-Stage Match Propensity	0.414	0.021
Pseudo-R^2	0.433	
Number of Observations	2,487,841	

Notes: Sources include all those listed in Table 1, the 2010 Census Unedited File (CUF), and the January 2011 Master Address File (MAF). The base category for address characteristic type includes the following: non-residential only, description, assorted noncity-style with some U.S. Postal Service Delivery Sequence File (DSF), assorted noncity-style with all DSF, P.O. Box, rural route with some DSF, rural route with all DSF, and no addresses found. Other base categories include single-unit structure for housing structure type, no spring 2010 DSF flag for spring DSF flag type, other source (mainly addresses in the Master Address File (MAF) prior to 2000) for address origin, and not in the 2000 Census for 2000 Census person categories. The first-stage occupancy propensities for Texas SNAP, Targus National Address File, and Corelogic come from the occupancy models described in footnote 11. The first-stage match propensity is the person-place pair's predicted value from the first-stage regression corresponding to the source the propensity is being interacted with. A 10 percent random sample person-place pairs is drawn, and the ones that are at addresses with no U.S. Postal Service Undeliverable As Addressed (UAA) received after the questionnaire mailing and with 2010 NRFU fieldwork with no POEs are used in the regression. A random sample is taken due to computer processing constraints. The standard errors are cluster-adjusted at the housing unit level.

Appendix C: Self-Response Quality Quasi-Likelihood Regressions

Table C1. Self-Response Quality Quasi-Likelihood Regression with IRS 1040 Data

Variable	Coefficient	Standard Error
Deceased	-0.437	0.020
Male	-0.192	0.004
Age 0-2	0.404	0.014
Age 3-17	0.047	0.008
Age 18-24	-0.548	0.005
Age 45-64	0.021	0.004
Age 65-74	0.085	0.005
Age 75+	-0.071	0.006
Hispanic	-0.299	0.005
African-American	-0.242	0.004
American Indian/Alaska Native	-0.286	0.013
Asian	-0.205	0.007
Native Hawaiian/Pacific Islander	-0.272	0.039
Some Other Race	-0.137	0.008
Multi-Race	-0.181	0.010
U.S. Citizen	-0.213	0.004
Legal Alien, Authorized to Work	-0.204	0.013
Legal Alien, Not Authorized to Work	-0.059	0.034
Other Alien	-0.130	0.054
Alien Student, Restricted Work Authorized	0.121	0.052
Conditionally Legalized Alien	-0.406	0.057
Ever Alien	-0.249	0.011
ITIN	-0.082	0.026
Married Filing Jointly	0.442	0.004
Married Filing Separately	0.134	0.009
Filing as Household Head	-0.368	0.005
Filing as Widow	0.124	0.039
Return Contains Schedule C	-0.076	0.004
Return Contains Schedule D	0.073	0.003
Return Contains Schedule E	-0.169	0.003
Return Contains Schedule F	-0.067	0.009
Return Contains Schedule SE	0.024	0.005
IRS Processing Week	0.028	0.001
IRS Processing Week Squared	-0.002	0.00006
IRS Processing Week Cubed	0.00002	0.000001
One PVSed Person	0.221	0.045
Two PVSed Persons	-0.012	0.045
Three PVSed Persons	-0.236	0.045
Four PVSed Persons	-0.288	0.045
Five PVSed Persons	-0.445	0.045
Six PVSed Persons	-0.584	0.045
Seven or More PVSed Persons	-0.735	0.045
One Non-PVSed Record	-0.282	0.010
Two Non-PVSed Records	0.017	0.014
Three Non-PVSed Records	-0.315	0.026
Four Non-PVSed Records	-0.115	0.023
Five or More Non-PVSed Records	0.200	0.017
Dependent PIK Elsewhere for Non-Dependent PIK Here	-0.208	0.010
Non-Dependent PIK Elsewhere for Dependent PIK Here	-0.238	0.016
2008 IRS 1040 Return at HU	-0.128	0.004
Share of IRS 2008, 2009 PIKs in Both Years	0.541	0.003
Electronic Filer	-0.008	0.002

