Call and Response: Modelling Longitudinal Contact and Cooperation using Wave 1 Call Records Data

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Non-technical summary

In longitudinal surveys, gaining and maintaining the cooperation of participant households is of crucial importance. With each passing wave of the study, if households that drop out behave differently from responding households survey estimates likely become biased. Reduced sample sizes also means estimates lose precision. Finally fieldwork becomes less efficient. One of the main strategies to address these problems is to find information that can identify the mechanism of nonresponse. In other words, to find the characteristics from the respondents as gathered by the survey (in the current or a previous wave) that are associated with increased likelihood of dropping out. One of the areas least explored in this regard is using call record data to model the nonresponse process. Briefly, call records are data collected by the interviewer from each contact attempt with the potential respondent (i.e. date, time, duration of contact, call outcome, etc.). This paper uses call records from Understanding Society's Wave 1 to model Wave 2, Wave 3 and Wave 4 household nonresponse. Results indicate that households which repeated unproductive contacts, broke appointments, registered above median proportion of "no replies", or began the call sequence with an unproductive contact in Wave 1 are at risk of future nonresponse.

Acknowledgements

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Abstract: For longitudinal surveys, there is little discussion on how call record data are able to account for household nonresponse. This paper uses call records as well as observed data from *Understanding Society's* Wave 1 to model Wave 2, Wave 3 and Wave 4 household contact and cooperation propensities. Multi-level logistic models are used to account for the nested structure of the data (households within interviewers). Results indicate that households which repeated unproductive contacts, broke appointments, registered above median proportion of "no replies", or began the call sequence with an unproductive contact in Wave 1 are at risk of future nonresponse.

1 Introduction

Survey nonresponse is a prime concern for survey methodologists and practitioners alike. Besides negatively impacting on survey costs and fieldwork efficiency, nonresponse results in diminished statistical power and potentially biased survey estimates. Furthermore, longitudinal surveys carry the compounded problem of attrition (Lynn, 2009a). The sample gathered at the first wave suffers from progressive nonresponse after each wave resulting in additional imprecision and potential bias. Therefore, efforts to reduce nonresponse are motivated not only by considerations of cost but also by concerns with data quality.

Broadly speaking, procedures that deal with nonresponse (including attrition in longitudinal surveys) can be grouped as pre- or post-fieldwork, or said differently, methods to *prevent* or *adjust* for nonresponse. For example, nonresponse prevention may be incorporated as a design feature and could include: cash incentives for respondents, advance letters or increased number of total interview attempts per potential respondent (Laurie and Lynn, 2009; Laurie et al., 1999). While generally effective, these only serve to attenuate (but never completely eliminate) nonresponse. Additionally, they may also compromise data quality if they exert any other (potentially biasing) effect besides increasing response rates. Lastly, these design features may also involve additional costs and field effort.

Adjustment of nonresponse usually occurs after data collection has finished and entails using auxiliary or associated survey data that can identify the mechanism of nonresponse and therefore minimize its effect via statistical controls such as weighting or imputation (more rudimentary procedures may involve simple case deletion). There is ample work to suggest which variables (whether auxiliary or those found in the questionnaire itself) may be associated with the nonresponse and noncontact mechanisms (Groves and Couper, 1998; Lepkowski and Couper, 2002; Uhrig, 2008). However, the correlations tend to be weak or endogenous. Moreover, while particular survey items may correlate with nonresponse mechanisms in some surveys they may not necessarily do so for other. In other words, the relationship between these survey items and the

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process of nonresponse may be topic-specific. Auxiliary variables are often collected as demographic aggregates (Callegaro, 2013; Kreuter, 2013), prone to error (West, 2013), or unable to identify what is most likely (if at least partially) a function of individual traits and decisions. Lastly, these auxiliary variables are not always readily available and, in some cases, no adjustment is possible.

Given all these limitations, a promising source of information to model the mechanisms of contact and cooperation are call records (data about the field process, also referred to as: process data, contact history data or call history data) (Durrant et al., 2013a; Henly and Bates, 2006; Kreuter and Olson, 2013; Wagner, 2013). Besides collecting the data associated with a given questionnaire, recording information about each call the interviewer makes with a potential respondent is a common practice among many survey organizations. For example, the time and duration of each call can be recorded along with a codified outcome ("no reply", "completed interview", "some interviewing done", "refusal", "appointment", or "other") (Kreuter and Casas-Cordero, 2010; Lynn et al., 2010). Along with call records, the interviewer may also include field observations (Kreuter and Olson, 2013), such as: condition of the household; type of dwelling; presence of alarm systems, gates, guard dogs; evidence of car ownership or infants in the house; etc. Respondent and interviewer identifiers may also be included in addition to derived aggregates from this type of data (e.g. total number of calls, time of first call, average field duration, etc.)

In comparison to conventional survey measurements and other forms of auxiliary data call records generally show stronger associations with the mechanisms of nonresponse. This is largely because of the conceptual proximity to the contact and cooperation phenomena. Put simply, call records measure the response processes. They register the sequence of events that lead to a given survey target being classified as "completed interview", "noncontact", "refusal", etc. In fact, more detailed classification is possible given the call records, as sample members may be deemed "difficult to contact", "reluctant", "hard-to-get" or "easy-to-get" (Hall et al., 2013; Lynn and Clarke, 2002; Lynn et al., 2002). These data also provide information about the

performance of the interviewer and trends of the fieldwork (Kreuter et al., 2010). For example, estimates of average call duration or proportion of call outcomes per interviewer allow for an evaluation of interviewer effort and efficiency as well as the level of difficulty in contacting and eliciting cooperation from sample subjects.

While not completely disregarded, call records remain fairly unexplored when dealing with nonresponse in longitudinal surveys. To be fair, there is a considerable amount of work on using these data to analyse and predict survey nonresponse in cross-sectional surveys or within waves of a panel study. These data have also been used to evaluate nonresponse error (Kreuter and Kohler, 2009; Kreuter and Olson, 2013; Lynn et al., 2002) optimize contact strategies (Wagner, 2013) and assess fieldwork effort (Durrant et al., 2011, 2013b; Kreuter et al., 2010; Mercer, 2012). More specifically, call histories have been used to identify survey bias between early and late respondents; model final outcome based on interaction of first contact; and determining best times of call to elicit higher response rates. However, with regards to longitudinal surveys, the literature is considerably smaller. Call records have been used to understand attrition in panel surveys (Bates, 2004; Henly and Bates, 2006) and flag potential dropouts so interviewers can tailor their field strategy. For example, the total number of contacts per respondent has been shown to be significantly associated with increased nonparticipation in future waves (De Keulenaer, 2005).

However, beyond summary statistics of call records and measures of extended interviewer effort, what remains to be analysed is how specific call sequences or events are able to account for household-level contact and cooperation propensities in subsequent waves. In fact, there is little research on determining the existence of underlying household-level contact and cooperation propensities in longitudinal surveys based on call records. Moreover, there is hardly any work on how call records fare when conditioning on other predictors of nonresponse (i.e. demographic traits and attitudinal characteristics).

Should call records reveal new insights in predicting response outcomes in subsequent waves, field strategies to curb noncontact and noncooperation could be adjusted at little or no additional

cost before data collection begins. While other predictors of nonresponse (like respondent attitudes, demographic traits or social context) are entirely dependent on the respondent, events observed in the call records are in part a function of decisions made by the field office and/or the interviewer. As the product of interviewing interactions, these data are specially convenient for fieldwork adjustment between waves. That these adjustments could potentially be made after only the first wave of a longitudinal study adds more value to their application given the considerable costs of developing and maintaining a survey of this type as well as the crucial importance of its first round of fieldwork.

1.1 Research Questions and Objectives

Specifically, this analysis is concerned with two questions:

1. Are there specific events and contact sequences observed at Wave 1 of a panel study associated with future contact and cooperation propensities?

2. Do call records from Wave 1 of a panel study reveal additional information about future contact and cooperation unobserved by demographic and attitudinal predictors of nonresponse?

To address these questions this paper explores the effects of aggregated Wave 1 individual and call record data and household traits. Model specification considers the conditionally independent processes of contact and cooperation (Campanelli et al., 1997; Groves and Couper, 1998; Lepkowski and Couper, 2002; Lynn et al., 2002; Nicoletti and Peracchi, 2005) and is informed by established theories of survey nonresponse (Groves and Couper, 1998; Lepkowski

and Couper, 2002). Additional controls include geographical markers[1] and stable household flags[2] to account for interviewer reallocation[3] as well as household alterations between waves.

