24th International Workshop on Household Survey Non-response,
4– 6 September 2013, London

THE 2011 CENSUS NON-RESPONSE LINKED STUDY

Neil A. Hopper and Karl Ashworth.
Office for National Statistics, UK

Background: Non-response in social surveys has two consequences for statistical inference. Firstly, it reduces the effective sample size and secondly, unless non-response occurs completely at random, it introduces bias.

Assessment of non-response bias requires inference of the survey measure of the non-respondents. As survey data are unavailable for non-respondents, this is usually achieved through use of external auxiliary data that is known for all members of the population, both respondents and non-respondents. The stronger the relationship between the auxiliary variable and the survey measure, the more effective weighting by the auxiliary variable will be at eliminating non-response bias. However, as the relationship between the auxiliary variable and the survey measure can vary for each target variable, the common approach is to produce a single general weight through the use of auxiliary variables that have a strong association with non-response.

The actual impact of non-response weighting depends on the relationship between the auxiliary variable and both response and the survey measure (table 1). Weighting by an auxiliary variable that is highly correlated with the survey measure carries little risk: even if the auxiliary variable is not correlated with response propensity, variance may be reduced. However, concentrating on auxiliary variables that explain response can be risky. Unless the auxiliary variable shows a high correlation with the survey measure also, weighting by auxiliary variables may increase variance with little impact on bias. This suggests that the assessment of non-response bias requires an analysis of the association of the auxiliary variable with both the response propensity and the survey measure.

Table 1: The effect of applying non-response weights based on an auxiliary variable (X) depends upon its association with both the response (R) and the survey measure (Y).

	Low association (*X,Y*)	High association (*X,Y*)
Low association (*X,R*)	Little effect on bias and variance	Little effect on bias, variance reduction
High association (*X,R*)	Little effect on bias, but variance inflation	Bias and variance reduction

Adapted from Zhang *et al*., 2013.

From a field perspective, the stronger the relationship of the auxiliary variable to the survey response, the more field resources can be targeted to reduce non-response, assuming the auxiliary data can be linked to the frame.

Few auxiliary variables are available in the UK for household based social surveys. In a social survey, the address of all the sampled units is known and so auxiliary variables whose values can be determined from addresses are potentially attractive. One such source is the decennial census, which collects information from all households and can be used to provide auxiliary information about survey respondents and non-respondents (though estimation is also limited by the census response rate). The Office for National Statistics (ONS) has carried out census-linked studies of survey non-response (CNRLS) following all censuses since 1971 (Foster, 1998; Freeth and Sparks, 2003). For the 2011 CNRLS, six surveys were analysed:

Crime Survey for England and Wales (CSEW)
Living Costs and Food Survey (LCF)
Life Opportunities Survey (LOS)
General Lifestyle Survey (GLF)
Labour Force Survey (LFS)
Opinions Survey (OPN)

There are three main areas of the 2011 CNRLS that we wish here to discuss. These are:

i) Limitations of the data linking process;
ii) Issues with studying bias exploration;
iii) Should we use the findings of the study to adjust for potential bias?

Each of these topics is discussed below.

Limitations of the data linking process: The CNRLS approach matches address based household variables derived from the 2011 Census to addresses selected for interview in household surveys within four months of the Census date. The key assumption of this approach is that non-responding survey households correspond to the Census household matched. A potential weakness of the approach is that non-respondent households in social surveys may also be less likely to respond in the Census and may also be more transient. Limiting the time between Census and Survey observations in the study is balanced against the need for a sufficient sample size for the study. The outcome of the matching process for the 33,000 wave one Labour Force Survey (LFS) households in the CNRLS field period is shown in table 2. Matching was performed with Census data at a point before any imputation takes place and includes Census dummy forms, unoccupied Census addresses as well as Census occupied households. Census dummy forms are completed late in the field process for all outstanding (non-responding) households.

Table 2: Matching rate by survey outcome of wave one unique LFS cases.

	Matched to Census (record type):			Unmatched
LFS outcome	occupied	unoccupied	dummy	
Co-operation	96%	1%	2%	1%
Non-contact	86%	3%	8%	4%
Refusal	94%	1%	3%	2%
Other non-response	90%	2%	5%	3%
Not eligible	34%	16%	24%	26%
Total	89%	2%	5%	4%

Matching rates are highest for co-operating households and lowest for non-contacted households, with the exception of households classified as survey ineligible. Survey ineligibles are not expected to match to Census occupied households. Extrapolation of the relationship between difference in the timing of the Census and survey observations and the match rate of ineligible households suggests that a change in status (through moves for example) can only explain a third of the matches. Should we include these matched ineligibles as a form of non-response?

In all of the surveys included in this study, at least 95% of co-operating households that matched to a Census occupied household contained at least one matched person. The value in the LFS was 98%. The 2-5% of co-operating households that matched to a Census occupied household but did not contain matched people are either matching errors or arose because of households moving in the time lag between survey interview and census date.