Pseudo-R^2	
Number of Observations	6,566,713

Notes: Sources include 2008-2009 IRS 1040 records, the 2010 Census Unedited File (CUF), and the 2010 Census Decennial Response File (DRF). This is a quasi-likelihood function using a binomial family variance with a logistic link. The base categories are 25-44 for age, white for race, missing citizenship for citizenship, and single filer for filing status. Dummy variables for missing gender, age, Hispanic origin, and race are also included. A 10 percent random sample of housing units containing 2009 Internal Revenue Service (IRS) 1040 records is drawn. Of those, responding housing units are included in the regression. Predicted values are applied to all housing units with 2009 IRS 1040 records. A random sample is taken due to computer processing constraints. The standard errors are robust.

Table C2. Self-Response Quality Quasi-Likelihood Regression with National Change of Address Data

Variable	Coefficient	Standard Error
Deceased	-0.201	0.345
Male	0.015	0.002
Age 0-2	-0.496	0.026
Age 3-17	-0.487	0.010
Age 18-24	-0.105	0.003
Age 45-64	-0.071	0.003
Age 65-74	-0.036	0.006
Age 75+	-0.205	0.006
Hispanic	-0.305	0.004
African-American	-0.373	0.003
American Indian/Alaska Native	-0.162	0.010
Asian	-0.164	0.007
Native Hawaiian/Pacific Islander	-0.231	0.027
Some Other Race	-0.176	0.007
Multi-Race	-0.122	0.008
U.S. Citizen	-0.039	0.004
Legal Alien, Authorized to Work	-0.044	0.009
Legal Alien, Not Authorized to Work	0.007	0.026
Other Alien	-0.175	0.047
Alien Student, Restricted Work Author.	0.196	0.034
Conditionally Legalized Alien	-0.240	0.044
Ever Alien	-0.161	0.007
ITIN	-0.735	0.014
One PVSed Person	-0.223	0.004
Two PVSed Persons	-0.237	0.005
Three PVSed Persons	-0.214	0.006
Four PVSed Persons	-0.237	0.007
Five or More PVSed Persons	-0.238	0.009
Number of Non-PVSed Records	-0.088	0.001
Departure Address in April 2009	2.076	0.011
Departure Address in May 2009	2.057	0.011
Departure Address in June 2009	2.082	0.011
Departure Address in July 2009	2.079	0.011
Departure Address in August 2009	2.055	0.011
Departure Address in September 2009	2.063	0.011
Departure Address in October 2009	2.077	0.011
Departure Address in November 2009	2.085	0.011
Departure Address in December 2009	1.939	0.011
Departure Address in January 2010	1.867	0.011
Departure Address in February 2010	1.796	0.011
Departure Address in March 2010	0.804	0.011
Departure Address in April 2010	0.782	0.012
Destination Address in April 2009	2.410	0.016
Destination Address in May 2009	2.575	0.015

Destination Address in June 2009	2.664	0.014
Destination Address in July 2009	2.696	0.014
Destination Address in August 2009	2.675	0.014
Destination Address in September 2009	2.644	0.014
Destination Address in October 2009	2.676	0.014
Destination Address in November 2009	2.671	0.015
Destination Address in December 2009	1.904	0.013
Destination Address in January 2010	1.769	0.013
Destination Address in February 2010	1.866	0.013
Destination Address in March 2010	1.483	0.013
Num. Moves, April 2009-March 2010	-0.103	0.001
Family Move	-0.123	0.002
Undeliverable Flag F	-0.116	0.023
Undeliverable Flag G	0.790	0.029
Undeliverable Flag K	0.099	0.003
Changed Address (vs. Added Address)	-0.084	0.002
Number of Observations	7,349,003	

Notes: Sources include 2009-2010 NCOA records, the 2010 Census Unedited File (CUF), and the 2010 Census Decennial Response File (DRF). This is a quasi-likelihood function using a binomial family variance with a logistic link. The base categories are 25-44 for age, white for race, missing citizenship for citizenship, destination address in April 2010 for address, and added address for changed vs. added address. Dummy variables for missing gender, Hispanic origin, and race are also included. Housing units with a self-response and with 2009-2010 National Change of Address (NCOA) records are used in the regression. Predicted values are applied to all housing units with NCOA data. The standard errors are robust.