2 Theory and concepts

Household surveys may involve (at least) two types of questionnaires: one for the residents and one for the household. While the first measures individual-level items, the latter measures household level traits such as family composition or general characteristics of the home. Therefore, cooperation with the corresponding survey instrument is the most obvious way of determining whether a household or individual responds or refuses. However, a further and more detailed classification is possible for households given the patterns of response of its corresponding individual residents. A household may be deemed "fully respondent" if all individuals within it participate, "partially respondent" if only some do or "only household questionnaire completed". Because this paper deals with call interactions with sampled households in the first wave of a longitudinal household survey, for the purposes of this analysis a household is considered responding when it completes at the very least the household questionnaire.

Cooperation only occurs conditional on contact – it is impossible for a noncontacted individual to cooperate with a survey. However, this does not necessarily mean that contact and cooperation are dependent. In fact, the literature suggests that these two are driven by different (and independent) trends and traits of the respondent, interviewer protocols, social context, respondent accessibility, and survey design (Groves and Couper, 1998; Lepkowski and Couper, 2002; Lynn et al., 2002; Nicoletti and Peracchi, 2005).

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[1]As geographic markers this paper resorts to the Lowest Super Output Area classification as defined by UK's Office for National Statistics. LSOA's are geographical zones with a minimum of 1000 and a maximum of 3000 inhabitants residing in 400 to 1200 households (Office for National Statistics, 2011).

[2]This analysis defines a household as stable when at least one individual member remains in a household between waves and its physical address stays fixed within a LSOA.

[3]Interviewer reallocation refers to the process (deliberate or otherwise) where households are approached by different fieldworkers between waves. It is important to note that interviewer reallocation is rarely (if ever) a random process. Indeed, interviewer continuity and household response may share common causes (Lynn et al., 2014). Therefore, it is important to take this non-random process into account when interpreting some of the findings of the analysis proposed in this paper.

Indeed, Groves and Couper (1998) provide a theoretical framework for contacting sample households and eliciting survey cooperation. Likelihood of contact is a function of at-home patterns of the respondent and the call strategy employed by the interviewer. In turn, the latter is influenced by attributes of the particular interviewer while the former is determined further by physical impediments to the respondent (or their household), as well as social-environmental and socio-demographic attributes of the sample member. Once contacted, the decision to cooperate with a survey occurs during householder-interviewer interaction. This interaction can be understood as a function of factors classified as either "out of" or "under" researcher control. Out of research control are the social environment (e.g. economic conditions, survey-taking climate, and/or neighbourhood characteristics) in addition to household traits (e.g. household structure, socio-demographic characteristics, and/or psychological predisposition). Controllable by the researcher are survey design (e.g. topic, mode of administration and respondent selection) as well as interviewer traits (e.g. socio-demographic traits, experience and expectations) (p. 25-46).

Thus, understanding and accounting for nonresponse demands careful consideration of these two sequentially-linked but ultimately separate processes of contact and cooperation. One approach that takes this into consideration (and which is adopted in this paper) involves separate (but conditional) modelling of the processes (contact conditional on eligibility; cooperation conditional on contact).

2.1 Using call records to model the nonresponse process

Identifying households as likely noncontacts and/or refusals in longitudinal surveys has immediate applications for fieldwork effort allocation and optimizing interviewing strategies. If potential nonrespondents can be flagged before data collection starts, tailored or adaptive approaches (Calinescu et al., 2012; Groves et al., 1992; Groves and Heeringa, 2006; Lynn, 2014; Morton-Williams, 1993; Oksenberg et al., 1986; Schouten et al., 2013; Wagner, 2008) can be implemented to minimize the effect of nonresponse on data quality and cost. Essentially, preventing nonresponse is made easier when it can be anticipated. Indeed the focus on prevention

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is based on the assumption that retaining collaborating survey respondents demands less effort than recuperating or converting dropouts. Moreover, because the phenomena observed in call records fall (at least partially) under the control of the interviewer, identifying particular call events or sequences that lead to future nonresponse could inform/modify interviewer behaviour protocols with the aim of reducing nonresponse.

Evaluating household – as opposed to individual – nonresponse is also rooted on a concern for fieldwork optimization. Preventing an entire household from dropping out automatically impacts on the future contactability and cooperation of the individual residents within it. The opposite is not necessarily true – individuals likely to drop out may live in an otherwise highly cooperative and/or contactable household. Thus, limiting analysis solely on the individual may hide higher-level dynamics that determine household (and therefore individual) nonresponse.

Of course, the nature of the data (especially call record data) also places the analysis at the household level. Call records are nested within the home and not a particular resident. Before interviewing commences, the interviewer's first concern is with finding and eliciting the cooperation of the household to then turn to the individuals within it. Even the "gatekeeper", or resident that first interacts with the interviewer at the doorstep, is best understood as a household artefact as it is likely to 1) not be individually identified 2) be a different individual between calls.

3 Data and methods

This analysis attempts to model response observed at Waves 2, 3 and 4 of a household longitudinal survey using covariates observed at Wave 1 (as well as two cross-wave controls). The dependent variables, contact and cooperation, are assumed to be a function of Wave 1 call record sequences, interviewer observations, survey data from the household and individual questionnaires as well as indicators for 1) interviewer continuity (Campanelli and O'Muircheartaigh,

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1999; Laurie et al., 1999; Lynn et al., 2014) and 2) geographically-stable households across waves.

3.1 Household contact and cooperation in *Understanding Society*

The data used for this analysis come from *Understanding Society*, the United Kingdom's Household Longitudinal Study comprised of approximately 40,000 households and close to 100,000 individuals interviewed in yearly waves. The sample is representative of all British households with an additional "boost sample" of the five main ethnic minorities in the UK. All household members over the age of 16 are interviewed. Fieldwork for Wave 1 began in 2009. Survey questions cover multiple topics, including: employment status and history, personal and household finances, health and general well-being, social attitudes, family composition and community engagement (McFall et al., 2013).

In total 26,200 households issued at Wave 2, 24,425 at Wave 3 and 21,320 at Wave 4 of the survey are analysed. They belong to the General Population Sample Component of Great Britain[4] (Lynn, 2009b). In Wave 2 a total of 382 households are dropped from the analysis as they report: 1) field periods longer than the 3 month limit[5] stipulated by the field protocols of *Understanding Society* or 2) empty call record data. In Wave 3, 336 households are removed for the same reasons as well as 277 in Wave 4.

As previously stated, in this analysis a household is said to cooperate when it answers (at a minimum) the household questionnaire (regardless of the residents' cooperation with the individual questionnaire). Given the sample design and following rules of the UKHLS[6], the house-

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[4]The General Population Sample is a component of *Understanding Society*, representing the UK household population over time (except for those consisting solely of post-2009 immigrants). Other sample components, like the the Ethnic Minority Boost, are excluded from the analysis as they required an additional screening procedure at the doorstep and created a different call record data structure. Because the British Household Panel Survey component was not measured in Wave 1 it is also disregarded from this analysis. Finally, the field management in Northern Ireland did not register call records and thus is also not included.

[5]For 99% of UKHLS households, the field is completed within three months of the date of the first call. Therefore, cases with extended field durations (over three months) are exceptionally rare and do not follow usual protocol.

[6]As Lynn (2009b, p.11-12) explains "All persons identified at wave 1 as sample members [...] will remain sample members indefinitely regardless of their location or household circumstances. Subsequent to wave 1, all new births whose mother is a sample member will themselves become a sample member. When sample members move, attempts

Final Outcome	Wave 2	Wave 3	Wave 4
Noncontact	1,467	977	780
Contact: Response	19,928	17,987	16,870
Contact: Refusal	2,991	3,088	2,131
Contact: Other Nonresponse	31	269	180
Non Eligible	279	578	518
Unknown Eligibility	1,504	1,526	841
Total	26,200	24,425	21,320

Table 1: Wave 2, Wave 3 and Wave 4 Household Outcomes

holds represented in Table 1 (those from Waves 2, 3 and 4) contain at least one individual who was sampled and cooperated with an individual and/or household interview at Wave 1. In other words, households that did not register any response at Wave 1 are not included in the final data to be analysed.

