Study of Error in Survey Reports of Move Month Using the U.S. Postal Service Change of Address Records

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Abstract

Correctly recalling where someone lived as of a particular date is critical to the accuracy of the once-a-decade U.S. Decennial Census. In the 2010 Census, all persons living in the U.S. were counted at the place they were living or staying as of Census Day, April 1, 2010. The data collection period for that census occurred over the course of a few months: February to August, with some evaluation operations occurring up to 11 months after Census Day in April. The assumption was that respondents could accurately remember moves and move dates on and around April 1st up to 11 months afterwards. Our research uses statistical models to investigate the validity of this assumption by comparing reports of move months in a U.S. Census Bureau survey with an administrative records database from the U.S. Postal Service containing requests to forward mail filed in March and April of 2010. We found some evidence that the length of time since the move affects memory error in reports of a move and the month of a move. Respondents were less likely to report a move when responding to a survey 10 to 11 months later than when responding to an identical survey either 2 to 3 months or 5 to 6 months later. However, the error in reporting a move did not differ when responding to a survey 5 to 6 months later compared to responding 2 to 3 months later. For movers, the analysis of the discrepancy between the reported move month and the NCOA record showed the length of time since the move had a similar effect on the error in the reports.

Key Words: administrative records, recall error, measurement error

1. Introduction

Accurately recalling the location where someone lived as of a particular date is critical to the accuracy of the once-a-decade United States decennial census. In the 2010 last census, all persons living in the U.S. were counted at the place they were living or staying as of Census Day, April 1, 2010. The data collection for that census took place over the course of a few months: February to August, with some evaluation operations occurring up to 11 months after Census Day in April. Respondents reported the required information for their households by mail or by speaking with an interviewer over the telephone or in person. For data collections occurring after Census Day, respondents often had to rely on their memory to determine where they were living on April 1. In part, the success of the census depended upon respondents recalling moves (for both themselves and others in their household) and move dates accurately because 11.6% of the population changed residences between January 1, 2010 and December 31, 2011 (U.S. Census Bureau, 2011). For the 2010 Census, the U.S. Census Bureau made the assumption that respondents could accurately remember moves and move dates on and around April 1st up to 11 months after April 1st. This paper reports the results of an investigation of the validity of this assumption.

Some survey methodologists also have made similar assumptions about the quality of respondents' recall of move dates. Move dates and places of residence often serve as anchors to aid memory of other events, particularly as part of the survey research technique that creates an event history (Belli, 1998). To our

[1] This report is released to inform interested parties and encourage discussion of work in progress. The views expressed on statistical, methodological, and operational issues are those of the authors and not necessarily those of the U.S. Census Bureau.

knowledge, the study of recall error associated with move dates is limited. Rubin and Baddeley (1989) and Huttenlocher, Hedges, and Bradburn (1990) investigated recall of dates, but not of migration dates.

Other researchers have studied recall error, called telescoping, where events are reported as happening either more recently than they actually happened (forward telescoping) or further back than they actually occurred (backwards telescoping). Researchers realize that recall errors occur in both directions and conduct studies aimed at determining whether the net effect of recall errors is zero or tends toward backward or forward telescoping (Neter and Waksberg 1964, Rubin and Baddeley 1989, Huttenlocher, Hedges, and Bradburn 1990, Janssen, Chessa, and Murre 2006). Much of the research has concluded that although there can be backwards telescoping, the net effect is more forward telescoping of events. This tendency is due to a variety of factors including weak bounding criteria, the inability to backward telescope future events, and the use of a less extensive retrieval process in the survey question. For example, the question: "How many times did you visit the doctor?" requires retrieving less precise information from memory than the question "What was the date of your last doctor's visit?" Responses to the first question tend to have more error than responses to the second question, which requires the respondent to think more to produce an answer. Many of these studies asked for recall periods of 2 months, or 4 months or slightly longer.

Janssen *et al.* (2006) found dates of events in the news that occurred 1000 days or more earlier were more likely to be telescoped forward; events that occurred between 100 to 1000 days earlier were more likely to be backwards telescoped; and no telescoping effect for reporting dates for recent events (those occurring less than 100 days ago).

The census and its evaluative operations need to accurately identify who lived at each address on April 1st. If telescoping the move month or forgetting to recall a move increases as the interview date gets farther away from the move, then data collected months after April 1st may be problematic. We investigate this question with thoughts to planning for the timing of nonresponse follow-up and evaluative operations for the 2020 Census.

The present study addresses this question by comparing survey responses of moves and move dates with an administrative records database from the U.S. Postal Service. The methodology uses logistic regression models and other analyses to investigate whether recall error increases as the length of time from the move increases. The standard of comparison, or control variable, for the analyses is the U.S. Postal Service National Change of Address (NCOA) files of requests to forward mail in March and April of 2010. We examine the accuracy of the reported move month and the direction of the error. Since the goal of the census is to count people at their residence on Census Day, April 1, 2010, we also investigate whether survey reports of a move month and the NCOA record are on the same side of Census Day (i.e., both before or both after), which affects whether a person is counted in the right location. In addition, we investigate error in reporting moves because the result of not reporting a move could be that the person is counted in the wrong location for the census.