Table C3. Self-Response Quality Quasi-Likelihood Regression with VSGI-NAR Data

Variable	Coefficient	Standard Error
Deceased	-0.351	0.006
Male	-0.040	0.002
Age 0-17	-0.522	0.014
Age 18-24	-0.479	0.007
Age 45-64	-0.059	0.002
Age 65-74	0.199	0.003
Age 75+	0.126	0.003
Hispanic	-0.425	0.004
African-American	-0.493	0.003
American Indian/Alaska Native	-0.336	0.010
Asian	-0.215	0.005
Native Hawaiian/Pacific Islander	-0.387	0.026
Some Other Race	-0.227	0.006
Multi-Race	-0.282	0.008
Married	0.102	0.002
U.S. Citizen	-0.233	0.002
Legal Alien, Authorized to Work	-0.226	0.007
Legal Alien, Not Authorized to Work	-0.157	0.021
Other Alien	-0.212	0.034
Alien Student, Restricted Work Authorized	0.154	0.027
Conditionally Legalized Alien	-0.390	0.027
Ever Alien	-0.263	0.006
ITIN	-0.969	0.025
Income <$20,000	0.006	0.004
Income $20,000-29,999	0.027	0.004
Income $30,000-39,999	0.069	0.004
Income $40,000-49,999	0.108	0.003
Income $50,000-74,999	0.144	0.003
Income $75,000-99,999	0.162	0.003

Income $100,000-124,999	0.136	0.003
Income $125,000-149,999	0.088	0.004
Log Length of Residence	0.027	0.0007
Owner	0.122	0.002
Renter	0.139	0.004
Number of Persons	0.053	0.002
One PVSed Person	0.357	0.013
Two PVSed Persons	0.426	0.014
Three PVSed Persons	0.232	0.016
Four or More PVSed Persons	0.053	0.017
One Non-PVSed Record	-0.035	0.009
Two or More Non-PVSed Records	-0.077	0.012
Number of Observations	11,420,245	

Notes: Sources include 2010 Veteran Service Group of Illinois Name and Address Resource Consumer file (VSGI-NAR) records, the 2010 Census Unedited File (CUF), and the 2010 Census Decennial Response File (DRF). This is a quasi-likelihood function using a binomial family variance with a logistic link. The base categories are 25-44 for age, white for race, missing citizenship for citizenship, $150,000 and above for income, and missing tenure for tenure. Dummy variables for missing gender, Hispanic origin, race, and length of residence are also included. A 20 percent random sample of housing units with VSGI-NAR records is drawn, and those housing units with a self-response are used in the regression. Predicted values are applied to all housing units with 2010 VSGI-NAR records. The standard errors are robust.

Table C4. Second-Stage Self-Response Quality Quasi-Likelihood Regression

Variable	Coefficient	Standard Error
Update/Leave	0.215	0.004
Military	-0.411	0.015
Urban Update/Leave	-0.041	0.006
City-Style, No DSF	0.128	0.020
City-Style, some DSF	0.087	0.018
City-Style, all DSF	0.136	0.018
City-Style and Noncity-Style, no DSF	0.045	0.019
City-Style (95-99.99%) and Noncity-Style, some DSF	0.102	0.018
City-Style (90-94.99%) and Noncity-Style, some DSF	0.074	0.018
City-Style (85-89.99%) and Noncity-Style, some DSF	0.050	0.019
City-Style (80-84.99%) and Noncity-Style, some DSF	0.042	0.019
City-Style (75-79.99%) and Noncity-Style, some DSF	0.023	0.020
City-Style (70-74.99%) and Noncity-Style, some DSF	-0.003	0.021
City-Style (<70%) and Noncity-Style, some DSF	-0.028	0.019
Assorted Noncity-Style, No DSF	0.064	0.022
Mobile or Other Housing Structure	-0.052	0.004
2-4-Unit Housing Structure	-0.060	0.004
5-9-Unit Housing Structure	0.126	0.005
10-19-Unit Housing Structure	0.174	0.005
20-49-Unit Housing Structure	0.214	0.005
50+-Unit Housing Structure	0.250	0.004
Housing Unit Not in 2000 Decennial	-0.017	0.005
Housing Unit Vacant in 2000 Decennial	0.016	0.003
Housing Unit Deleted in 2000 Decennial	-0.054	0.008
Housing Unit Imputed Response in 2000 Decennial	-0.081	0.015
Housing Unit Self-Response in 2000 Decennial	0.076	0.002
Spring 2010 DSF Deliverable Flag	0.317	0.015
Spring 2010 DSF X Flag	0.265	0.015
6-Month Periods Since Last DSF Deliverable Flag	0.012	0.0009
Never Had DSF Deliverable Flags	0.239	0.013
Had DSF Deliverable Flag Every Time Since Fall 2008	0.014	0.005
2000 LUCA Address	-0.028	0.005