3.2 Variable selection

Besides the call records, information about geographical markers, the characteristics of the dwelling, household size, demographics, levels of political & community engagement, and previous interview experience was used to construct covariates of contact and cooperation. These were selected according to established theories of household nonresponse and comparable empirical studies (Groves and Couper, 1998; Kalsbeek et al., 2002; Lepkowski and Couper, 2002; Uhrig, 2008). In total, 26 variables were considered for the models. While some were originally collected at the household level, others needed to be aggregated from the individual respondent files or call records to fit the structure of the dataset. Further data reduction resulted from the construction of index variables. As previously stated, all these independent variables were gath-

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will be made to follow them to their new location and interview them there. Even when a sample member moves out of the UK they will remain in the sample, though no attempt will be made to carry out face-to-face interviews. [...] At every wave the intention will be to interview all members of each household containing at least one sample member. [...] But at each wave subsequent to wave 1, there will be many cases where household composition has changed since the previous wave, resulting in sample members being co-resident with non sample members. All such non sample members will be interviewed at any wave when they are co-resident with a sample member, but they do not themselves become sample members and are not therefore followed if they leave the household of sample member(s)."

ered in Wave 1 (except for interviewer and LSOA continuity) and are used to model outcomes observed in Wave 2, Wave 3 or Wave 4.

Categories	Variable name	Level of data collection
Call Records	Status of first call	Call
	At least one broken appointment	Call
	Repeat unproductive contacts	Call
	Above median proportion of noncontacts	Call
Geographical markers	Geographical Region	Household
	Urban indicator	Household
Characteristics of dwelling	Dwelling type	Household
	Groundfloor indicator	Household
	House in worse condition than neighbours	Household
Household size	Number of residents	Household
Demographics	Baby present	Household
	Residents in poor health	Individual
	National origin of household	Individual
	Working status	Individual
	Pensioners in household	Individual
	Deprivation indicator	Household
	Household tenure	Household
Political & community engagement	No political interest among residents	Individual
	Community attachment	Individual
Previous interview experience	Consent to linkage	Individual
	Someone else present during interview	Individual
	Suspicious during interview	Individual
	Understood interview questions	Individual
	Item nonresponse	Individual
Cross-Wave Controls	Same interviewers across waves	Household
	Same LSOA across waves	Household

Table 2: Variable Selection

3.2.1 Call records

With regards to our covariates of interest, four variables are generated from the call records. These derived variables identify problematic call sequences assumed to be associated with re-duced household contactability and propensity to cooperate.

Status of first call can be any of the following: "no reply", "appointment set", "unproductive contact", "some interviewing done", "any other status" or "completed interview"[7]. Houses where

[7]Call statuses have been relabelled from the original dataset to aid interpretation of the data. The original variable includes only five possible values. For this analysis, a sixth value was derived - "completed interview". It distin-

an appointment is set but are followed by any call status besides "some interviewing done" or "completed interview" are deemed "at least one broken appointment". A similar event pattern is recorded in houses where "unproductive contact" occurs more than once in a row to single out cases where the interviewer repeatedly engages the respondent but no appointment is made nor any interviewing achieved. Finally, based on the distribution of noncontact calls, households are divided in two groups: those with a proportion of total "no replies" below the corresponding wave sample median and those above it.

3.2.2 Other nonresponse covariates

1. Geographical markers: Geographical markers include UK Government Office Regions, an urbanicity indicator. These two variables are originally collected at the household level.

2. Characteristics of the dwelling: With regards to the characteristics of the dwelling, a house can be: "detached", "semi-detached", "terraced / end", "flat / maisonette / purpose / converted", "bedsit / with business / sheltered / institution / other". In addition, there is an indicator to determine whether the household is on a ground floor or elsewhere. Finally, according to the interviewer's observation a house can be deemed to be in a "better / same" or "worse" condition than its neighbours.

3. Household size: Household size refers to the total number of residents (including responding and nonresponding residents).

4. Demographics: Demographic information include presence of a baby in the household; aggregated health status, national origin and employment status of the residents; deprivation indicator and household tenure. Specifically, presence of a baby is determined by a binary indicator for homes with at least one child under the age of 2 as observed in Wave 1.

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guishes calls where partial interviewing was done from those cases where the entire interviewing was completed and no more calls were necessary to collect additional information. Moreover, the term "unproductive" was added to the "contact" status as it reflects those calls where the interviewer was able to contact the interviewee but no interviewing or appointment resulted.

The health status of a household is determined by the proportion of residents who declared being in "poor" health. The two possible values of the variable are: "all in poor health" or "at least one not in poor health". Additionally, according to the individual national origin, a household is classified as either: "all British", "mixed", or "all non-British". Similar aggregation is used for employment ("no one works", "at least one works, but not long hours"[8], "at least one works long hours" or "all work long hours") and presence of pensioners in the household ("no pensioners", "at least one pensioner", "all pensioners"). A deprivation index is constructed from a battery of questions that ask responding households whether they "have", "can't afford" or "do not need" any of the following: annual holiday, monthly drink/meal out with friends, two pairs of all weather shoes for all adults in the house, enough money for household repairs, household contents insurance, money for savings/retirement plan, money to replace worn out furniture or money to replace broken appliance. A household is said to be materially deprived if it answers that it cannot afford at least two of these items. Lastly, household tenure is classified as either: "owner / mortgager" or "all others".

5. Political and community engagement: If no individual residents express any political interest, the household is labelled "no political interest among residents". Otherwise, it becomes "some political interest among residents". Community attachment is determined by an index that totals the responses from eight self-completion questions related to an individual's willingness or habit of interacting with neighbours and/or community organizations. The household average of the aggregated individual responses is placed into quartiles based on the aggregated distributions for all households, where Q1 indicates the lowest possible attachment among the households and Q4 the highest. Because of the high frequency of item missingness (likely due to proxy respondents and other questionnaire administration limitations) a further category of "missing" is added to the scale for a total of five possible values for this variable.

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[8]"Long hours" entails working more than 35 hours a week.

6. Previous interview experience: Six variables account for the respondents' previous interview experience (as observed in Wave 1). Depending on the willingness of individuals to consent to linking their survey data with administrative records, a household is classified as either "no one consents" or "at least one consents". Based on the presence of someone else (besides the interviewer and respondent) during any of the household's corresponding individual interviews, it is classified as "someone else present" or "no one else present". Based on interviewer assessment, individuals' suspicions with the survey as well as their understanding of the questions are also aggregated to the household level so that these become "some suspicion"/"no suspicion" or "excellent understanding"/"less than excellent understanding". Item nonresponse from the individual interviews is aggregated from all residents in the household. Given the skewness of the resulting distribution, the results are converted to a logarithmic scale and complemented by an indicator with values "no item nonresponse" or "some item nonresponse".

3.2.3 Cross-wave controls

Finally, two cross-wave controls are derived. The first identifies households as having the same vs. different interviewer across waves while the second identifies households that remain in the same Lower Super Output Area between waves[9]. As mentioned previously, in the UKHLS (and likely in most face-to-face household surveys) interviewer allocation between waves is a nonrandom process. Whether an interviewer is sent to the same household as in a previous wave is a function of deliberate processes including (among others) continued employment of the interviewer with the field agency and/or individual(s) moving houses beyond the area assigned to the interviewer. Thus, these cross-wave indicators are included in the models to account for

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[9]While not immediately equivalent to a fixed home address, the LSOA variable allows for the analysis of household stability across waves. While it is possible (and even probable) that some movers remain within the vicinity of a previous residence, separating households based on their LSOA across waves correctly identifies those households that move a considerable distance. Further, the analysis of fixed geographical location can be relaxed if it is assumed that LSOAs are homogeneous regarding contact and cooperation propensities. In other words, households that move within a neighbourhood may be assumed to keep certain traits about their structure and other variables possibly correlated with nonresponse vs. households that move outside of the original neighbourhood.

processes likely and substantially confounded with nonresponse, but which are not the main focus of this analysis. To the extent that these particular covariates are discussed it will not be done to ascertain specific interviewer effects but to address (and control for) a particularity of the data as collected by the UKHLS. Indeed, the main focus of this analysis remains wave 1 call record sequences and their association with wave 2, 3 and 4 household contact and cooperation.

3.3   Modelling strategy

In total, 18 different models are evaluated for this analysis. The specifications result from a combination of three different analytical dimensions:

1. Outcome of interest (contact vs. cooperation).

2. Wave of observed outcome (Wave 2, Wave 3 or Wave 4).

3. Model specification:

   (a) Reduced form: Other predictors of nonresponse (i.e. demographic and attitudinal variables) + cross-wave controls (indicators of geographical and interviewer continuity across waves per household).

