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Dependent Interviewing: Effects on Respondent Burden and Efficiency of Data Collection

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Dependent interviewing techniques, where substantive information from previous interviews is fed forward and used in the formulation of questions or to prompt post-response edit checks, are increasingly employed by panel surveys. While there is substantial evidence that dependent interviewing improves the quality of longitudinal data, claims of improved efficiency of data collection and reduced respondent burden are mostly anecdotal. This article uses data from a large experiment to systematically compare the effects of different question designs on efficiency and burden. The comparison highlights the wide variety of design options for dependent interviewing questions and their corresponding effects. In the present setup, efficiency gains were mainly due to reductions in coding costs for occupation and industry questions. The article concludes by identifying the conditions under which dependent interviewing offers the largest scope for efficiency gains and burden reduction.

Key words: Panel surveys; data collection; questionnaire design; costs.

1. Introduction

All panel surveys feed forward *identifying* information to enable tracing and selection of respondents, and may also use such information as a basis for routing through the questionnaire. Increasingly panel surveys also feed forward *substantive* information, for example answers from previous interviews about income sources or labour market activity. These are used to remind respondents of previous reports and to route around follow-up questions if no changes have occurred (proactive dependent interviewing) or to prompt post-response edit checks to verify changes (reactive dependent interviewing). The main reasons for using dependent interviewing (DI) techniques are either to improve data quality, by reducing false rates of change (see Hill 1994; Hoogendoorn 2004; Jäckle and Lynn 2007; Lynn et al. 2004; 2006; Lynn and Sala 2006; Murray et al. 1991) and item nonresponse (Bates and Okon 2003; Moore and Griffiths 2003), or to increase the efficiency of data collection and reduce respondent burden. While the effects of DI on data quality have been investigated empirically, evidence of the effects on efficiency and burden is mostly anecdotal. The present article evaluates the effects of DI on efficiency

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and burden using data from a large-scale experiment, which compared proactive and reactive DI with independent interviewing for a range of survey items.

The general conception is that "Dependent interviewing can bring very significant savings in both interview and coding time" (Lynn et al. 2006, p. 364). Proactive DI can be used to identify whether the respondent's situation has changed, and if it has not, to route around redundant follow-up questions to which the responses are already known from the previous interview. This can reduce the redundancy of questions and shorten interview durations. The previous responses can be imputed for the current interview, which for open-ended questions in addition reduces coding costs. Fewer redundant (and therefore potentially irritating) questions and shorter interview durations also reduce respondent burden. Presenting previous answers to respondents can in addition make questions less tedious and demanding: the cognitive task of remembering becomes a task of recognising (Hoogendoorn 2004). Finally, the required answers may be shorter and easier. For example a question about current occupation can be phrased as a yes/no question ("Last time you said your occupation was $<OCCUPATION>$. Are you still in that occupation?") instead of an open-ended question.

The effects of DI on efficiency and burden are not easily unravelled. Mathiowetz and McGonagle (2000, p. 411) noted that "the effect of dependent interviewing on administration time [is not clear]; the interviewers for several studies have indicated that the use of rosters resulted in more efficient interviewing (no quantitative data available), but the need to resolve conflicting pieces of information may lead to increases in administration time." Hoogendoorn (2004) described an application of proactive DI to questions on assets and liabilities and concluded that it did not lead to a substantial reduction in respondent burden in terms of interview duration. This conclusion requires qualification, however. Proactive DI can have opposing effects on sets of questions that are repeated an indefinite number of times. In Hoogendoorn's case respondents were first asked to report all assets and liabilities and then asked a set of follow-up questions about the characteristics of each item. If proactive DI reduced under-reporting in the first stage by reminding respondents of assets reported in the past, it would have multiplied the number of times the follow-up questions were asked. So although proactive DI may lead to savings in questions and interview duration for a given number of items reported, overall these savings may be compensated by reductions in under-reporting.