Post-2000 LUCA Address	-0.019	0.008
2010 Address Canvassing Address	-0.103	0.007
2010 Decennial Added Address	-0.364	0.010
Targeted Block, Additional Form Sent	-0.247	0.003
Targeted Block, Additional Form Not Sent	0.027	0.002
Block Blanketed with Second Forms	-0.148	0.002
Bilingual Form	-0.140	0.003
Business Address	-0.088	0.020
Residential, Excluded from Delivery Statistics	-0.121	0.010
Built After 2000	0.076	0.029
Has Location Description in MAF	-0.036	0.003
Missing DSF Route	0.051	0.013
MAF Valid Unit Status	-0.282	0.014
Mean Number of AR Addresses Per Person	-0.026	0.0007
HUD CHUMS Here	-0.723	0.079
HUD CHUMS Here* Quality Response Propensity	0.896	0.087
HUD PIC Here	-3.575	0.128
HUD PIC Here* Quality Response Propensity	4.356	0.143
HUD TRACS Here	-5.483	0.308
HUD TRACS Here* Quality Response Propensity	6.401	0.332
IRS1040 Here	-4.656	0.020
IRS1040 Here* Quality Response Propensity	5.482	0.022
IRS 1099 Here	-2.106	0.030
IRS 1099 Here* Quality Response Propensity	2.494	0.033
SSS Here	2.072	0.066
SSS Here* Quality Response Propensity	-2.573	0.074
Medicare Here	-0.905	0.054
Medicare Here* Quality Response Propensity	1.031	0.058
IHS Here	-1.472	0.338
IHS Here* Quality Response Propensity	1.555	0.378
NCOA Here	-0.470	0.003
NCOA Here* Quality Response Propensity	0.217	0.004
SSR Here	-1.573	0.078
SSR Here* Quality Response Propensity	1.745	0.089
NY SNAP Here	-2.960	0.122
NY SNAP Here* Quality Response Propensity	3.347	0.142
Texas SNAP Here	-3.438	0.088
Texas SNAP Here* Quality Response Propensity	3.975	0.105
Experian-EDR Here	1.140	0.055
Experian-EDR Here* Quality Response Propensity	-1.373	0.061
Experian-Insource Here	-1.275	0.034
Experian-Insource Here* Quality Response Propensity	1.459	0.038
InfoUSA Here	-1.555	0.032
InfoUSA Here* Quality Response Propensity	1.896	0.036
Melissa Here	-0.422	0.043
Melissa Here* Quality Response Propensity	0.475	0.047
Targus-Consumer Here	-1.144	0.039
Targus-Consumer Here* Quality Response Propensity	1.319	0.043
Targus National Address File Here	1.268	0.118
Targus National Address File Here* Quality Response Propensity	-1.448	0.129
Targus Wireless Here	-0.052	0.054
Targus Wireless Here* Quality Response Propensity	-0.022	0.059
VSGI-NAR Here	-0.067	0.042
VSGI-NAR Here* Quality Response Propensity	0.091	0.046
VSGI-TRK Here	-0.936	0.040
VSGI-TRK Here* Quality Response Propensity	1.109	0.044

Corelogic Here	0.364	0.106
Corelogic Here* Quality Response Propensity	-0.464	0.115
Number of Observations	8,694,606	