   (b) Expanded form: Call sequences + other predictors of nonresponse (i.e. demographic and attitudinal variables) + cross-wave controls (indicators of geographical and interviewer continuity across waves per household).

   (c) Expanded form: First call status + other predictors of nonresponse (i.e. demographic and attitudinal variables) + cross-wave controls (indicators of geographical and interviewer continuity across waves per household).

Because contact and cooperation produce dichotomous outcomes, logistic models are employed in this analysis. Also, given the hierarchical nature of the data (households nested within interviewers) this paper uses random intercept fixed effect models (Rasbash et al., 2015). Within

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wave and for each outcome of interest, the three corresponding model specifications are anal-ysed comparatively to determine the marginal effects of call record data on the mechanisms of nonresponse after conditioning on demographic and attitudinal predictors of nonresponse (i.e. geographical markers, characteristics of the dwelling, household size, demographics, levels of political & community engagement, and previous interview experience) and accounting for any possible differential effects on contact and/or cooperation attributable to the particular dynamics of cross-wave household composition, mobility and interviewer allocation as collected in the UKHLS data. Coefficients are reported as odds ratios.

	Outcome	Specification
Wave 2	Contact	1. Other NR predictors + x-wave controls 2. Sequences + Other NR predictors + x-wave controls 3. First call + Other NR predictors + x-wave controls
	Cooperation	4. Other NR predictors + x-wave controls 5. Sequences + Other NR predictors + x-wave controls 6. First call + Other NR predictors + x-wave controls
Wave 3	Contact	7. Other NR predictors + x-wave controls 8. Sequences + Other NR predictors + x-wave controls 9. First call + Other NR predictors + x-wave controls
	Cooperation	10. Other NR predictors + x-wave controls 11. Sequences + Other NR predictors + x-wave controls 12. First call + Other NR predictors + x-wave controls
Wave 4	Contact	13. Other NR predictors + x-wave controls 14. Sequences + Other NR predictors + x-wave controls 15. First call + Other NR predictors + x-wave controls
	Cooperation	16. Other NR predictors + x-wave controls 17. Sequences + Other NR predictors + x-wave controls 18. First call + Other NR predictors + x-wave controls

Table 3: 18 Model Specifications

3.4 Equations

$$\text{logit}\left\{P(Contact_{ij} = 1)\right\} = \beta_{0j} + \beta_1 X_{ij} + \beta_2 Y_{ij} + \beta_3 Z_{ij} + \varepsilon_{ij} \quad (1)$$

$$\beta_{0j} = \beta_0 + \upsilon_j \quad (2)$$

$$\text{logit}\left\{P(Cooperation_{ij} = 1 | Contact_{ij} = 1)\right\} = \beta_{0j} + \beta_1 X_{ij} + \beta_2 Y_{ij} + \beta_3 Z_{ij} + \varepsilon_{ij} \quad (3)$$

$$\beta_{0j} = \beta_0 + \upsilon_j \quad (4)$$

$$\begin{bmatrix} \upsilon_{0j} \end{bmatrix} \sim N(0, \, \Omega_u) \, : \, \Omega_u = \begin{bmatrix} \sigma_{u0}^2 \end{bmatrix} \quad (5)$$

Where: **X** represents a vector of call record predictors of response (first call status or problematic call sequences); vector **Y** includes all other predictors of response (geographical markers, characteristics of dwelling, household size, demographic traits, political and community engagement and previous interview experience); and finally **Z** all cross-wave indicators (interviewer, LSOA continuity and their interaction). i is the household level identifier and j the interviewer level identifier. ε and υ denote the unobserved error terms for the households and interviewers respectively. The grand mean of the outcome variable (contact or cooperation) is represented by β_0, while β_{0j} is the corresponding mean for any given interviewer. The random intercept residuals are assumed to be normally distributed, centred around a mean of 0 and independent. Their variance-covariance matrix is represented by [σ_{u0}^2].

4 Results

4.1 Are there specific events and contact sequences observed at Wave 1 of a panel study associated with future contact and cooperation propensities?

UKHLS data indicate that specific events and contact sequences are indeed associated with future contact and cooperation propensities. There are significant and sizeable effects observed

in the call records of Wave 1 that are associated with Wave 2, Wave 3 and Wave 4 contact and cooperation propensities.

4.1.1 Contact

As shown in Tables 5, 6 & 7, an increased proportion of Wave 1 no replies is associated with reduced contactability in Waves 2, 3 and 4. While it is to be expected that nonresponding households will likely report increased number of "no reply" calls within a given wave, these data show increased no reply calls continue to have an effect in future waves. It bears repeating that all households considered for this analysis are successfully interviewed in Wave 1. In other words, among a certain segment of Wave 1 households, increased no replies does not immediately result in Wave 1 nonresponse; instead their effect is delayed and observed as Wave 2, Wave 3 or Wave 4 noncontact. While initially contactable (and cooperating) there seems to be an underlying difficulty of contact for these households which eventually results in nonresponse.

Similarly, the occurrence of broken appointments is indicative of future noncontact. Here too, the interviewer is able to engage with the respondent and eventually secure a completed interview in Wave 1. Nevertheless, before securing said interview, the data collection for that particular household is interrupted: a pre-arranged interview does not occur on the agreed upon date and has to be rescheduled. Even if these households later cooperate, their tendency to break appointments is seemingly associated with a difficulty of contact in subsequent waves.

The status of the first call at Wave 1 is considerably (yet barely significantly) associated with reduced contactability in Wave 3 alone (first time no replies and unproductive contacts are less likely to be contacted). Similarly, repeated unproductive calls only correlates with reduced contact in Wave 3, but not for Wave 2 or 4.

One could speculate that broken appointments and/or increased proportion of "no replies" signal limited at-home-routines. Even if the interviewer is able to complete an interview with a hard-to-reach household in the first wave, later its underlying difficulty results in future nonresponse. Otherwise, one could theorize broken appointments and "no replies" as early signs of

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soft refusals. While unable to say no in Wave 1, these otherwise latent nonrespondents are perhaps more comfortable with not answering the door and showing lack of interest to the survey by Waves 2, 3 or 4.

Obviously, these theories remain to be validated. Nevertheless, UKHLS data show that contact propensities are associated with previous wave call dynamics. The effects reported here (broken appointments and above median proportion of "no replies") behave in expected ways - it is sensible to assume that people who cannot be contacted are likely to have busy schedules or purposely avoid interviewer calls (whether cold or by appointment). What is more remarkable, however, is that these effects replicate not just after one wave but even after two and three waves from the initial round of data collection. This suggests that hard-to-contact patterns observed in the call records hold constant across time. Said differently, a household that is hard to reach once will likely be hard to reach again (and again, and again).

4.1.2 Cooperation

Call data are also significantly and sizeably associated with future household cooperation (Tables 5, 6 & 7). Broken appointments in previous waves are indicative of reduced likelihood of future cooperation. Repeated unproductive contacts are also associated with decreased cooperation in subsequent waves. However, a household's proportion of "no replies" in the previous wave does not show any significant or sizeable association. Here at-home-routines are no longer tenable assumptions since cooperation is conditional on initial contact. Instead, prior respondent-interviewer interactions likely determine the propensity to successfully complete the interview. Therefore, one could propose that these Wave 1 broken appointments and/or repeated unproductive calls are possibly due to the household's unwillingness to cooperate and not necessarily its contactability.

Furthermore, if the status of the first call in Wave 1 is an unproductive contact (i.e. the interviewer engages the respondent but is not able to agree on a future appointment or begin an interview), it is more likely that by Waves 2, 3 or 4 that household will not cooperate with

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the survey. Similarly, if the first call in Wave 1 is a partial interview, by Wave 3 that household is considerably more likely to cooperate once contacted. Thus, not only is the first wave very important for continued household cooperation, but indeed the very first call with the sampled household.

Here too, the significance and direction of the covariates are consistent with expectations. Moreover, Wave 1 call dynamics are associated not just with the cooperation propensities of the wave immediately after but also for those of Wave 3 and 4.

4.2 Do call records from Wave 1 of a panel study reveal additional information about future contact and cooperation unobserved by demographic and attitudinal predictors of nonresponse?