2. Research strategy

The Census Bureau conducted a telephone survey, called the Recall Bias Study (RBS), as part of the research surrounding the 2010 Census (Linse, Pape, Rosenberger, and Contreras 2012). We used RBS data to study recall error for moves and move dates. One frame of the RBS consisted of records from an extract of the NCOA dated May 1, 2010. This file only contained records that had reported a change of address (moves) in either March or April of 2010 submitted by May 1, 2010. While it is possible these reported change of addresses do not necessarily imply an actual physical move from a housing unit to another, for our purposes they were classified as movers. Therefore, those who moved in March or April of 2010 but completed the USPS form after May 1 are not part of this analysis. A sample of the NCOA

records that met the conditions for the study was matched to a commercial database in May 2010 to obtain a telephone number for the address where the mail was forwarded. Addresses with telephone numbers in the file were assigned randomly to three RBS interview panels, corresponding to interview months. The timing for these interview panels approximated the timing of different census operations: June 2010, September 2010, and February 2011. Records with a telephone number were called for the RBS interview. Using AAPOR Response Rate 2 (American Association of Public Opinion Research 2011) that includes sample units of unknown eligibility in the denominator, response rates ranged from 63 to 69 percent.

The RBS instrument contained questions worded exactly as, or very similar to, the questions used in actual census operations. The instrument collected an independent roster of people currently living or staying in the contacted housing units and other addresses where a person could have been counted on or around Census Day, April 1, 2010. The respondent was a member of the current household who was 18 years or older. The respondents were asked if they or anyone in the household had moved to the address during 2010 and if so, to give the date the move occurred, including the month, day and year. These were household interviews where the respondent may or may not have been the person in the household whose name was on the NCOA form. Thus, the information collected could have been a self-report or a proxy report.

Our research strategy relies on assuming that the month on the NCOA form used to begin forwarding mail to the new address is the 'true' move month. With this assumption, we are able to study recall bias in the RBS by comparing the reported month of the move to the NCOA month. The difference in the reported month and the NCOA month provides data to look for patterns of forward or backwards telescoping. We used logistic regression models and a multinomial analysis to study the effects of the length of time between the "true" move and the survey interview, the respondent, and other characteristics of the move.

One characteristic that may affect recall of move month is whether the move was for a family or an individual, which was collected on the NCOA form. In a multi-person household, a proxy response by another household member who did not move may not be as accurate as a self-response. Another characteristic of the move that may affect recall is whether the move is temporary or permanent. The NCOA form asked whether the move was temporary or permanent.

3. Data limitations

RBS confronted some expected and some surprising challenges in creating a list of telephone numbers for interviewing and collecting the data. The original file from NCOA had 5.9 million records almost equally distributed between March and April (Diffendal and Moldoff 2010). Of these, about 4.3 million records had addresses that linked to addresses on the Census Bureau's Master Address File and were in the continental U.S. The restriction to the continental U.S. kept the sample cases within four time zones. An initial sample of 67,000 was selected using a sampling design that considered characteristics of the NCOA records including the distribution of month of move, ZIP Code, and whether the move was for an individual or for a family. In May 2010, the NCOA sample records were matched to a commercial database to retrieve telephone numbers. Of those, 18,324 successfully linked to telephone numbers at the forwarding address. For budget reasons, a sample of 13,500 (4,500 in each interview month) was selected to send to the call center for interviewing.

The response rates were 68.8% for the June interview month, 66.4% for the September interview month, and 63.4% for the February interview month (Linse *et al.* 2012). However, the respondents did not always report an address that corresponded to the forwarding or originating address on the NCOA record. In addition, many did not report a household member with the name that was on the NCOA record. Some of

the discrepancies may be due to matching errors that occurred when retrieving telephone numbers, such as linking the forwarding address to the telephone number of a former resident. Possibly a cause of some of the discrepancies is that people on the NCOA record moved again before the interview took place, and the link was to the older address since the retrieval of telephone numbers for all the interview months was done in May. In some cases, the person on the NCOA record appeared to have forwarded mail to an address other than where he/she was moving.

At the end of data collection, 3,424 RBS respondents reported an address and a household member with a name that matched the NCOA forwarding address and name. Of these, 1,968 respondents reported that the person whose name matched the NCOA name had stayed at a different address during 2010. Each of these people was assigned the status of Mover from one address to another or Cycler between multiple addresses based on the entirety of the interview and all the data collected. Of the 1,968 respondents, 1,740 reported a move to the NCOA forwarding address and the date of the move. We restricted our analyses to the datasets of size 3,424 and 1,740 to assure that the NCOA record and the RBS interview referred to the same person and the same move.

Our unit of analysis is the household. We assume that the responding households for each interview month constitute an independent random sample without replacement of the NCOA records in March and April 2010, and that non-respondents are missing at random. We used unweighted data in fitting the models because there are no population controls available for the subsets we employ in this population (Griffin 2011).