Notes: Sources include all those listed in Table 1, the 2010 Census Unedited File (CUF), and the January 2011 Master Address File (MAF). This is a quasi-likelihood function using a binomial family variance with a logistic link. The base category for address characteristic type includes the following: non-residential only, description, assorted noncity-style with some U.S. Postal Service Delivery Sequence File (DSF), assorted noncity-style with all DSF, P.O. Box, rural route with some DSF, rural route with all DSF, and no addresses found. Other base categories include single-unit structure for housing structure type, no spring 2010 DSF flag for spring DSF flag type, and other source (mainly addresses in the Master Address File (MAF) prior to 2000) for address origin. The 1st-stage nondiscrepant response propensity is the predicted value for the housing unit from the 1st-stage regression corresponding to the source the propensity is being interacted with. A 10 percent random sample of housing units is drawn, and those housing units with a self-response are used in the regression. Predicted values are applied to all housing units. The standard errors are robust.

Appendix D: Fieldwork Response Quality Quasi-Likelihood Regressions

Table D1. Fieldwork Response Quality Quasi-Likelihood Regression with IRS 1040 Data

Variable	Coefficient	Standard Error
Deceased	0.424	0.022
Male	-0.028	0.003
Age 0-2	0.101	0.011
Age 3-17	-0.003	0.007
Age 18-24	-0.142	0.005
Age 45-64	0.046	0.004
Age 65-74	0.027	0.007
Age 75+	0.046	0.008
Hispanic	-0.134	0.004
African-American	-0.116	0.003
American Indian/Alaska Native	-0.101	0.012
Asian	-0.127	0.008
Native Hawaiian/Pacific Islander	-0.190	0.030
Some Other Race	-0.081	0.008
Multi-Race	-0.075	0.009
U.S. Citizen	-0.047	0.005
Legal Alien, Authorized to Work	-0.049	0.013
Legal Alien, Not Authorized to Work	0.046	0.032
Other Alien	0.082	0.052
Alien Student, Restricted Work Authorized	0.040	0.047
Conditionally Legalized Alien	-0.145	0.056
Ever Alien	-0.122	0.011
ITIN	-0.020	0.021
Married Filing Jointly	0.244	0.004
Married Filing Separately	0.103	0.009
Filing as Household Head	-0.022	0.004
Filing as Widow	0.132	0.041
Return Contains Schedule C	-0.026	0.005
Return Contains Schedule D	0.039	0.004
Return Contains Schedule E	-0.048	0.004
Return Contains Schedule F	0.003	0.012
Return Contains Schedule SE	-0.001	0.005
IRS Processing Week	-0.005	0.001
IRS Processing Week Squared	0.0002	0.00006
IRS Processing Week Cubed	-0.0000016	0.0000009
One PVSed Person	0.135	0.034
Two PVSed Persons	0.059	0.034

Three PVSed Persons	0.037	0.034
Four PVSed Persons	0.042	0.034
Five PVSed Persons	-0.056	0.034
Six PVSed Persons	-0.465	0.034
Seven or More PVSed Persons	-0.422	0.034
One Non-PVSed Record	-0.107	0.009
Two Non-PVSed Records	0.010	0.011
Three Non-PVSed Records	-0.164	0.020
Four Non-PVSed Records	-0.065	0.018
Five or More Non-PVSed Records	0.135	0.013
Dependent PIK Elsewhere for Non-Dependent PIK Here	-0.067	0.009
Non-Dependent PIK Elsewhere for Dependent PIK Here	-0.050	0.017
2008 IRS 1040 Return at HU	-0.097	0.003
Share of IRS 2008, 2009 PIKs in Both Years	0.269	0.003
Electronic Filer	-0.004	0.003
Number of Observations	1,837,972	

Notes: Sources include 2008-2009 IRS 1040 records, the 2010 Census Unedited File (CUF), and the 2010 Census Decennial Response File (DRF). This is a quasi-likelihood function using a binomial family variance with a logistic link. The base categories are 25-44 for age, white for race, missing citizenship for citizenship, and single filer for filing status. Dummy variables for missing gender, Hispanic origin, and race are also included. A 10 percent random sample of housing units with 2009 Internal Revenue Service (IRS) 1040 records is drawn, and of those that are also NRFU housing units are included in the regression. Predicted values are applied to all housing units with 2009 IRS 1040 records. A random sample is taken due to computer processing constraints. The standard errors are robust.