If call records are able to account for future contact and cooperation, can their effects also account for the unexplained variance of response models based on demographic and attitudinal covariates? In other words, do call sequences reveal information about the processes of nonresponse that is not captured by factors such as household's composition, geographical location, family composition, employment status, social attitudes of its residents, or the characteristics of the dwelling?

To determine whether call records reveal additional information about the contact and cooperation propensities, the 18 models considered for this analysis are grouped in trios of expanded and reduced forms per specification. For every expanded model (i.e. call records + other nonresponse covariates + cross-wave covariates) there exists a corresponding reduced form (i.e. other nonresponse covariates + cross-wave covariates). The comparison allows to test the marginal effects of the call records after conditioning on 1) other covariates of nonresponse as well as 2) any possible cross-wave interviewer allocation dynamics or household continuity effects particular to UKHLS that might also account for future nonresponse. As Table 4 shows, including first call status does not significantly improve the fit when compared to the reduced contact models in any of the waves. Additionally, by Wave 4 first call information does not significantly improve the fit

Wave	Outcome	Call	χ^2	d.f.	Prob. $> \chi^2$
2	Contact	Sequence vs. Reduced	36.35	4	0
		First call vs. Reduced	8.12	5	0.1500
	Cooperation	Sequence vs. Reduced	28.86	4	0
		First call vs. Reduced	32.33	5	0
3	Contact	Sequence vs. Reduced	38.68	4	0
		First call vs. Reduced	12.50	5	0.0285
	Cooperation	Sequence vs. Reduced	38.44	4	0
		First call vs. Reduced	43.97	5	0
4	Contact	Sequence vs. Reduced	27.24	4	0
		First call vs. Reduced	11.42	5	0.0437
	Cooperation	Sequence vs. Reduced	29.52	4	0
		First call vs. Reduced	16.24	5	0.0062

Table 4: Likelihood Ratio Tests. Expanded (Call records + Other NR Covariates + Cross-Wave Controls vs. Reduced models (Other NR Covariates + Cross-Wave Controls)

when compared to the reduced cooperation model. All other comparable pairs report significant terms. In other words, for the remaining models the call data do account for additional variation that is left unexplained by the other covariates of nonresponse as well as the cross-wave controls.

4.2.1 Control variables: other nonresponse covariates & cross-wave controls

Nevertheless, while call data report sizeable and significant covariates, the same occurs for some of the control variables included in the analysis. Most of these effects are partially consistent with expectations and comparable research.

In particular, certain dwelling types are associated with reduced contact. Pensioner households are also less contactable. Home ownership is likely to increase contactability, while lack of political interest decreases it. The strongest associations with contact are found among those households where the same interviewer is kept and/or stayed in the same LSOA between waves. (However, it should be stressed that interviewer allocation between waves is not a random process. Instead, this likely reflects the deliberate decision of field offices which in turn might be confounded with the response mechanisms.) Lack of political interest and suspicion of the pre-

vious survey wave are associated with reduced cooperation, while consent to linkage indicates increased cooperation.

However, while the call events display consistent effects for both Waves 2, 3 and 4 the same cannot be said for the control covariates of nonresponse. In fact, the magnitude and significance (and to a lesser extent the direction) of some of the coefficients (including: material deprivation, national origin, community attachment, self-reported health status, understanding of the questionnaire, and presence of a baby) are altered between waves. Still, for most of the remaining controls no apparent effect is ever observed. Thus, call data account not just for additional significant explanatory power in the models of nonresponse, but indeed report more stable effects across the three waves when compared to the control covariates. Perhaps, this cross-wave consistency is due to the conceptual proximity of the call dynamics to the contact and cooperation processes.

5 Discussion

Given the relative magnitude of the estimated coefficients of some of these call covariates, the significant contribution of these data to future nonresponse is potentially applicable for fieldwork design, especially in longitudinal surveys.

More specifically, these findings suggest that households which repeated unproductive contacts, broke appointments, registered above median proportion of "no replies", or began the call sequence with an unproductive contact are at risk of future nonresponse. The risk is consistent for Waves 2, 3 and 4. This risk is not trivial if one considers the frequency of occurrence of these types of call sequences. Indeed, repeated unproductive contacts occur in 9.5% of the responding households of Wave 1. Similarly, in 13% of these same households broken appointments are observed and for 15.5% the first call is an unproductive contact. Obviously, the risk is magnified when one considers the multiplicative effect of these events (for example, in 2% of Wave 1

responding cases, households whose first call was an unproductive contact would later break an appointment).

If the risks are apparent, so too are the potential applications for nonresponse prevention. Based on their call behaviour on the first wave of *Understanding Society*, households could be grouped by propensity for noncontact and/or noncooperation and exposed to tailored treatments which address theoretical causes of the events observed in the contact data. For example, in households where appointments were broken, a cross-wave mailing that acknowledges this occurrence could be drafted and include suggestions for more flexible calling times in the future. Similarly, the interviewers who registered these broken appointments could be consulted to explore possible drivers of noncontact or noncooperation in these types of households that are not immediately obvious in the data. For future longitudinal household surveys, interviewer training should address the importance of first call interactions and in particular the risk of unproductive contacts.

Interestingly, broken appointments are the only call sequence that account for both nonresponse processes. Further research could explore possible drivers of these by addressing the likely different mechanisms of refusing vs. not being contactable for an interview on a date previously agreed upon.

Future research could also address some of the previously mentioned limitations of this analysis. Indeed, the nonrandom allocation of interviewers between waves conditions any discussion of potential application of these findings. Efforts to disentangle the unobserved correlates of nonresponse inherent in the cross-wave interviewer allocation procedures could include randomized experiments where some interviewers are encouraged to incorporate response inducement strategies in their households based on the call record data from previous waves. Replication of this analysis in comparable household longitudinal studies could also serve to validate its findings and potentially resolve this limitation. Should similar findings be found in these comparable studies, new insights on the confounding effect of allocating interviewers nonrandomly between waves could be found.

Additionally, based on the structure of the data, future analysis could explore cross-level interactions between the interviewer clusters and some of the call record covariates. For example, are some interviewers more likely of incurring in broken appointments or repeated unproductive contacts? Can new all-purpose fieldwork protocols be designed from the findings of these analysis or do particular interviewers demand particular training based on the performance of the call data? These could be explored by including not just random intercepts, but also random slopes to the models already discussed here.

Furthermore, that these data are non-experimental also qualifies the findings discussed previously. The analysis presented here is understood within the context of UKHLS data. Surely, some of the findings suggest effects in expected and reasonable directions. Nevertheless, it bears repeating that since these are observational data, the analysis and findings are not (as of yet) generalizable.

The analysis presented here focused on the household level given: 1) the structure of the data (call records nested in the household) and 2) an interest in exploring household-level dynamics of contact as well as cooperation with a view towards optimizing possible nonresponse prevention strategies. Nevertheless, individual-level dynamics were ignored (or at best aggregated to the household-level) in these analysis. Future work could address this limitation. In particular, the possible effect of individual respondents' attitudinal, behavioural and contextual predispositions on cooperation propensity and how they may correlate with patterns observed in the corresponding call record.

Similarly, while this analysis focused on nonresponse prevention, there is no discussion of call records' impact on nonresponse bias. A first step towards addressing this limitation would be exploring what other differences (if any) exist between the groups identified by the call records. In other words, are those households that break appointments systematically different from those that do not when it comes to basic demographic composition? Response bias? Furthermore, do these call record patterns remain constant across the waves within households? In other words,

are there "repeat offenders" of problematic call sequences? If so, what possible impact may this have on nonresponse bias and data quality of their responses in general?

Finally, given the reduction of explanatory power of the models between Waves 2, 3 and 4 the relevance of these findings should be explored further by incorporating data from Waves 5 and onwards as they become available.

References

Bates, N. (2004). Contact histories: A tool for understanding attrition in panel surveys. Paper presented at the 58th Annual AAPOR Conference. May 13-16 2004. Phoenix, Arizona.

Calinescu, M., Schouten, B., and Bhulai, S. (2012). Adaptive survey designs that minimize nonresponse and measurement risk. *Statistics Netherlands*.

Callegaro, M. (2013). Paradata in web surveys. In Kreuter, F., editor, *Improving Surveys with Paradata: Analytic Uses of Process Information*, Wiley Series in Survey Methodology, pages 261–279. Wiley, Hoboken, N.J.

Campanelli, P. and O'Muircheartaigh, C. (1999). Interviewers, interviewer continuity, and panel survey nonresponse. *Quality and Quantity*, 33(1):59–76.