4. Analysis approach

Statistical models provide a useful tool for identifying characteristics that are associated with the accuracy in reporting a move and a move date. If a characteristic of a move is significant in a statistical model predicting the difference between the reported move month and the "true" move month, then there is an association between that characteristic and the response variable, defined in our study to reflect the presence of recall error. Our focus is on identifying whether the length of time since the move and other characteristics were associated with the accuracy of the RBS reported move month. Since the variables are categorical, we use the SAS procedure Logistic (SAS 2009) to fit the models.

In this paper, we first examine failure to report moves. Each person should be counted at his/her residence on April 1 for the census. If a person moves into the unit after April 1st, but before the census interview occurs and the respondent forgets to report this move in the interview, then the person can be counted in the wrong location. For this analysis, we fit a logistic model for the single response variable *Move* as follows:

Move = 1, if the RBS reported a move for the person on the NCOA record
0, if the RBS failed to report a move for the person on the NCOA record.

Next, we investigate whether there is any evidence of disagreement between the survey reports of move month and the NCOA records. For this analysis, we fit a logistic model for the variable *NoBias* as follows:

NoBias = 1, if the RBS reported move month is the same as the NCOA record
0, if the RBS reported move month is different from the NCOA record.

We recognize that many moves occur at the end of the month and some movers may have the forwarding of their mail start the last day of the month while their residency at the new location starts the first day of the next month. Therefore, we created a tolerance by defining a RBS response of one month and the

NCOA record having the last day of the previous month or the first day of the next month as agreeing (*NoBias=1*).

The variable *NoBias* indicates how accurate the RBS reported month is when compared to the NCOA month. However, the census and its evaluations want to know where the person lived on April 1, 2010. The reported move month could have some error but still accurately reflect whether the move was before or after a particular date. For example, if the "true" month of the move was February but the respondent reports March, the person will still be counted at the correct location as of April 1. However, if the true move month was February and the respondent reports May, then the person is counted in the wrong location. Therefore, we examine the error in reporting Census Day address by fitting a logistic model for the variable *SameSide* as follows:

SameSide = 1, if the RBS reported month and the NCOA month are both before, in, or after April
0, if the NCOA month is March and the RBS reported month is April or later, or the NCOA month is April and the RBS reported month is March or earlier.

We used the forward stepwise option in SAS procedure Logistic to fit the models for *Move, NoBias,* and *SameSide.* The independent variables we considered included:

- *Interview month*: June, August, February, which corresponds to length of time from Census Day – roughly, 2, 5 and 10 months from Census Day.
- *Respondent*: self-response or proxy response. A self-response occurred when the person on the NCOA record also answered the RBS questions. A proxy response occurred when someone else in the household answered the RBS questions for the person whose name was on the NCOA record.
- *Household type:* One-person household or multiple-person household as reported in the RBS interview.
- *Move Type,* a three-level variable that combines the household type and the number of people moving: One-person household, Individual move in a multi-person household, and Family move in a multi-person household. We created this variable using data from the RBS interview and the NCOA form.
- *Type-Respondent*, a three-level variable that combines the household type, the move type, and the type of respondent: Self response, proxy respondent in multi-person household where the NCOA record indicated a family move, and proxy respondent in a multi-person household where the NCOA record indicated an individual move. The last group we refer to as *Individual move proxies* within this paper.
- *Permanency of Move* as indicated on NCOA form: temporary or permanent
- *Duration of Move,* a two-level variable based on the RBS interview that indicates whether a person moved from one residence to another (Mover) or alternates between two or more residences (Cycler). (Defined only for households that report a move.)

For *Move*, the stepwise procedure selected the variables *Interview Month*, *Move Type,* and *Permanency of Move*. For both *NoBias* and *Sameside*, the stepwise procedure chose the variables *Interview Month* and *Move Type*. In these models, the reference levels categories were June for *Interview Month*, one-person household for *Move Type,* and permanent for *Permanency of Move*.

We use a different methodology to investigate whether the net effect of the time since the move on recall error tends to be backward or forward, or whether the errors tend to cancel out. To examine the direction of recall error, we define the variable *Recall bias* with three levels defined by whether the reported move month is the same as, before, or after the NCOA move month. We use the same tolerance in defining

agreement as before. In this study, the RBS reported month minus the NCOA month could only be a value between -3 and 9 because the RBS move month was allowed to be January through December 2010 and the NCOA or "true" move month was either March or April 2010. Therefore, we define the variable Recall Bias as follows:

Recall Bias = zero when the NCOA month and the RBS month are the same,
forwards when the RBS month minus the NCOA month ranges from 1 to 9,
backwards when the RBS month minus the NCOA month equals -1, -2, or -3.

Crossing the three-level *Recall Bias* variable by three-level *Type-Respondent* variable produces a variable with nine cells, which we can view as a 9-cell multinomial variable (Johnson and Kotz 1969). Then we can use the properties of a 9-cell multinomial distribution to compare two of those cells, backwards and forwards, separately for self-response, Family move proxies, and Individual move proxies. However, our focus is to examine the direction of the recall error for self-responses by movers and proxy responses from household members who were not movers themselves. Therefore, we do not analyze the category for Family move proxy because some of these respondents moved with the person named on the NCOA record and some did not, and we cannot identify which is which.