Matching rates for responding households appear reasonably high and consequently we can be reasonably sure that there census auxiliary data is mostly accurate. As we have no survey data on non-respondent household we cannot link the household reference person for such cases to ensure that we have got corresponding households at the same address. Table 2 shows that matching rates for non-respondent households are lower for survey non-respondents than respondents. It may even be that non-respondents are more likely to move than respondent households; in cases were address matching is ambiguous, survey respondents allow resolution through person matching, which is not possible for survey non-respondents. This produces two considerations. Not only are non-respondents less likely to be represented in the CNRLS dataset because of matching failure, it is also possible that survey non-respondent households are less likely to be the household at the census address than are survey respondent households. This latter concern is speculative but more generally we need to be aware of the inherent quality issues with the CNRLS which should be considered alongside what the CNRLS may tell us about the quality of the surveys investigated.

Bias exploration: As discussed earlier, any assessment of non-response bias requires inference of survey measures of the non-respondents. Post stratification of households based on an auxiliary variable assumes that non-response occurs at random within each stratum, an assumption that carries risk (table 1). Non-response bias may vary for each survey measure. However, analysis for each survey measure is resource intensive. A survey general approach is to explore what factors affect the propensity to respond. Understanding this can certainly inform the field work but the extent to which the approach can detect potential non-response bias depends on how strong the correlation between the auxiliary variable and the survey measure is. If the approach is to inform field work then it is worth studying non-response as a stepwise process: overcoming non-contact and then refusal. This distinction is irrelevant for bias exploration but may become important if adjustments are made as separate adjustments for non-contact and refusal may be preferable to a single adjustment.

ONS is currently undertaking a detailed exploration of factors associated with non-response and potential bias taking into account a number of census based auxiliary variables.

However, this study is not yet complete so we have here focused on an eclectic selection of interim findings.

Preliminary CNRLS analysis suggests that survey response in general is better explained by variables describing household accommodation and composition rather than by individual level variables describing, for example, householder ethnicity, economic activity or health. Focusing on the LFS, and in particular and restricting ourselves to the first wave of survey data, the strongest factor that explains non-response is mode. At the time of the 2011 CNRLS around 30% of wave one LFS cases were assigned to the telephone unit, with the remainder of the cases being assigned to field interviewers. The CNRLS revealed a lower response propensity for householders[1] in single adult occupation who were under 55 years of age relative to other householder typologies.

As a one-off exercise to assess potential bias at the point in time of the census[2] an auxiliary variable based on the combination of four dichotomous variables chosen by their impact on LFS response rates was used to assess potential non-response bias. The auxiliary variable combined mode, presence or absence of dependent children, single adult occupier or not, and household reference person under 55 years of age or not to produce 16 classes. In cases where the household reference person was 55 years of age or older and had dependent children, the single occupancy variable was removed, leaving 14 classes. Weighting by this auxiliary variable had little effect on the raw estimates for the proportion of adults economically active and the proportion of such adults ILO unemployed (raw estimate was 0.4% lower than the weighted estimate in relative terms for proportion economically active and unchanged for the proportion ILO unemployed).

The creation of non-response weighting classes should ideally result in between group heterogeneity and within group homogeneity and also reflect a stable non-response process. With a wide range of potential variables it is not always clear which should be included the non-response adjustment model. Consequently, we have been exploring a range of different models incorporating different combinations of variables and classes. Perhaps, not surprisingly, a range of estimates for non-response bias can be produced depending on the model used. How do we decide which, if any, is most appropriate? Moreover, what should we do to explore the stability of the assumption of a stable non-response process over time within the context of decreasing household survey response rates?

Bias adjustment: A key question is whether we should be using non-response weights at all? Perhaps it would be better to provide details of the study with current estimates adjusted by non-response weighting as a quality measure, albeit this would be a resource intensive exercise with our current processing systems and unlikely to be a routine output. Non-response weights produced by the CNRLS can only be updated following a Census. They are essentially static weights based on conditions observed at the time of the previous Census and used on the assumption of stability over time. In case of the LFS, the 2011 CNRLS was

[1] Individual level socio-demographic data is taken from the Household Reference Person.

[2] Mode has not been included in our more detailed exploration of bias because allocation is not random and selection effects for mode may be confounded with non-response selection effects making the potential non-response model inherently unstable.

performed at a time when the assignment of wave one cases to the telephone unit was being trialled. ONS has already reduced the number of wave one telephone interviews. This changing allocation would create a dilemma for producing non-response weights incorporating mode for future use in the LFS: cases were not assigned to the telephone unit randomly. Does the stability issue mean that we should move to an updatable weighting strategy? Such a method would probably need to be based on small geographies rather than household type. The political desire to move away from the traditional census increases the need to move away from census based non-response weights.

To what extent are we convinced that non-response weights actually get us closer to the true value? As discussed above, non-response bias effects depend on the combinations of auxiliary variables used for weighting. This in itself creates uncertainty as to the true impact of non-response bias. Decisions regarding the choice of auxiliary variable can be subject to prejudice. How far will we allow our expectations to guide us?

References:

Foster, K. (1998). 'Evaluating non-response on household surveys'. GSS Methodology Series **8**, 1-50.

Freeth, S. and Sparks, J. (2003). 'Summary of the 2001 Census-linked studies of survey non-response.' Unpublished (internal ONS document).

Zhang, L.-C., Thomsen, I. and Kleven, Ø. (2013) 'On the Use of Auxiliary and Paradata for Dealing with Non-sampling Errors in Household Surveys'. International Statistical Review. doi: 10.1111/insr.12009.