Campanelli, P., Sturgis, P., and Purdon, S. (1997). *Can You Hear Me Knocking: an Investigation into the Impact of Interviewers on Survey Response Rates.* Social and Community Planning Research, London.

De Keulenaer, F. (2005). Using process data to predict attrition from a panel survey: a case study. Proceedings of the Survey Research Methods Section, American Statistical Association.

Durrant, G. B., D'Arrigo, J., and Muller, G. (2013a). Modeling call record data: Examples from cross-sectional and longitudinal surveys. In Kreuter, F., editor, *Improving Surveys with Paradata: Analytic Uses of Process Information*, pages 281–308. Wiley, London.

Durrant, G. B., D'Arrigo, J., and Steele, F. (2011). Using paradata to predict best times of contact, conditioning on household and interviewer influences. *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, 174(4):1029–1049.

Durrant, G. B., D'Arrigo, J., and Steele, F. (2013b). Analysing interviewer call record data by using a multilevel discrete time event history modelling approach. *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, 176(1):251–269.

Groves, R. M., Cialdini, R., and Couper, M. P. (1992). Understanding the decision to participate in a survey.pdf. *Public Opinion Quarterly*, 56(4):475–495.

Groves, R. M. and Couper, M. P. (1998). *Nonresponse in Household Interview Surveys*. Wiley series in Probability and Statistics: Survey Methodology Section. Wiley, New York, 1 edition.

Groves, R. M. and Heeringa, S. G. (2006). Responsive design for household surveys: tools for actively controlling survey errors and costs. *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, 169(3):439–457.

Hall, J., Brown, V., Nicolaas, G., and Lynn, P. (2013). Extended field efforts to reduce the risk of non-response bias have the effects changed over time? can weighting achieve the same effects? *Bulletin of Sociological Methodology/Bulletin de Méthodologie Sociologique*, 117(1):5–25.

Henly, M. and Bates, N. (2006). Using call records to understand response in panel surveys. Alexandria, Virginia. American Statistical Association. Survey Research Methods Section.

Kalsbeek, W. D., Yang, J., and Agans, R. P. (2002). Predictors of nonresponse in a longitudinal survey of adolescents. In *Proceedings of the American Statistical Association (Survey Research Methods Section)*, pages 1740–1745.

Kreuter, F. (2013). Improving surveys with paradata: Introduction. In Kreuter, F., editor, *Improving Surveys with Paradata: Analytic Uses of Process Information*, Wiley Series in Survey Methodology, pages 1–9. Wiley, Hoboken, N.J.

Kreuter, F. and Casas-Cordero, C. (2010). Paradata. *German Council for Social and Economic Data Working Paper*, 2010. Berlin.

Kreuter, F., Couper, M. P., and Lyberg, L. E. (2010). The use of paradata to monitor and manage survey data collection. In *Proceedings of the Joint Statistical Meetings, American Statistical Association*, pages 282–296.

Kreuter, F. and Kohler, U. (2009). Analyzing contact sequences in call record data. potential and limitations of sequence indicators for nonresponse adjustments in the european social survey. *Journal of Official Statistics*, 25(2):203–226.

Kreuter, F. and Olson, K. (2013). Paradata for nonresponse error investigation. In Kreuter, F., editor, *Improving Surveys with Paradata: Analytic Uses of Process Information*, Wiley Series in Survey Methodology, pages 13–42. Wiley, Hoboken, N.J.

Laurie, H. and Lynn, P. (2009). The use of respondent incentives on longitudinal surveys. In Lynn, P., editor, *Methodology of Longitudinal Surveys*, Wiley Series in Survey Methodology, pages 205–233. Wiley, Chichester.

Laurie, H., Smith, R. A., and Scott, L. (1999). Strategies for reducing nonresponse in a longitudinal panel survey. *Journal of Official Statistics*, 15(2):269–282.

Lepkowski, J. M. and Couper, M. P. (2002). Nonresponse in the second wave of longitudinal household surveys. In Groves, R. M., Dillman, D. A., Eltinge, J. L., and Little, R. J. A., editors, *Survey Nonresponse*, Wiley series in Probability and Statistics, pages 259–272. Wiley, New York.

Lynn, P. (2009a). Methods for longitudinal surveys. In Lynn, P., editor, *Methodology of Longitudinal Surveys*, Wiley Series in Survey Methodology, pages 1–19. Wiley, Chichester.

Lynn, P. (2009b). Sample design for understanding society. *ISER Working Paper Series*, 2009(01). Colchester: Institute for Social and Economic Research, University of Essex.

Lynn, P. (2014). Coping with nonresponse. In Engel, U., Jann, B., Lynn, P., Scherpenzeel, A., and Sturgis, P., editors, *Improving Survey Methods: Lessons from Recent Research*, European Association of Methodology Series, pages 319–338. Routledge, New York.

Lynn, P. and Clarke, P. (2002). Separating refusal bias and non-contact bias: Evidence from UK national surveys (lynn and clarke 2002). *Journal of the Royal Statistical Society: Series D (The Statistician)*, 51(3):319–333.

Lynn, P., Clarke, P., Martin, J., and Sturgis, P. (2002). The effects of extended interviewer efforts on nonresponse bias. In Groves, R. M., Dillman, D. A., Eltinge, J. L., and Little, R. J. A., editors, *Survey Nonresponse*, Wiley series in Probability and Statistics, pages 135–147. Wiley, New York, 1 edition.

Lynn, P., Jäckle, A. E., and Blom, A. G. (2010). Understanding cross-national differences in unit non-response: The role of contact data. In Harkness, J. A., Braun, M., Edwards, B., Johnson, T. P., Lyberg, L. E., Mohler, P. P., Pennell, B.-E., and Smith, T. W., editors, *Survey methods in multinational, multiregional, and multicultural contexts*, Wiley Series in Survey Methodology, pages 335–355. John Wiley & Sons Inc., Hoboken, NJ, US.

Lynn, P., Kaminska, O., and Goldstein, H. (2014). Panel Attrition: How Important is Interviewer Continuity? *Journal of Official Statistics*, 30(3).

McFall, S. L., Petersen, J., Kaminska, O., and Lynn, P. (2013). Understanding society – UK household longitudinal study: Wave 1-3, 2009-2012 user manual. Colchester: Institute for Social and Economic Research, University of Essex.

Mercer, A. (2012). Using paradata to understand effort and attrition in a panel survey. *Section on Survey Research Methods – JSM*.

Morton-Williams, J. (1993). *Interviewer approaches*. Dartmouth, Aldershot.

Nicoletti, C. and Peracchi, F. (2005). Survey response and survey characteristics: microlevel evidence from the european community household panel. *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, 168(4):763–781.

Office for National Statistics (2011). Super output areas. `http://www.ons.gov.uk/ons/guide-method/geography/beginner-s-guide/census/super-output-areas--soas-/index.html`. Accessed: 2014-10-18.

Oksenberg, L., Coleman, L., and Cannell, C. F. (1986). Interviewers' voices and refusal rates in telephone surveys. *Public Opinion Quarterly*, 50(1):97–111.

Rasbash, J., Charlton, C., Browne, W., Healy, M., and Cameron, B. (2015). *MLwiN Version 2.34*. Centre for Multilevel Modelling, University of Bristol.

Schouten, B., Calinescu, M., and Luiten, A. (2013). Optimizing quality of response through adaptive survey designs. *Survey Methodology*, 39(1):29–58.

Uhrig, S. C. (2008). The nature and causes of attrition in the british household panel study. *ISER Working Paper Series*, 2008(05). Colchester: Institute for Social and Economic Research, University of Essex.

Wagner, J. (2013). Using paradata-driven models to improve contact rates in telephone and face-to-face surveys. In Kreuter, F., editor, *Improving Surveys with Paradata: Analytic Uses of Process Information*, Wiley Series in Survey Methodology, pages 145–170. Wiley, Hoboken, N.J., 1 edition.

Wagner, J. R. (2008). *Adaptive survey design to reduce nonresponse bias, PhD Thesis*. University of Michigan, Ann Arbor.

West, B. T. (2013). The effects of errors in paradata on weighting class adjustments: A simulation study. In Kreuter, F., editor, *Improving Surveys with Paradata: Analytic Uses of*

Process Information, Wiley Series in Survey Methodology, pages 361–388. Wiley, Hoboken, N.J.