To compare the observed probabilities of the backwards and forwards cells across the three interview months, we analyze the conditional probabilities of backwards and forwards conditional on the type of respondent. The reason for conditioning on the type of respondent is that the distribution of the type of respondent is different in each interview month. When we condition on self-reports and n is the number of self-reports in an interview month, we have a 3-cell multinomial in each interview month where n_b, n_z, and n_f denote the number of observations of backwards telescoping, zero error, and forwards telescoping, respectively, where $n = n_b + n_z + n_f$ (Johnson and Kotz 1969). The estimated conditional probabilities of backwards telescoping $p_b = n_b/n$. The estimated conditional probabilities of zero error, p_z, and forwards telescoping, p_f , are defined in an analogous manner. The estimated variance of the difference in the estimated conditional probabilities p_b, - p_f is given by

$$Var(p_b - p_f) = Var(p_b) + Var(p_f) - 2Cov(p_b, p_f)$$
$$= \frac{p_b(1-p_b)}{n} + \frac{p_f(1-p_f)}{n} - 2\frac{p_b p_f}{n}.$$

The same approach may be used to estimate the difference in the observed conditional probabilities of backwards and forwards telescoping for Individual move proxies.

5. Results

For our analysis, we first examine error in reporting a move by fitting a logistic regression model for the variable *Move*. Next, we examine the accuracy of the reporting of move month by fitting a logistic regression model for *NoBias*. Then we examine the effect of errors in reporting the move month on the accuracy of the reporting of Census Day residence by fitting a logistic regression model for *SameSide*. To study the direction of the recall error in move month, we use the variables *Type-Respondent* and *Recall Bias* and the properties of a multinomial distribution. We want to examine whether the net effect of the errors tends to be zero or whether there is a greater tendency for respondents to report the move as being either before or after the NCOA month.

5.1 Model for *Move*

We study the accuracy of survey reports of a move by fitting a logistic regression model for the variable *Move* using the 3,424 RBS respondents who reported an address and a household member with a name

that agreed with the NCOA forwarding address and name. The distribution of the respondents across months is 1,342 in June; 1,182 in September, and 900 in February. Although the forward stepwise procedure selected *Permanency of Move* as one of the variables and it was significant, we found the model fit with *Permanency of Move* produced a few large residuals and a residual pattern that indicated a need for interaction terms. Closer inspection revealed that the number of observations in the cells were small for *Permanency of Move=Temporary*, with the smallest having only 16 observations. The small cell sizes exacerbated by counter-intuitive results led us not to have confidence that the interactions would represent real effects. Therefore, we did not include *Permanency of Move* in our analysis. The results for *Interview month* and *Move type* are the essentially the same whether or not *Permanency of Move* is included in the model.

Table 1 shows the estimates of variables in the model for *Move* and their p-values. An examination of the showed that hover around zero, although the residual for one-person households in February is a little larger which we attribute to the smaller sample of reported moves for that cell. Table 2 shows further evidence of a good fit of the model for *Move* by displaying the general agreement between of the means of observed and estimated probabilities calculated within four ranges of the estimated probabilities.

Table 1. Results for logistic model for *Move*.

Parameter		Estimate	St. Error	Chi-Square	Pr >ChiSq
Intercept		0.542	0.121	20.170	<0.001
Interview month	Sept	-0.082	0.083	0.976	0.323
	Feb	-0.507	0.089	32.518	<0.001
Move type	Family	0.342	0.124	7.590	0.006
	Individual	-0.488	0.123	15.755	<0.001

Source: Recall Bias Study analysis file. n=3,424; AIC = 4511.99; Concordance = 55.7%

Table 2. Comparison of the means of observed and estimated probabilities of reporting a move (*Move*) calculated within four ranges of the estimated probability

	p < 0.49	0.49 <= p < 0.52	0.52 <= p < 0.64	p >= 0.64
No. of obs.	445	1175	629	1175
observed	0.3865	0.5081	0.5946	0.7702
estimated	0.3886	0.5041	0.6052	0.7696

Since the model in Table 1 shows an association between *Move* and the variables *Interview Month* and *Move Type*, we explore the differences in the observed probabilities of accurately reporting a move between the levels of these variables to examine the net effect on recall error. For *Interview Month*, Table 3 shows the probabilities of accurately reporting a move in June at 0.616, September at 0.596, and February at 0.484 with standard errors of 0.013, 0.014, and 0.017, respectively. Table 3 shows the difference between the probabilities of responding accurately in June and September is 0.020 with a p-value of 0.309. Therefore, the data indicates no difference between the accuracy of reports by March and April movers answering in June and those answering in September. Table 3 also shows he difference between the observed probabilities for February and June is 0.132 with a p-value < 0.001, and the difference between the observed probabilities for September and February is 1.112 with a p-value <0.001. Therefore, the data indicates that March and April movers are less likely to report a move 10 to 11 months after a move than 2 to 3 months afterwards and less likely to report a move 10 to 11 months after a move than 5 to 6 months afterwards.

Table 3. Observed estimates of probabilities of reporting a move (*Move*) by *Interview Month* and estimates of the difference between months

	Estimate	St.Error	p-value
Interview Month			
June	0.616	0.013	-
Sept	0.596	0.014	-
Feb	0.484	0.017	-
Difference in Interview Months			
June - Sept	0.020	0.019	0.309
June - Feb	0.132	0.021	<0.001
Sept - Feb	0.112	0.022	<0.001

Source: Recall Bias Study analysis file.

