Appendix 2. Detailed Methodology

Our focus is on identifying which variables are associated with the accuracy of the RBS reports of a move and move month. In this appendix, we define the variables we used to reflect presence of recall error and covariates. Our methodology used statistical tests to compare observed probabilities of accurate reports in binomial and multinomial analyses.

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. In addition, we assume that non-respondents are missing at random although there is no way to tell if this assumption is plausible. We use unweighted data in our analyses because there are no population controls available for the subsets we employ in this population (Griffin 2011). The data loss and lack of population controls compromises the ability to make inferences to the larger population. However, in spite of the limitations of our dataset, we believe that our approach and results could be informative for future studies of memory error and for census and survey planning and research.

A2.1 Presence of recall error

First, we 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. Using the dataset with the 3,424 interviews where the respondent reported the name and address on the NCOA file, we analyze the response variable *Move* defined 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. Using the dataset with 1,740 interviews where the respondent reported a move to the NCOA address and a date of the move, we analyze the response variable *NoBias* defined 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, using the same dataset as used for *NoBias*, we examine the error in reporting Census Day address by analyzing the variable *SameSide* defined 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.

For all three analyses, we wanted to study whether the accuracy of the reports regarding moves was affected by the length of time since the move, the respondent, and the type of move. The definition of *Respondent type* was motivated by the desire to separate the respondents who reported their own moves (self-response) from respondents reporting about a move made by another household member (proxy response). A respondent whose name was on the NCOA was called a *Self* respondent regardless of the size of the household. If the NCOA form said the move was for a family and the respondent's name was not on the NCOA form, it was called a *Family other* response. Keep in mind that even though the NCOA form indicated a family move, we do not have independent verification of which members in the household made the move. If the NCOA form said the move was for an individual, a respondent whose name was not on the NCOA form was called an *Individual proxy*.

Chi-square tests showed there is a statistical relationship between *Interview month* and *Respondent type* and each of the three variables, *Mover*, *NoBias*, and *SameSide*. Even so, we did preliminary analyses to confirm the strength *Interview month* and *Respondent type* in explaining differences in accuracy of the survey reports. To check on whether other reasonable variables had greater or complementary explanatory power to *Interview Month* and *Respondent type*, we used the forward stepwise option in SAS procedure Logistic (2009) to fit the models for *Move, NoBias,* and *SameSide.* The independent variables we considered were:

- *Household type:* One-person household or multiple-person household as reported in the RBS interview.
- *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.)

The stepwise procedure chose the variables *Interview month* and *Respondent type,* for all three variables, *Move*, *NoBias* and *Sameside*. Although *Household type* also entered for *NoBias*, and *Permanency of Move* entered for *Move*, none of the candidate independent variables entered for all three dependent variables. Upon further examination, we found small cells that led us to doubt the explanatory power of *Household type* and *Permanency of Move* and decided not to

include them in our analyses. We also included interactions in the stepwise procedures but they were not selected.

The analyses of the variables *Move*, *NoBias*, and *Sameside* rely on the properties of the binomial distribution since each takes the values *0* or *1*. Using *Move* as an example, let n_J , n_S , and n_F be the number of observations in June, September, and February, respectively. For June, n_{J1} equals the number of respondents who report a move and n_{J0} equal the number not reporting a move, so that $n_J = n_{J1} + n_{J0}$. Analogous definitions hold for n_{S1} and n_{S0} for September and n_{F1} and n_{F0} for February. The observed probability of reporting a move (*Move=1*) in June p_{J1} equals n_{J1}/n_J while the comparable observed probability for September p_{S1} equals n_{S1}/n_S and for February p_{F1} equals n_{F1}/n_F. To examine the effect of the length of time since the move on the accuracy of the reports of a move, we calculate the difference in observed probabilities of reporting a move. For example, the difference between June and September is $(p_{J1} - p_{S1})$ and the estimated variance of the difference is given by

$$V(p_{J1} - p_{S1}) = p_{J1},(1- p_{J1},)/n_J + p_{S1}(1- p_{S1})/n_S,$$

The calculations are analogous for comparisons of observed probabilities between other pairs of interview months. In addition, the approach holds for investigating the effect of the length of time on the accuracy of reports of move month (*NoBias=1*) and on reports of Census Day residence (*SameSide=1*). To examine the effect of the type of respondent on the accuracy of the reports of a move and move month, we apply the same approach to the differences in observed probabilities of reporting correctly between the levels of the variables *Respondent type*.

A2.2 Direction of recall error

We use a different methodology to investigate the net effect of the time since the move on recall error. To examine the net effect and 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 allowed the reporting of a move between 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.

To study the direction of recall error, we use the *Respondent type* variable defined in the previous section. Crossing the three-level *Recall Bias* variable by three-level *Respondent type* 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 other* respondent, and *Individual proxies*.

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 is $p_b = n_b/n$. 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 Family other and Individual proxy respondents. When conditioning on the level of *Respondent type*, a chi-square test found a statistical relationship between *Interview Month* and *Recall Bias* for *Self* and *Family other* levels, but not for the *Individual proxy* level. However, the analysis of *Recall Bias* in Section 4.4 includes the data for *Individual proxies* for completeness.

To study the direction of the recall error in move month, we use the variables –*Respondent type* 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. The analyses include the Holm adjustment of the p-values for 29 hypothesis tests. Our discussion uses the significance level of 0.10 for the adjusted p-values. For the chi-square tests, both the initial and the adjusted p-values are presented because the initial values provided the basis for decisions on whether to proceed with further tests. Since the differences in probabilities for the levels of the variables can be positive or negative, the p-values are two-sided.