Appendices

	Wave 2					
	Household Contact			Household Cooperation		
	1	2	3	4	5	6
First Call Status						
Completed interview			1			1
No Reply			0.887			0.888
Unproductive Contact			1.001			0.676***
Appointment made			1.060			0.842
Some interviewing done			1.272			1.168
Any other status			0.989			0.716*
Appointments						
Made & Broke Appointments		1			1	
Made & Kept Appointments		1.370***			1.210**	
Did Not Make Appointments		1.399***			1.234**	
Repeat unproductive contacts		0.918			0.766***	
Above median % of no replies		0.792***			1.034	
Geographical Region						
London	1	1	1	1	1	1
North East	0.729	0.731	0.733	0.970	0.957	0.946
North West	0.857	0.852	0.855	0.932	0.923	0.916
Yorkshire And The Humber	0.587***	0.575***	0.586***	0.814	0.799	0.800
East Midlands	0.904	0.899	0.908	1.097	1.089	1.083
West Midlands	0.649**	0.648**	0.645**	0.940	0.940	0.940
East Of England	1.453*	1.438*	1.449*	1.298*	1.287*	1.295*
South East	1.252	1.229	1.245	1.135	1.135	1.139
South West	0.897	0.875	0.897	1.206	1.184	1.195
Wales	0.587**	0.580**	0.585**	1.154	1.141	1.133
Scotland	0.682**	0.670**	0.677**	0.899	0.893	0.892
Urban Indicator	1.039	1.031	1.037	0.970	0.966	0.970
Dwelling type						
Detached	1	1	1	1	1	1
Semi	0.988	0.995	0.987	1.011	1.015	1.008
Terraced + End	0.738**	0.756**	0.742**	0.987	0.989	0.974
Flat/Maisonette + Purpopse + Converted	0.587***	0.597***	0.590***	0.875	0.871	0.861
Bedsit + W/Bsiness + Sheltr + Inst + Oth	0.917	0.922	0.913	0.943	0.947	0.940
Groundfloor property	0.972	0.977	0.972	0.979	0.986	0.979
Condition of property with respect to neighbours						
Better Or Same	1	1	1	1	1	1
Worse	0.740**	0.750**	0.745**	1.149	1.157	1.149
No Info + Miss	1.115	1.072	1.087	1.300	1.344	1.418
Number of people in household	0.977	0.966	0.968	1.018	1.031	1.027
At least one baby in household	1.222	1.227*	1.217	1.224*	1.214*	1.212*
All residents in poor health (self-reported)	0.754	0.743*	0.748	0.744**	0.746**	0.746**
National origin of household						
All Nonbritish	1	1	1	1	1	1
Mixed	1.470*	1.422*	1.464*	1.486**	1.449*	1.476**
All British	1.291**	1.283**	1.287**	0.902	0.892	0.902
Working status						
No One Works	1	1	1	1	1	1
At Least 1 Works But Not Long Hours	1.028	1.062	1.036	0.755***	0.764***	0.757***
At Least 1 Works Long Hours	0.925	0.950	0.935	0.893	0.898	0.892
All Work Long Hours	0.652***	0.685***	0.670***	0.902	0.901	0.894
Presence of pensioner						
No Pensioner	1	1	1	1	1	1
At Least 1 Pensioner	0.841*	0.860	0.848	0.644***	0.647***	0.646***
All Pensioners	1.553***	1.486***	1.530***	0.609***	0.609***	0.611***
Deprivation indicator (at least 2 items unaffordable)	0.908	0.913	0.906	1.171**	1.182**	1.169**
Owner/Mortgager	1.178*	1.168*	1.181*	1.022	1.017	1.025
No political interest	0.722***	0.732***	0.723***	0.794***	0.799***	0.794***
Community Attachment						
Q4	1	1	1	1	1	1
Q3	1.101	1.101	1.102	0.898	0.897	0.895
Q2	0.981	0.981	0.984	0.855*	0.856*	0.854*
Q1	1.057	1.064	1.062	0.845*	0.842*	0.846*
Missing	0.784*	0.809*	0.793*	0.611***	0.615***	0.615***
No one consents to data linkage	0.797***	0.804**	0.801***	0.579***	0.583***	0.582***
No one present during interview	0.828**	0.831**	0.829**	1.024	1.026	1.025
No suspicion during interview	1.078	1.076	1.075	1.580***	1.570***	1.565***
Excellent understanding of interview questions	1.097	1.090	1.101	1.342***	1.333***	1.338***
Item Nonresponse (log)	0.891**	0.889**	0.891**	0.900***	0.901***	0.900***
Dummy Item Nonresponse (log)	1.076	1.067	1.074	0.910*	0.911*	0.910*
Same LSOA across Waves (1 & 2)	2.900***	2.962***	2.920***	1.667***	1.697***	1.679***
Same interviewer across Waves (1 & 2)	2.257***	2.257***	2.262***	3.114***	3.140***	3.094***
Same LSOA * Same interviewer (interaction)	1.913***	1.864***	1.902***	1.018	0.990	1.009
Constant	4.964***	4.354***	5.237***	3.413***	2.837***	4.049***
Constant (Random Intercept)	1.160***	1.163***	1.161***	1.125***	1.123***	1.122***
Observations	24104	24104	24104	22684	22684	22684
Log Likelihood	-4835.4	-4817.2	-4831.3	-7981.5	-7967.1	-7965.3
Degrees Of Freedom	44	48	49	44	48	49
aic	9762.7	9734.4	9764.6	16055.0	16034.1	16032.6
Odds ratios (Exponentiated coefficients). * p<0.05, ** p<0.01, *** p<0.001						

Row group labels (left margin, vertical): Wave 1 Call Records; Other Wave 1 NR Covariates; x-wave