Our next examination assesses the effect of the levels of the variable *Move Type* on accurately reporting a move. Table 4 shows the probabilities of accurate reports are 0.674 for a Family move, 0.470 for an Individual move, and 0.595 for a move by a One-person household with standard errors of 0.012, 0.013, and 0.027, respectively. The difference between the observed probabilities of reporting Family move and a move by a One-person household is 0.079 with a p-value of 0.007 indicating that Family moves are more likely to be reported than a move by a One-person household. The difference between the observed probability of reporting a Family move and an Individual move is 0.204 with a p-value < 0.001 indicating that Family moves are more likely to be reported than an Individual move in a multi-person household. The difference in the probability of reporting a move for an Individual move and a One-person household move is 0.125 with a p-value < 0.001 indicating that an Individual move is less likely to be reported than a One-person household move.

Table 4. Observed estimates of probabilities of reporting a move (*Move*) by *Move Type* and estimates of the difference between move types

	Observed	St.Error	p-value
Move Type			
Family	0.674	0.012	-
Individual	0.470	0.013	-
1-Person	0.595	0.027	-
Difference in Move Types			
Family - Individual	0.204	0.017	<0.001
Family - 1-Person	0.079	0.029	0.007
1-Person - Individual	0.125	0.030	<0.001

Source: Recall Bias Study analysis file

5.2 Model for *Nobias*

The model for *NoBias* examines variables associated with accuracy in reporting a move month. Table 5 shows the results of the logistic model for *NoBias* using the independent variables *Interview month* and *Move Type* based on the 1,740 RBS responses that reported a move to the NCOA forwarding address with the date and included a person with the name on the NCOA record in the household. The distribution of the responses across interview months is 760 in June; 611 in September, and 369 in February. An examination of the residuals showed that they are close to zero, but are larger for the estimates for One-person household, which we attribute to the cells for One-person households being the smallest each

month, having about 10 percent of the observations. Table 6 shows further evidence of a good fit of the model for *NoBias* by displaying the general agreement between of the means of observed and estimated probabilities calculated within four ranges of the estimated probabilities.

Table 5. Results for logistic model for *NoBias*

Parameter		Estimate	St.Error	Chi-Square	Pr> ChiSq
Intercept		1.776	0.211	70.653	<.0001
Interview month	Sept	-0.200	0.127	2.491	0.115
	Feb	-0.585	0.140	17.441	<.0001
Move type	Family	-0.434	0.213	4.169	0.041
	Individual	-0.880	0.216	16.585	<.0001

Source: Recall Bias Study analysis file. n=1,740; AIC = 1991.8; Concordance = 52.5%

Table 6. Comparison of Observed and Estimated probabilities of reported move month agreeing with NCOA move month (*NoBias*) by ranges of the estimated probability

	p < 0.65	0.65 <= p < 0.72	0.72 <= p < 0.80	p >= 0.80
No. of obs	140	676	785	139
observed	0.6071	0.6820	0.7720	0.8705
estimated	0.5771	0.6886	0.7766	0.8423

Since the model in Table 5 shows an association between *NoBias* and the variables *Interview Month* and *Move Type*, we explore the differences in the observed probabilities of agreement between the reported and NCOA move month among the levels of these variables to examine the net effect on recall error. For *Interview Month*, Table 7 shows the probabilities of the reported move month agreeing with the NCOA month are 0.768 in June, 0.735 in September, and 0.650 in February with standard errors of 0.015, 0.018, and 0.025, respectively. The difference in the observed probabilities for September and June is 0.034 with a p-value of 0.154 and the difference between the probabilities for February and June is 0.118 with a p-value less than 0.001. The difference between the probabilities for September and February is 0.085 with a p-value of 0.006. Therefore, the evidence indicates that March and April movers are less likely to report an accurate move month 10 months after Census Day than 2 months afterwards, and are less likely to report an accurate move month 10 months after Census Day than 5 months afterwards. The model confirms that the data does not detect a difference in accuracy of responses between 2 and 5 months after Census Day and that the error in the recall of the move month increases between 5 and 10 months after Census Day.

Next, we examine the effect of the levels of *Move Type* on the agreement between the reported move month and the NCOA move month. Table 8 shows the observed probabilities of agreement are 0.757 for a Family move, 0.666 for an Individual move, and 0.826 for a move by a One-person household with standard errors of 0.014, 0.019, and 0.028, respectively. The difference in the probabilities for a Family move and an Individual move is 0.091 with a p-value less than 0.001. The difference in the probabilities for Individual move and a One-person household move is -0.068 with a p-value of 0.031 while the difference in the probabilities for a Individual move and a One-person move is -0.160 with a p-value less than 0.001. These results indicate that agreement between the reported and NCOA move months is more likely for a One-person household move than a Individual or Family move. Also, agreement in reported and NCOA move months is more likely for moves by a Family than moves by an Individual in a multi-person household.