This article provides a systematic comparison of the effects of different DI designs on efficiency and burden for questions on current employment, earnings, school-based qualifications, income sources and labour market activities since the previous interview. The comparison highlights the variety of design options for DI questions and their corresponding effects. Different scenarios are distinguished depending on the extent to which the DI design eliminates redundancies or adds questions and the extent to which net effects depend on the stability of characteristics or on the effect of DI on under-reporting. The indicators of respondent burden and efficiency of data collection used here are the length of time respondents took to answer questionnaire sections, the count of questions asked and the count of open-ended questions subsequently coded. These measures are directly related to the costs of interviewing and coding and are often used as measures of *actual* respondent burden (see Hedlin et al. 2005, Section 1.2). Respondent burden, however, also depends on respondents' *perceptions* of the survey experience. Bradburn

(1978) first introduced the notion of perceived burden. He suggested that burden should be measured using subjective measures such as required effort and stress caused by survey questions, in addition to objective measures of interview length and frequency of interviews. This concept was operationalised by Hedlin et al. (2005), who developed indices of respondent burden from both objective measures, including the time it took to complete the survey, and subjective measures, including the perceived difficulty of questions, instructions and the general layout, perceived length, perceived utility and attitudes towards the survey. In the present study, information about perceived (subjective) burden was not available and the focus is therefore on the effects of dependent interviewing on actual (objective) burden.

The experimental data and the design of the dependent interviewing questions are presented in Section 2, followed by an outline of the expected effects in Section 3. Section 4 examines the effect of reactive and proactive DI for each of the five experimental questionnaire sections. Section 5 concludes by drawing out the conditions under which DI offers the largest scope for improvements in terms of efficiency and burden.

2. Data and Experimental DI Questions

The data stem from an experiment carried out as part of a project on "Improving Survey Measurement of Income and Employment (ISMIE)" funded by the UK Economic and Social Research Council Research Methods Programme. The study followed up respondents from the UK low-income subsample of the European Community Household Panel Survey, for which funding expired in 2001. Respondents had been interviewed annually, since 1994 as a stand-alone survey and since 1997 as part of the British Household Panel Survey (BHPS). The experimental study was based on the 2002 BHPS questionnaires, although some sections were shortened and others added for methodological purposes (for details see Jäckle et al. 2004). Computer assisted personal interviews (CAPI) were sought with all full respondents to the 2001 survey and achieved with 1,033 adults (89%). Fieldwork took place in spring 2003.

Three versions of questions were developed: proactive dependent interviewing (PDI), reactive dependent interviewing (RDI) and independent interviewing (INDI). The INDI version used the standard BHPS questions. Respondents were randomly assigned to one of the three treatment groups. The experimental questions were limited to five sections of the questionnaire. These covered current employment, earnings from employment, labour market activities since the previous interview (including employment, self-employment, unemployment and spells out of the labour force, such as retirement and full-time education), income sources (including State benefits and other sources of unearned income, such as rents and private transfers) and school-based qualifications.

The DI questions were mainly designed to improve data quality, although the PDI questions on current and retrospective occupation and industry were designed to also reduce redundancy of questions and coding. The effects on data quality were examined by Jäckle and Lynn (2007), Lynn et al. (2004; 2006) and Lynn and Sala (2006). Jäckle (2009) discussed the DI design features in detail and synthesised and contrasted the effects of different DI designs on data quality. The effects of DI on burden and efficiency of data collection have however not been considered and are examined here.

Appendix 1 summarises the topic content, routing and response format of the experimental questions. (The full experimental questionnaire script is available in Appendix 2 of the ISMIE User Guide: Jäckle et al. 2005.) The first four columns list the INDI questions against which the effects of DI are compared. The other columns show how these were adapted with DI. In all cases the routing refers only to sample members who were routed into the relevant section in the first place. For example, the INDI questions about current employment were asked of all respondents who earlier in the interview had reported having worked during the past seven days.

Based on Appendix 1, Table 1 synthesises the differences between the experimental questions which are expected to affect burden and efficiency. The first column indicates the type of question used with INDI: occupation and industry were open-ended questions requesting verbatim descriptions; employment status, managerial status and size of workforce were closed questions; earnings was an open question requesting a numeric answer; the questions about income sources, labour market history and school qualifications were sets of questions that were repeated as indeterminate loops, for example once for each income source reported. The following sections illustrate the RDI and PDI versions and give examples of question wording.

2.1. *Reactive DI*

With the RDI versions respondents were always asked the INDI question first. Some respondents were then asked additional follow-up questions (see Appendix 1). The objective was to verify apparent changes in reports and to ascertain that changes were not spurious, caused for example by different descriptions and subsequent coding of industry and occupation or by recall or data entry errors. For some items the follow-up questions were always asked; for others they were only asked if reports were inconsistent or inconsistent beyond a predefined threshold (see Table 1). RDI therefore involved additional questions compared to the INDI version, but not necessarily for all sample members.