Table D2. Fieldwork Response Quality Quasi-Likelihood Regression with National Change of Address Data

Variable	Coefficient	Standard Error
Deceased	0.099	0.310
Male	0.024	0.002
Age 0-2	-0.124	0.019
Age 3-17	-0.027	0.007
Age 18-24	-0.141	0.002
Age 45-64	0.119	0.002
Age 65-74	0.247	0.005
Age 75+	0.416	0.005
Hispanic	-0.166	0.003
African-American	-0.137	0.002
American Indian/Alaska Native	-0.082	0.007
Asian	-0.153	0.005
Native Hawaiian/Pacific Islander	-0.199	0.018
Some Other Race	-0.107	0.005
Multi-Race	-0.075	0.006
Ever Alien	-0.124	0.005
ITIN	-0.592	0.009
One PVSed Person	-0.037	0.003
Two PVSed Persons	-0.022	0.003
Three PVSed Persons	-0.034	0.004
Four PVSed Persons	-0.053	0.005
Five or More PVSed Persons	-0.063	0.007
Number of Non-PVSed Records	-0.028	0.0008
Departure Address in April 2009	1.355	0.007
Departure Address in May 2009	1.312	0.007
Departure Address in June 2009	1.334	0.007
Departure Address in July 2009	1.348	0.007
Departure Address in August 2009	1.356	0.007
Departure Address in September 2009	1.410	0.007

Departure Address in October 2009	1.453	0.007
Departure Address in November 2009	1.498	0.007
Departure Address in December 2009	1.483	0.007
Departure Address in January 2010	1.492	0.007
Departure Address in February 2010	1.539	0.007
Departure Address in March 2010	1.410	0.007
Departure Address in April 2010	-0.576	0.008
Destination Address in April 2009	1.161	0.011
Destination Address in May 2009	1.228	0.011
Destination Address in June 2009	1.216	0.010
Destination Address in July 2009	1.200	0.010
Destination Address in August 2009	1.179	0.010
Destination Address in September 2009	1.157	0.010
Destination Address in October 2009	1.148	0.010
Destination Address in November 2009	1.135	0.011
Destination Address in December 2009	-0.275	0.010
Destination Address in January 2010	-0.333	0.010
Destination Address in February 2010	-0.349	0.010
Destination Address in March 2010	-0.428	0.009
Num. Moves, April 2009-March 2010	-0.085	0.001
Family Move	0.203	0.001
Undeliverable Flag F	0.384	0.019
Undeliverable Flag G	0.705	0.023
Undeliverable Flag K	-0.009	0.002
Changed Address (vs. Added Address)	-0.060	0.001
Number of Observations	7,669,545	

Notes: Sources include 2009-2010 NCOA records, the 2010 Census Unedited File (CUF), and the 2010 Census Decennial Response File (DRF). This is a quasi-likelihood function using a binomial family variance with a logistic link. The base categories are 25-44 for age, white for race, missing citizenship for citizenship, destination address in April 2010 for address, and added address for changed vs. added address. Dummy variables for missing gender, Hispanic origin, and race, as well as six citizenship categories are also included in the regression. Housing units with both 2010 NRFU fieldwork and 2009-2010 National Change of Address (NCOA) records are used in the regression. Predicted values are applied to all housing units with NCOA data. The standard errors are robust.

Table D3. Fieldwork Response Quality Quasi-Likelihood Regression with VSGI-NAR Data

Variable	Coefficient	Standard Error
Deceased	0.305	0.006
Male	0.009	0.002
Age 0-17	-0.229	0.011
Age 18-24	-0.119	0.006
Age 45-64	0.012	0.002
Age 65-74	0.111	0.004
Age 75+	0.170	0.004
Hispanic	-0.208	0.004
African-American	-0.216	0.003
American Indian/Alaska Native	-0.163	0.010
Asian	-0.173	0.006
Native Hawaiian/Pacific Islander	-0.273	0.024
Some Other Race	-0.145	0.006
Multi-Race	-0.124	0.008
Married	0.025	0.002
U.S. Citizen	-0.061	0.003
Legal Alien, Authorized to Work	-0.049	0.007
Legal Alien, Not Authorized to Work	0.022	0.021
Other Alien	0.043	0.032
Alien Student, Restricted Work Authorized	0.122	0.028