Table 7. Observed estimates of probabilities of reported move month agreeing with NCOA move month (*NoBias*) by *Interview Month* and estimates of the difference between months

	Observed	St.Error	p-value
Interview Month			
June	0.768	0.015	-
Sept	0.735	0.018	-
Feb	0.650	0.025	-
Difference in Interview Months			
June - Sept	0.034	0.024	0.154
June - Feb	0.118	0.029	<0.001
Sept - Feb	0.085	0.031	0.006

Source: Recall Bias Study analysis file

Table 8. Observed estimates of probabilities of reported move month agreeing with NCOA move month (*NoBias*) by *Move Type* and estimates of the difference between move types

	Observed	St.Error	p-value
Move Type			
Family	0.757	0.014	-
Individual	0.666	0.019	-
1-Person	0.826	0.028	-
Difference in Move Types			
Family - Individual	0.091	0.023	<0.001
Family - 1-Person	-0.068	0.032	0.031
Individual - 1-Person	-0.160	0.034	<0.001

Source: Recall Bias Study analysis file

5.3 Model for *SameSide*

We fit a logistic regression model for the variable *SameSide* using the same 1,740 responses used in fitting the model for *NoBias*. Table 9 shows the estimates of the model parameters and their p-values. The variables *Interview month* and *Move Type* had a significant effect on whether the RBS reported month and the NCOA record month were on the same side of Census Day, both having a p-value less than 0.001. An examination of the residuals showed that they are very small but are slightly larger for One-person households, which we attribute to the cells for One-person households being the smallest each month, having about 10 percent of the observations. Table 10 shows further evidence of a good fit of the model for *SameSide* by displaying the general agreement between of the means of observed and estimated probabilities calculated within four ranges of the estimated probabilities.

Since there is an association between *SameSide* and the variables *Interview Month* and *Move Type*, we explore the differences in the observed probabilities of agreement between the reported and Census Day residence among the levels of these variables to examine the net effect on recall error. For *Interview Month*, Table 11 shows the probabilities of agreement between the reported and NCOA Census Day residence are 0.850 in June, 0.854 in September, and 0.783 in February with standard errors of 0.013, 0.014, and 0.021, respectively. The difference in the probabilities of agreement between the reported and NCOA Census Day residence for September and June is -0.004 with a p-value of 0.823, and the difference June and February is 0.067 with a p-value of 0.008. Therefore, there is no evidence that the responses from March and April movers are more or less likely to be on the same side of April 1when the

elapsed time is five months after Census Day than two months afterwards. However, the evidence indicates that 10-month retrospective reports are less likely to be on the same side of April 1 than 2-month retrospective reports. The difference between the probabilities for September and February is 0.071 with a p-value of 0.006. This evidence indicates that responses from March and April movers are more likely to be on the same side of Census Day five months retrospectively than 10 months retrospectively. These differences indicate that there would not be any more error in enumeration for movers five months after Census Day than there was two months after Census Day; however, there would be more error in enumeration of movers 10 months after Census Day. This type of evidence raises a concern for the Census and its evaluations if they are conducted more than six months after Census Day.

Table 9. Results for logistic model for *SameSide*

Parameter		Estimate	St.Error	Chi-Square	Pr> ChiSq
Intercept		2.231	0.257	75.289	<.0001
Interview month	Sept	0.019	0.154	0.015	0.902
	Feb	-0.452	0.163	7.679	0.006
Move Type	Family	-0.353	0.261	1.837	0.175
	Individual	-0.777	0.263	8.744	0.003

Source: Recall Bias Study analysis file. n = 1,740; AIC = 1530.9; concordance = 51.1%

Table 10. Comparison of Observed and Estimated probabilities of reported Census Day residence agreeing with NCOA Census Day residence (*SameSide*) by ranges of the estimated probability

	p < 0.80	0.80 <= p < 0.86	0.86 <= p < 0.90	p >= 0.90
No. of obs	140	715	746	139
observed	0.7429	0.8084	0.8686	0.9137
estimated	0.7316	0.8125	0.8684	0.9038

Table 11. Observed estimates of probabilities of reported Census Day residence agreeing with NCOA Census Day residence (*SameSide*) by *Interview Month* and estimates of the difference between months

	Observed	St.Error	p-value
Interview Month			
June	0.850	0.013	-
Sept	0.854	0.014	-
Feb	0.783	0.021	-
Difference in Interview Months			
June - Sept	-0.004	0.019	0.823
June - Feb	0.067	0.025	0.008
Sept - Feb	0.071	0.026	0.006

Source: Recall Bias Study analysis file.

Next, we examine the net effect of the levels of the variable *Move Type* on the agreement between the reported Census Day address and the NCOA Census Day address. Table 12 shows the observed probabilities of agreement are 0.856 for a Family move, 0.794 for an Individual move, and 0.893 for a move by a One-person household with standard errors of 0.011, 0.016, and 0.023, respectively. The difference in the probabilities for a Family move and Individual move in a multi-person household is 0.062 with a p-value of 0.002. Therefore, the evidence indicates the survey reports and the NCOA records

are more likely to agree on Census Day residence for a Family move than those where an Individual in the household moves. The difference between the probabilities for Individual move in a multi-person household versus One-person household move is 0.099 with a p-value less than 0.001 indicating agreement between reported and NCOA Census Day address is less likely for a move by an Individual in a multi-person household than for a move by a One-person household. The difference in the probability for a Family move and a One-person household move is 0.037 with a p-value of 0.147 indicating there is no evidence that survey reports and the NCOA records for Family moves are more or less likely to be on to agree on Census Day residence than those for One-person household moves.