In the case of current occupation and industry a follow-up question was always asked to ascertain whether the verbatim answer referred to the same occupation or industry as in the previous interview. For example, Question R-j2 in Appendix 1 read "Is that the same employer that you were working for last time we interviewed you, on $<$*DATE OF INTERVIEW*$>$, when we recorded your employer as $<$*EMPLOYER*$>$?" For school-based qualifications a follow-up question was triggered for every new qualification reported (R-q1): "You have told me that you have gained $<N_2>$ $<$*QUALIFICATIONS OF TYPE X*$>$ since last time we interviewed you, and my records show that you previously had $<N_1>$ $<$*QUALIFICATIONS OF TYPE X*$>$, so, you now have a total of $<N_1 + N_2>$ $<$*QUALIFICATIONS OF TYPE X*$>$: is that correct?"

For earnings a follow-up question was triggered if the report was 10% higher or lower than the previous report. Question R-e1 was "So, your $<$*GROSS/NET*$>$ pay has gone $<$*UP/DOWN*$>$ since last time we interviewed you, from $<AMOUNT_1>$ per $<PERIOD_1>$ to $<AMOUNT_2>$ per $<PERIOD_2>$: is that correct?"

For all other sections, follow-up questions were asked whenever a report was inconsistent with the previous report. For example, Question R-i1 about unearned income

Table 1. Design of ISMIE dependent interviewing questions

Question	INDI Response	RDI Follow-up	PDI Question type	Replaces INDI if no change	Response
Current employment					
Occupation	Open (text)	Always	Remind, still	Yes	Yes/No
Industry	Open (text)	Always	Remind, still	Yes	Yes/No
(Self-)Employed	2 Categories	If inconsistent	Remind, still	Yes	Yes/No
Managerial duties	3 Categories	If inconsistent	Remind, still	Yes	Yes/No
Size of workforce	9 Categories	If inconsistent	Remind, still	Yes	Yes/No
Earnings from employment	Open (number)	If change exceeds threshold	Remind, still	No	Yes/No
Income sources	Loop	If inconsistent	Remind, continue	No	Loop[a]
Labour market history	Loop	If inconsistent	Remind, confirm	No	Loop[a,b]
School-based qualifications	Loop	If new qualifications	Remind, confirm	No	Loop[a]

[a] Wording of some of the INDI questions adapted for the DI loops.
[b] Fewer questions than in the INDI loop.

sources was "Can I just check, according to our records you have in the past received <*INCOME SOURCE*>. Have you received <*INCOME SOURCE*> at any time since <*DATE OF INTERVIEW*>?" Similarly Question R-j3 about current employment was "So, since last time we interviewed you, on <*DATE OF INTERVIEW*>, you've changed from being <*EMPLOYMENT STATUS*$_1$> to <*RESPONSE TO I-J4*>: is that correct?"

In all cases respondents were asked to correct and, except for current occupation, industry and income sources, to explain reasons for discrepancies. Interviewers recorded these explanations as verbatim text.

2.2. *Proactive DI*

With PDI respondents were always reminded of the answers they had given in the previous interview. This previous information was however used in different ways, with different implications for burden and efficiency (see Table 1). For some topics the previous information was used to ask whether the respondent's situation was still the same (remind, still). If yes, this replaced the original INDI question; if no, the original INDI question was also asked. That is, with "remind, still" questions, PDI meant additional (yes/no) questions if the respondent's situation had changed. If the situation had not changed, the (yes/no) PDI question replaced the INDI question, which would often have been more difficult (for example open-ended). For other topics the previous information was used to ask respondents to confirm the survey records (remind, confirm). In this case, the PDI questions were always additional and did not replace any INDI questions. In some cases, the previous reminder was merely used as a boundary incorporated into the wording of the original INDI question (remind, continue). In this case, PDI did not affect the number of questions, but did lengthen question wording.

"Remind, still" questions were used for all questions about current employment. Question P-j1, for example, read "Last time we interviewed you, on <*DATE OF INTERVIEW*>, you said your occupation was <*OCCUPATION*>. Are you still in that same occupation?" If "no," respondents were in addition asked the open INDI question (I-j1): "What was your (main) job last week? Please tell me the exact job title and describe fully the sort of work you do." The answer was coded to the Standard Occupational Classification. In contrast, for respondents who were still in the same occupation, the PDI yes/no question replaced the open-ended INDI question and the occupation code from the previous wave was brought forward. The same logic applied to the questions about the respondent's employer and the closed questions about the employment characteristics. A "Remind, still?" question was also used to ask about current earnings (P-e1): "Last time we interviewed you, on <*DATE OF INTERVIEW*>, our records show that your pay was <*AMOUNT*> per <*PERIOD*> <*GROSS/NET*>. Is that still the case now, or has your pay changed?" In this case, the INDI questions were however asked additionally of all respondents, as the purpose of including the PDI question was to test whether it would capture changes in earnings.