Table 5: Wave 2

| | Wave 3 | | | | | |
| | Household Contact | | | Household Cooperation | | |
	7	8	9	10	11	12
Wave 1 Call Records						
First Call Status						
Completed interview		1			1	
No Reply		0.656*			1.013	
Unproductive Contact		0.654*			0.764**	
Appointment made		0.795			0.960	
Some interviewing done		0.923			1.830**	
Any other status		0.612			0.817	
Appointments						
Made & Broke Appointments			1			1
Made & Kept Appointments			1.449***			1.170**
Did Not Make Appointments			1.446***			1.171*
Repeat unproductive contacts			0.765*			0.725***
Above median % of no replies			0.764***			1.079
Other Wave 1 NR Covariates						
Geographical Region						
London	1	1	1	1	1	1
North East	0.782	0.787	0.777	0.918	0.906	0.897
North West	0.854	0.837	0.838	1.162	1.153	1.145
Yorkshire And The Humber	0.860	0.833	0.852	1.154	1.129	1.135
East Midlands	1.209	1.201	1.210	1.197	1.191	1.189
West Midlands	0.788	0.781	0.780	1.024	1.024	1.027
East Of England	1.344	1.322	1.341	1.343**	1.337**	1.345**
South East	1.444*	1.413*	1.446*	1.224*	1.227*	1.232*
South West	0.867	0.834	0.860	1.188	1.167	1.180
Wales	0.580**	0.563**	0.569**	1.159	1.143	1.144
Scotland	0.746	0.724*	0.736	0.911	0.904	0.909
Urban Indicator	1.117	1.102	1.115	0.870**	0.865**	0.868**
Dwelling type						
Detached	1	1	1	1	1	1
Semi	0.813	0.820	0.814	0.961	0.963	0.957
Terraced + End	0.741**	0.757*	0.742**	0.988	0.988	0.976
Flat/Maisonette + Purpopse + Converted	0.605***	0.610***	0.605***	1.007	1.000	0.989
Bedsit + W/Bsiness + Sheltr + Inst + Oth	0.594	0.591	0.594	0.962	0.961	0.953
Groundfloor property	1.136	1.131	1.134	0.824*	0.827	0.819*
Condition of property with respect to neighbours						
Better Or Same	1	1	1	1	1	1
Worse	0.815	0.829	0.825	1.186	1.190	1.183
No Info + Miss	0.664	0.656	0.682	2.826	2.946	2.958
Number of people in household	0.897***	0.887***	0.895***	0.975	0.991	0.981
At least one baby in household	1.107	1.099	1.093	1.381***	1.365***	1.368***
All residents in poor health (self-reported)	1.499	1.475	1.482	0.831	0.836	0.839
National origin of household						
All Nonbritish	1	1	1	1	1	1
Mixed	1.061	1.027	1.060	1.258	1.233	1.234
All British	1.011	0.999	1.010	1.142	1.130	1.135
Working status						
No One Works	1	1	1	1	1	1
At Least 1 Works But Not Long Hours	0.995	1.035	1.014	0.746***	0.755***	0.746***
At Least 1 Works Long Hours	0.976	1.003	1.000	0.834**	0.832**	0.825**
All Work Long Hours	0.813	0.860	0.847	0.762**	0.750***	0.751***
Presence of pensioner						
No Pensioner	1	1	1	1	1	1
At Least 1 Pensioner	1.003	1.036	1.008	0.763***	0.762***	0.769***
All Pensioners	2.787***	2.660***	2.716***	0.718***	0.720***	0.726***
Deprivation indicator (at least 2 items unaffordable)	0.793**	0.798**	0.789**	1.070	1.076	1.067
Owner/Mortgager	1.276**	1.260**	1.285**	1.068	1.062	1.066
No political interest	0.821*	0.837*	0.820*	0.808***	0.812***	0.809***
Community Attachment						
Q4	1	1	1	1	1	1
Q3	1.017	1.016	1.024	0.876*	0.875*	0.871*
Q2	1.085	1.089	1.094	0.961	0.965	0.959
Q1	1.016	1.021	1.030	0.832**	0.830**	0.832**
Missing	0.782	0.816	0.799	0.747***	0.753***	0.751***
No one consents to data linkage	0.899	0.917	0.910	0.610***	0.614***	0.615***
No one present during interview	0.903	0.908	0.910	1.047	1.049	1.049
No suspicion during interview	1.004	0.998	0.997	1.358***	1.354***	1.349***
Excellent understanding of interview questions	1.104	1.100	1.110	1.103*	1.095*	1.099*
Item Nonresponse (log)	0.907	0.906	0.908	0.950	0.952	0.952
Dummy Item Nonresponse (log)	0.967	0.959	0.967	0.959	0.962	0.958
x-wave						
Same LSOA across Waves (1 & 3)	2.720***	2.774***	2.739***	0.861*	0.867	0.863
Same interviewer across Waves (1 & 3)	2.365***	2.337***	2.368***	1.180	1.175	1.173
Same LSOA * Same interviewer (interaction)	0.940	0.919	0.931	1.580***	1.567***	1.584***
Constant	10.16***	9.094***	14.18***	7.577***	6.443***	8.089***
Constant (Random Intercept)	1.104*	1.100*	1.110*	1.083***	1.083***	1.083***
Observations	22038	22038	22038	21083	21083	21083
Log Likelihood	-3574.9	-3555.6	-3568.7	-8775.7	-8756.5	-8753.7
Degrees Of Freedom	44	48	49	44	48	49
aic	7241.9	7211.2	7239.4	17643.4	17612.9	17609.4
Odds ratios (Exponentiated coefficients). * $p<0.05$, ** $p<0.01$, *** $p<0.001$						

Table 6: Wave 3

	Wave 4					
	Household Contact			Household Cooperation		
	13	14	15	16	17	18
Wave 1 Call Records						
First Call Status						
Completed interview			1			1
No Reply			0.981			1.002
Unproductive Contact			0.791			0.802*
Appointment made			1.046			0.978
Some interviewing done			1.880			1.276
Any other status			0.923			1.098
Appointments						
Made & Broke Appointments		1			1	
Made & Kept Appointments		1.353**			1.254***	
Did Not Make Appointments		1.482***			1.284***	
Repeat unproductive contacts		0.811			0.746***	
Above median % of no replies		0.761***			0.961	
Other Wave 1 NR Covariates						
Geographical Region						
London	1	1	1	1	1	1
North East	0.791	0.790	0.772	0.793	0.786	0.779
North West	0.887	0.877	0.871	0.926	0.918	0.916
Yorkshire And The Humber	0.984	0.962	0.973	1.026	1.003	1.010
East Midlands	1.089	1.079	1.083	1.031	1.027	1.023
West Midlands	0.812	0.805	0.813	0.982	0.976	0.982
East Of England	1.523*	1.516*	1.523*	1.135	1.127	1.138
South East	1.033	1.016	1.038	1.034	1.029	1.034
South West	1.125	1.095	1.120	1.201	1.180	1.193
Wales	0.911	0.880	0.890	0.872	0.857	0.857
Scotland	0.763	0.741	0.766	0.765*	0.756*	0.765*
Urban Indicator	1.031	1.019	1.029	1.057	1.049	1.052
Dwelling type						
Detached	1	1	1	1	1	1
Semi	0.850	0.854	0.849	0.965	0.970	0.964
Terraced + End	0.854	0.869	0.851	0.946	0.954	0.940
Flat/Maisonette + Purpopse + Converted	0.562***	0.565***	0.557***	0.999	0.999	0.987
Bedsit + W/Bsiness + Sheltr + Inst + Oth	0.715	0.720	0.708	0.948	0.951	0.934
Groundfloor property	0.795	0.799	0.790	0.913	0.918	0.912
Condition of property with respect to neighbours						
Better Or Same	1	1	1	1	1	1
Worse	0.742*	0.762*	0.742*	1.099	1.112	1.096
No Info + Miss	0.798	0.774	0.834	0.948	0.956	0.984
Number of people in household	0.860***	0.850***	0.862***	0.946*	0.953	0.951*
At least one baby in household	1.084	1.076	1.065	1.207*	1.194*	1.198*
All residents in poor health (self-reported)	0.736	0.714	0.741	0.632***	0.627***	0.637***
National origin of household						
All Nonbritish	1	1	1	1	1	1
Mixed	0.955	0.926	0.936	1.262	1.225	1.249
All British	1.141	1.128	1.129	1.067	1.048	1.062
Working status						
No One Works	1	1	1	1	1	1
At Least 1 Works But Not Long Hours	1.143	1.205	1.143	0.874	0.898	0.875
At Least 1 Works Long Hours	0.919	0.951	0.915	0.961	0.972	0.957
All Work Long Hours	0.778	0.834	0.777	0.942	0.959	0.935
Presence of pensioner						
No Pensioner	1	1	1	1	1	1
At Least 1 Pensioner	0.839	0.863	0.849	0.819**	0.825**	0.821**
All Pensioners	2.414***	2.319***	2.423***	0.761***	0.754***	0.766**
Deprivation indicator (at least 2 items unaffordable)	0.783**	0.789**	0.777**	1.002	1.012	1.001
Owner/Mortgager	1.504***	1.488***	1.507***	0.985	0.979	0.985
No political interest	0.707***	0.716***	0.708***	0.804***	0.811***	0.803***
Community Attachment						
Q4	1	1	1	1	1	1
Q3	1.148	1.150	1.142	0.893	0.895	0.890
Q2	0.952	0.958	0.943	0.869	0.871	0.865
Q1	1.030	1.041	1.036	0.877	0.878	0.877
Missing	0.637**	0.667**	0.644**	0.778**	0.795**	0.782**
No one consents to data linkage	0.833*	0.846	0.845	0.718***	0.726***	0.723***
No one present during interview	1.012	1.022	1.018	1.040	1.044	1.040
No suspicion during interview	0.958	0.945	0.952	1.232***	1.224***	1.226***
Excellent understanding of interview questions	1.113	1.111	1.118	1.185***	1.179**	1.185***
Item Nonresponse (log)	0.966	0.964	0.970	0.984	0.986	0.986
Dummy Item Nonresponse (log)	0.920	0.911	0.918	0.960	0.960	0.959
x-wave						
Same LSOA across Waves (1 & 4)	2.702***	2.748***	2.706***	1.241**	1.256**	1.246**
Same interviewer across Waves (1 & 4)	1.247	1.244	1.239	1.275*	1.270*	1.280*
Same LSOA * Same interviewer (interaction)	1.561**	1.527*	1.569**	1.318*	1.302*	1.313*
Constant	23.87***	21.58***	24.92***	7.196***	6.085***	7.494***
Constant (Random Intercept)	1.101	1.108	1.098	1.038	1.040*	1.039
Observations	19699	19699	19699	18947	18947	18947
Log Likelihood	-2902.6	-2889.0	-2896.9	-6777.7	-6762.9	-6769.6
Degrees Of Freedom	44	48	49	44	48	49
aic	5897.2	5878.0	5895.8	13647.3	13625.8	13641.1
*Odds ratios (Exponentiated coefficients). * p<0.05, ** p<0.01, *** p<0.001*						

Table 7: Wave 4