Table 12. Observed estimates of probabilities of reported Census Day residence agreeing with NCOA Census Day residence (*SameSide*) by *Move Type* and estimates of the difference between move types

	Observed	St.Error	p-value
Move Type			
Family	0.856	0.011	-
Individual	0.794	0.016	-
1-Person	0.893	0.023	-
Difference in Move Types			
Family - Individual	0.062	0.020	0.002
Family - 1-Person	0.037	0.026	0.147
Individual - 1-Person	0.099	0.028	<0.001

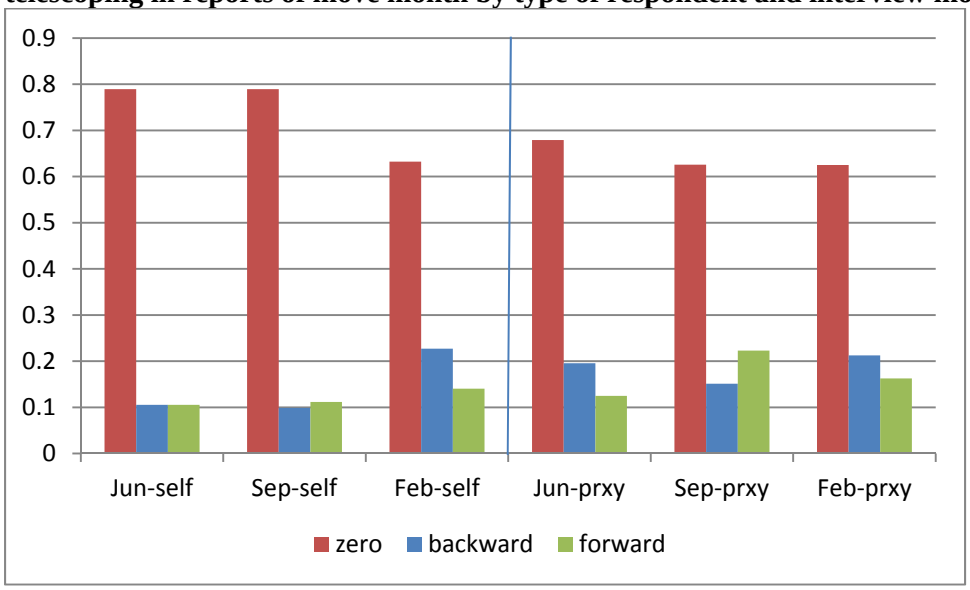
Source: Recall Bias Study analysis file

5.4 Analysis of *Recall Bias*

Now we turn our attention to investigating whether the net effect of recall error in move month tends to be backwards or forwards as the time since the move increases, or whether the errors tend to cancel each other out. For this analysis, we use the 1,253 self-responses or Individual move proxies of the 1,740 observations that included a person with the name on the NCOA record in the household and reported a move to the NCOA forwarding address along with the date. We excluded family moves where the respondent was not the person on the NCOA record from the model. If they were a mover, their report would be a self-report; if they were not a mover, their report would have been a proxy report. To eliminate the possible noise in the data due to the situation, we excluded these moves. The distribution of the responses across interview months is 362 self-responses and 184 Individual move proxies in June; 304 self-responses and 139 Individual move proxies in September, and 185 self-responses and 80 Individual move proxies in February. Figure 1 provides some insight by showing a bar graph of the estimated conditional probabilities by type of respondent and interview month.

Figure 1 shows that self-responses appear to have a different telescoping pattern than the Individual move proxies. The observed forwards and backwards probabilities for self-responses are very close to each other and stable two and five months after Census Day. Then both observed probabilities increase 10 months after Census Day, but the observed backwards probability has a larger increase. There is no logical pattern between observed forwards and backwards probabilities for the Individual move proxies as time passes from June to September to February. Individual move proxies appear to have more inherent variability than self-responses.

Figure 1. Observed Conditional Probabilities of backwards telescoping, zero error, and forwards telescoping in reports of move month by type of respondent and interview month



Source: Recall Bias Study analysis file.

Table 13 shows the results for comparing the observed probabilities for backward and forward telescoping and their differences by *Interview month* separately for self-responses and Individual move proxies.

Table 13. Estimates of conditional probabilities of backward and forward telescoping and their differences by *Interview month* for self-responses and Individual move proxies

Interview month	backward	St. error	forward	St. error	difference	St. error	p-value
Self-response							
June	0.105	0.016	0.105	0.016	0	0.021	1.000
Sept	0.099	0.017	0.112	0.018	-0.013	0.023	0.575
Feb	0.227	0.031	0.141	0.026	0.087	0.035	0.015
Individual move proxy							
June	0.196	0.029	0.125	0.024	0.071	0.034	0.040
Sept	0.151	0.030	0.223	0.041	-0.072	0.041	0.080
Feb	0.213	0.046	0.163	0.054	0.050	0.106	0.356

Source: Recall Bias Study analysis file.