For income sources the reminder merely provided a boundary and memory support. In these "remind, continue" type questions, the respondent was reminded of previous sources and asked whether he or she had continued to receive these (P-i1): "According to our records, when we last interviewed you, on <*DATE OF INTERVIEW*>, you were receiving

$<$*INCOME SOURCE*$>$, either yourself or jointly. For which months since $<$*MONTH OF INTERVIEW*$>$ have you received $<$*INCOME SOURCE*$>$?" After going through a loop of questions about the details of each income source previously reported, respondents were asked the INDI questions in order to capture any additional sources received since the previous interview. This involved showing the respondents four showcards, each containing a list of up to ten income sources.

For the labour market activity history and school-based qualifications, the respondent was asked to verify the information recorded in the previous interview. The "remind, confirm" question about qualifications (P-q1) was: "According to our records from previous interviews, you have $<$*HIGHEST QUALIFICATION*$>$. Is that correct?" Respondents were then asked an adapted version of the loop of questions about qualifications gained since the previous interview.

The activity history questions were designed to reduce redundancy of questions for all respondents, by eliminating the overlap in activity reports across interviews. In the INDI version, respondents were asked to report details of their current activity at each interview. In the following year, they were asked about their activities since the start of fieldwork for the previous wave. Respondents therefore reported on their Wave t current activity again in Wave $t + 1$: either in the form of the $t + 1$ current activity if this had not changed, or in the retrospective histories if the activity had changed. The PDI design eliminated the overlap in the activity history questions by reminding respondents of their previous report of current activity at t and asking when this had ended: (P-h1) "When we last interviewed you, on $<$*DATE OF INTERVIEW*$>$, our records show that you were $<$*ACTIVITY*$>$. Is that correct?" This was used as the starting point for asking about subsequent activities during the reference period, until the $t + 1$ current activity was reached. For each employment spell reported in the activity history section, respondents were routed through a loop of 15 questions about the characteristics of the employment. Not asking about the wave t current activity again at $t + 1$ therefore meant that respondents were asked three questions fewer, if they had not been in employment at time t, or 15 questions fewer, including two open-ended questions about occupation and industry, if they had been in employment.

3. Expected Effects of DI

With RDI the only differences compared to INDI were the additional follow-up questions and requests for clarification. One would therefore expect all RDI questions to have either no effect or adverse effects on efficiency and respondent burden. The differences compared to INDI will be particularly large for those questions where the follow-up questions were asked of all respondents (follow-up, always), but may make less of a difference for other questions where the follow-up was only asked of respondents who provided inconsistent reports (follow-up if inconsistent or with threshold).

The PDI questions can be grouped into four scenarios according to their expected effects on efficiency and burden. First, the design of the (remind, confirm) school-based qualification and (remind, still) earnings questions always implied additional questions, before asking adapted versions of the INDI questions. One would not therefore expect any gains in efficiency or reductions in respondent burden.

Second, for the current employment questions the net effect of PDI depended on the degree of stability experienced by respondents. If their situation had not changed since the previous interview, the (remind, still) PDI questions replaced potentially more difficult and longer INDI questions. One would therefore expect the PDI question to reduce burden, interview duration and for open-ended INDI questions also coding costs. If, however, the respondent had experienced a change, the original INDI question was asked in addition to the PDI question. The net effect of PDI for the sample therefore depends on the rates of change in the characteristics measured.

Third, in the labour market activity history questions redundancies in reporting the previous current economic activity were reduced for all respondents by using the "remind, confirm" questions to eliminate overlapping reference periods. One would therefore always expect the PDI activity history questions to be more efficient. Since INDI asked a larger number of questions about employment spells than about nonemployment spells, the gains are likely to be larger if the prevalent activity at Wave t was employment. However, the subsequent scenario also has an effect on the activity history questions.