Conditionally Legalized Alien	-0.114	0.027
Ever Alien	-0.177	0.006
ITIN	-0.479	0.026
Income <$20,000	-0.049	0.005
Income $20,000-29,999	-0.071	0.004
Income $30,000-39,999	-0.060	0.004
Income $40,000-49,999	-0.067	0.004
Income $50,000-74,999	-0.058	0.004
Income $75,000-99,999	-0.038	0.004
Income $100,000-124,999	-0.034	0.004
Income $125,000-149,999	-0.010	0.006
Log Length of Residence	0.018	0.0008
Owner	0.097	0.002
Renter	0.002	0.004
Number of Persons	-0.003	0.002
One PVSed Person	-0.135	0.014
Two PVSed Persons	-0.118	0.015
Three PVSed Persons	-0.231	0.017
Four or More PVSed Persons	-0.290	0.018
One Non-PVSed Record	0.012	0.011
Two or More Non-PVSed Records	0.288	0.013
Number of Observations	3,378,193	

Notes: Sources include 2010 Veteran Service Group of Illinois Name and Address Resource Consumer file (VSGI-NAR) records, the 2010 Census Unedited File (CUF), and the 2010 Census Decennial Response File (DRF). This is a quasi-likelihood function using a binomial family variance with a logistic link. The base categories are 25-44 for age, white for race, missing citizenship for citizenship, $150,000 and above for income, and missing tenure for tenure. Dummy variables for missing gender, Hispanic origin, race, and length of residence are also included. A 20 percent random sample of housing units with VSGI-NAR records is drawn, and those housing units also with 2010 NRFU fieldwork are used in the regression. Predicted values are applied to all housing units with 2010 VSGI-NAR records. The standard errors are robust.

Table D4. Second-Stage Fieldwork Response Quality Quasi-Likelihood Regression

Variable	Coefficient	Standard Error
Update/Leave	0.261	0.004
Military	0.072	0.016
Urban Update/Leave	0.070	0.005
City-Style, No DSF	0.029	0.014
City-Style, some DSF	-0.051	0.010
City-Style, all DSF	-0.016	0.010
City-Style and Noncity-Style, no DSF	0.052	0.013
City-Style (95-99.99%) and Noncity-Style, some DSF	-0.039	0.011
City-Style (90-94.99%) and Noncity-Style, some DSF	-0.025	0.011
City-Style (85-89.99%) and Noncity-Style, some DSF	0.006	0.012
City-Style (80-84.99%) and Noncity-Style, some DSF	0.015	0.013
City-Style (75-79.99%) and Noncity-Style, some DSF	0.033	0.014
City-Style (70-74.99%) and Noncity-Style, some DSF	0.014	0.015
City-Style (<70%) and Noncity-Style, some DSF	0.094	0.012
Assorted Noncity-Style, No DSF	0.202	0.018
Mobile or Other Housing Structure	-0.042	0.003
2-4-Unit Housing Structure	-0.137	0.003
5-9-Unit Housing Structure	-0.098	0.004
10-19-Unit Housing Structure	-0.082	0.004
20-49-Unit Housing Structure	-0.040	0.004
50+-Unit Housing Structure	-0.025	0.003
Housing Unit Not in 2000 Decennial	-0.022	0.004
Housing Unit Unoccupied in 2000 Decennial	0.089	0.002