For self-responses by March and April movers, we compare the observed probabilities of backward to forward telescoping for each interview month by calculating the difference. We see that the difference in the direction of the errors in June and September is not significant, implying the errors offset each other two months or five months after Census Day. However, the data indicate that backward telescoping is greater than forward telescoping in February. Therefore, by 10 months after Census Day, backwards telescoping is not offset by forward telescoping.

Next, for Individual move proxies for March and April movers, we compare the difference in the conditional probabilities of backward and forward telescoping for each interview month. We see that the difference in the direction of the errors is significant two months after Census Day indicating backward

telescoping is greater than forward telescoping. However, by five months after Census Day, there is weak evidence that the opposite is true, forward telescoping is larger than backward telescoping. Then by 10 months after Census Day, the difference between the conditional probabilities of backwards and forwards telescoping is not significant. In our view, the data do not present a well-defined pattern over the studied period. Possibly a pattern would have emerged if there had been a larger number of Individual move proxies among the interviews collected in September and February.

6. Summary

The analyses showed the length of time since the move and the move type affect the accuracy of survey reports of a move and the reported move month. When viewing the results, one must be mindful of the limitations in using NCOA file as a source for movers as well as the limitations of the data collection in this study. The NCOA file has undercoverage in that many movers do not file a request to forward mail. Since the RBS asked only about moves in 2010, our use of the 2010 NCOA records may result overcoverage because some people may have moved prior to January 1, 2010 but waited to file a NCOA request until March or April of 2010. Even when a forwarding request is filed at the time of a move, people may forward mail to one address but move to another. Only 20% of addresses link to a telephone number even though check with Census Bureau files showed these addresses were residential. In spite of the data limitations, the results of this analysis contribute to the knowledge regarding the accuracy of survey reports of moves and the nature of the recall error.

The effect of the length of time since the move affected the variables of interest in somewhat different ways. Respondents were less likely to report a move when responding to a survey 10 to 11 months later than when responding to an identical survey either 2 to 3 months or 5 to 6 months later. However, the error in reporting a move did not differ when responding to a survey 5 to 6 months later compared to responding 2 to 3 months later. For movers, the analysis of the discrepancy between the RBS reported move month and the NCOA record showed no significant difference in error in reports of move month given 2 to 3 months after the move and 5 to 6 months afterwards. The error in the reported move month increased between 5 to 6 months and 10 to 11 months after the move.

Similarly, the analysis of *SameSide* did not detect a difference in the odds of accurate reports of the address where respondents lived on Census Day given by March and April movers 2 months after Census Day versus 5 months afterwards. On the other hand, 10 months after Census Day, reports of Census Day address had more error than those 2 or 5 months after Census Day. The observed estimate of error in Census Day address for movers for both 2 and 5 months after Census Day was 15%, with a standard error of 1%. However, 10 months after Census Day, the observed estimate of error for movers was 50% higher at 22%, with a standard error of 2%.

The type of move affected the accuracy of reporting moves and the accuracy of the reported move month. Respondents for family moves and one-person household moves were more likely to report a move than were respondents in households where only an individual member moved. In multi-person households, moves by an individual household member were less likely to be reported than a family move. Although family moves are more likely to be reported than one-person household moves, when they are reported, one-person household move dates are more accurate than family move dates. Among movers, respondents for family moves and one-person household moves were more likely to give accurate reports of the move month than were respondents for households where another individual moved. The same pattern held when we considered the accuracy of the reporting of Census Day residence. There was no evidence of a difference in accuracy of Census Day residence from reports for a family move than from a one-person household, but both family moves and one-person household moves were more likely to have an accurate Census Day residence than individual household member moves.

When we examined the direction of the error in the reported move month, we found that the errors in self-reports tended to offset each other for reports 2 to 3 months after the move and 5 to 6 months afterwards. However, when self-reports were 10 to 11 months after the move, there was more backwards than forwards telescoping. A trend for the direction of the recall error did not emerge for Individual move proxies over the period studied, likely due to a smaller number of observations in this category.

Our results find backwards telescoping but differ somewhat from Janssen *et al.* (2006) about when the backwards telescoping begins. We did not detect a telescoping effect for RBS self-reports of move month 60 to 90 days or 150 to 180 days after a move although we did detect backward telescoping 300 to 330 days after the move. Janssen *et al.* (2006) detected backward telescoping 100 to 1,000 days after the move and no telescoping effect less than 100 days after an event.. The two studies interviewed different populations and used different questionnaires, both of which could account for the differences in the beginning of backwards telescoping. Possibly the design of the RBS questionnaire was effective in aiding recall enough to extend the length of time before backwards telescoping began. Further research is needed to determine whether the beginning of backwards telescoping varies by the characteristics of the respondent, the nature of the event, length of time since the event, and the design of the questionnaire. With more knowledge about factors that influence the beginning of backwards telescoping, researchers will be able to design surveys in a manner that reduces the effect of recall error on results.

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