Fourth, for the questions on activity history spells and income sources the net effect of PDI depends on the effect on under-reporting. In these sections a predetermined number of questions were asked about each spell or source reported by the respondent. Depending on the number of spells or sources reported, the total number of questions therefore varied across respondents. (These sections can be thought of as "indeterminate loops," where the size of the loop is known in advance but it is not known how often the loop will be repeated.) For a given number of reported spells the "remind, continue" or "remind, confirm" question should simplify the recall and identification of income sources and activity spells, especially since both types of questions are burdensome, because they involve long lists or require retrospective recall. On the other hand, if the reminder reduces under-reporting of spells, PDI has a multiplicative effect on the number of questions respondents have to answer, since the loop is repeated once for each additional spell reported (this differs from the first two scenarios, where the PDI questions are merely additive.) The net effect of PDI on the indeterminate loop sections therefore depends on the effect of PDI on under-reporting.

Before examining the results, it is worth mentioning how the design of the DI questions in the ISMIE experiment compared to that in other surveys currently using DI techniques. The comparison is not straightforward, however, because different surveys use DI for different sets of questions and apply a variety of design features. In general the ISMIE PDI questions on occupation and industry were similar to those in the Current Population Survey (CPS), the Survey of Labour and Income Dynamics (SLID) and the Survey of Income and Programme Participation (SIPP). The main difference is that these surveys make more use of routing around follow-up questions on employment characteristics. The PDI question on income sources was similar to that in the SIPP, as was the RDI question on earnings. Finally, the RDI question on income sources was similar to that in the SLID. (For information on DI in these surveys, see Hiltz and Cléroux 2004a; 2004b; Kostanich and Dippo 2002; Moore and Griffiths 2003.) The comparison with PDI designs in other surveys suggests that there is scope for further efficiency gains compared to the ISMIE setup if more extensive use is made of skipping follow-up questions in situations where a respondent reports no change. There is also more scope for efficiency gains in surveys

where the proportion of respondents who have not experienced changes is larger. This is likely to be the case in surveys with shorter intervals between interviews, such as the CPS where interviews take place monthly.

4. Results: DI Can Increase Efficiency and Reduce Burden

As expected, the effects of DI on efficiency and burden varied considerably across questions, depending on their nature and design. Each experimental questionnaire section is therefore discussed separately, rather than drawing conclusions for the interview as a whole. The indicators of efficiency and burden used were (1) the mean number of questions asked, (2) the mean number of open-ended questions which required subsequent coding and (3) the mean administration time in minutes (Table 2). The hypotheses about the effects of DI were tested by testing for differences in means of these indicators, comparing each DI treatment to INDI. Sample sizes for these tests varied, since the analysis for each section was based on the subsample of respondents who would have been asked the experimental questions: qualification questions were asked of all respondents; earnings were only asked of employees; current employment included the employed and self-employed; income sources included respondents who had reported at least one source in the previous interview; the labour market history section included only respondents whose activity had changed during the reference period.

Separate information on administration time was available for the demographic section of the survey, which included the qualification questions, and for the household finance section, which included the income source questions. The questions related to economic activity (current employment, earnings and activity history) were timed as one survey section. Table 2 does not therefore include the average durations for these three experimental sections. Instead, Table 3 presents the results of regressing the administration time for the combined economic activity sections on dummies for the

Table 2. Mean number of questions and section timings

Section	Mean	INDI	RDI	PDI
Current employment	Number of questions asked	5.8	8.0***	6.0
	Number of questions coded	2.0	2.0	0.7***
	N	166	155	168
Earnings from employment	Number of questions asked	6.5	6.7	7.3***
	N	149	137	149
Income sources	Number of questions asked	15.1	16.9*	21.4***
	Length of section (mins)	11.2	10.6	11.9
	N	262	274	252
Labour market history	Number of questions asked	14.8	14.1	6.6***
	Number of questions coded	2.1	1.8	0.4***
	N	75	82	99
School-based qualifications	Number of questions asked	0.7	0.4	1.4***
	Length of section (mins)	3.3	2.9*	3.7
	N	348	344	341

Notes: Asterisks (*) indicate results from a test of difference in means compared with INDI.
***$P < .001$, **$.001 < P < .01$, *$.01 < P < .05$. Source: ISMIE survey.