Spring 2010 DSF Deliverable Flag	0.113	0.012
Spring 2010 DSF X Flag	0.176	0.012
6-Month Periods Since Last DSF Deliverable Flag	0.004	0.0007
Never Had DSF Deliverable Flags	0.119	0.011
Had DSF Deliverable Flag Every Time Since Fall 2008	-0.005	0.005
2000 LUCA Address	0.022	0.005
Post-2000 LUCA Address	0.122	0.007
2010 Address Canvassing Address	-0.038	0.006
2010 Decennial Added Address	-0.433	0.007
Targeted Block, Additional Form Sent	-0.100	0.002
Targeted Block, Additional Form Not Sent	0.130	0.007
Block Blanketed with Second Forms	-0.106	0.002
Bilingual Form	-0.131	0.002
Business Address	0.645	0.017
Residential, Excluded from Delivery Statistics	0.329	0.008
Built After 2000	-0.054	0.027
Has Location Description in MAF	0.017	0.003
Missing DSF Route	0.143	0.010
MAF Valid Unit Status	-0.836	0.007
Mean Number of AR Addresses Per Person	-0.047	0.0006
HUD CHUMS Here	-0.678	0.093
HUD CHUMS Here* Quality Fieldwork Propensity	0.858	0.110
HUD PIC Here	-3.300	0.122
HUD PIC Here* Quality Fieldwork Propensity	4.132	0.148
HUD TRACS Here	-3.871	0.347
HUD TRACS Here* Quality Fieldwork Propensity	4.827	0.410
IRS1040 Here	-3.289	0.022
IRS1040 Here* Quality Fieldwork Propensity	3.977	0.027
IRS 1099 Here	-1.520	0.033
IRS 1099 Here* Quality Fieldwork Propensity	1.739	0.039
SSS Here	0.114	0.082
SSS Here* Quality Fieldwork Propensity	-0.208	0.099
Medicare Here	0.172	0.066
Medicare Here* Quality Fieldwork Propensity	-0.212	0.079
IHS Here	-1.965	0.381
IHS Here* Quality Fieldwork Propensity	2.256	0.455
NCOA Here	-0.546	0.003
NCOA Here* Quality Fieldwork Propensity	0.425	0.004
SSR Here	-1.367	0.083
SSR Here* Quality Fieldwork Propensity	1.576	0.102
NY SNAP Here	-2.405	0.142
NY SNAP Here* Quality Fieldwork Propensity	2.969	0.179
Texas SNAP Here	-3.576	0.143
Texas SNAP Here* Quality Fieldwork Propensity	4.325	0.178
Experian-EDR Here	-0.755	0.054
Experian-EDR Here* Quality Fieldwork Propensity	0.832	0.064
Experian-Insource Here	-0.420	0.037
Experian-Insource Here* Quality Fieldwork Propensity	0.449	0.043
InfoUSA Here	-0.746	0.032
InfoUSA Here* Quality Fieldwork Propensity	0.890	0.036
Melissa Here	-0.331	0.045
Melissa Here* Quality Fieldwork Propensity	0.381	0.053
Targus-Consumer Here	0.120	0.045
Targus-Consumer Here* Quality Fieldwork Propensity	-0.120	0.053
Targus National Address File Here	-1.020	0.108
Targus National Address File Here* Quality Fieldwork Propensity	1.218	0.125

Targus Wireless Here	-0.236	0.067
Targus Wireless Here* Quality Fieldwork Propensity	0.252	0.079
VSGI-NAR Here	0.109	0.049
VSGI-NAR Here* Quality Fieldwork Propensity	-0.096	0.058
VSGI-TRK Here	-0.226	0.044
VSGI-TRK Here* Quality Fieldwork Propensity	0.258	0.052
Corelogic Here	-2.049	0.054
Corelogic Here* Quality Fieldwork Propensity	2.423	0.062
Number of Observations	3,554,729	

Notes: Sources include all those listed in Table 1, the 2010 Census Unedited File (CUF), and the January 2011 Master Address File (MAF). This is a quasi-likelihood function using a binomial family variance with a logistic link. The base category for address characteristic type includes the following: non-residential only, description, assorted noncity-style with some Delivery Sequence File (DSF), assorted noncity-style with all DSF, P.O. Box, rural route with some DSF, rural route with all DSF, and no addresses found. Other base categories include single-unit structure for housing structure type, no spring 2010 DSF flag for spring DSF flag type, and other source (mainly addresses in the Master Address File (MAF) prior to 2000) for address origin. The 1st-stage vacant and delete status propensities are the predicted values for the housing unit from the 1st-stage regression corresponding to the source the propensity is being interacted with. A 10 percent random sample of housing units at risk of 2010 NRFU fieldwork is drawn, and those housing units also with no USPS Undeliverable as Addressed notification (UAA) and with 2010 NRFU fieldwork are used in the regression. The standard errors are robust.