Table 3. Predicted administration times for the combined economic activity sections

	OLS			Summary Statistics	
Administration time (minutes)	Coeff.	Std. Err.	*P*	Mean	Std. Err.
PDI	−0.065	0.415	0.876	0.331	0.471
RDI	0.073	0.399	0.854	0.333	0.472
Currently employed	9.685	0.948	0.000	0.473	0.500
Currently employed*PDI	−1.760	1.398	0.179	0.163	0.370
Currently employed*RDI	−1.974	1.325	0.137	0.150	0.357
Currently earning	−1.451	0.959	0.130	0.420	0.494
Currently earning*PDI	2.151	1.326	0.105	0.145	0.352
Currently earning*RDI	3.390	1.340	0.012	0.132	0.339
Labour market activity history	5.741	0.486	0.000	0.255	0.436
Labour market activity history*PDI	−2.784	0.668	0.000	0.092	0.289
Labour market activity history*RDI	−0.104	0.689	0.880	0.081	0.272
Constant	1.670	0.285	0.000	–	–
N	1,030				
Adjusted R^2	0.670				

Source: ISMIE survey.

experimental sections answered and interactions with the treatment groups expected to affect timing. The reference group in this regression were INDI respondents who were not currently in work, had reported no earnings and whose labour market activity had not changed during the reference period. This group took on average 1.7 minutes to complete the economic activity sections. The coefficients indicate by how many minutes, on average, the administration time differed for respondents in different treatment groups and reporting different labour market situations compared to this reference group. The final two columns document summary statistics for the explanatory variables.

4.1. Effects of RDI

For those questions where all respondents were asked a follow-up question, Table 2 suggests support for the hypothesis that RDI would have a significantly negative effect on burden and efficiency. For the employment section, where the RDI questions on occupation and industry were asked of all sample members, the mean number of questions was 8.0, compared to 5.8 with INDI ($P < .001$). This difference in the number of questions is however not reflected in the administration times: reporting current employment with the RDI version did not lengthen the administration time compared to INDI (Table 3).

In the other sections, where only the subsample of respondents with inconsistent reports was asked follow-up questions, the only significant differences in the mean number of questions asked were in the section on unearned income sources. Here the follow-up questions increased the number of questions from 15.1 to 16.9 ($P < .05$), but again did not affect the administration time. The lack of effect in the other sections reflects the fact that follow-ups only affected a small proportion of the sample. The timing of the demographic section, which included the school qualification questions was slightly shorter with RDI

than INDI. This is unexpected, as there is no reason why the number of questions asked with RDI would ever be smaller than with INDI. The qualification questions were however only a small subset of the demographic section and there may have been differences due to sampling variance in the proportions of respondents routed around other sets of questions in this section. Finally, although the number of questions in reporting current earnings was not significantly different, Table 3 suggests that the RDI earnings questions took on average 3.4 minutes longer than the corresponding INDI questions. For these questions, RDI respondents were asked whether the apparent change in earnings was correct, and if they said it was not, they were in addition asked to provide a clarification, which the interviewer recorded as verbatim text. The additional verbatim explanations may have taken a long time to administer; however, an open-ended clarification was only recorded for one of the RDI respondents. The size of this difference in administration time is therefore also unexpected.

4.2. Effects of PDI: School-based Qualifications and Earnings

In these sections the PDI design involved an additional question for all respondents. This is reflected in Table 2: PDI increased the mean number of questions by just under one in both sections ($P < .001$). Confirming previous reports of school-based qualifications somewhat increased the duration of the demographic section (Table 2) and reporting earnings with PDI increased the timing of the employment and labour market history section (Table 3) compared to INDI. Neither difference was significant, however.

For current earnings all PDI respondents were also asked the INDI questions about their current earnings, regardless of whether they had reported a change or not in response to the PDI "remind, still" question. Efficiency gains could in theory have been achieved by skipping the INDI questions if respondents reported no change. In practice such a design would be doubtful, due to concerns that respondents might tend to report "no change" to avoid follow-up questions. Although the present experiment did not produce an underestimation of change in earnings with PDI compared to INDI, the risk could be higher if PDI was used repeatedly and respondents' earnings were fed forward over multiple waves (see Jäckle 2009).

4.3. Effects of PDI: Current Employment

In this section the net effect of PDI depended on the degree of stability experienced by respondents: if no changes had occurred, the closed PDI question replaced the INDI question and the responses from the previous interview were imputed; if changes had occurred respondents were asked the original INDI questions in addition to the PDI questions. According to Table 2, PDI did not significantly affect the mean number of questions asked. The number of open-ended questions about occupation and industry was however significantly reduced: from 2.0 with INDI to 0.7 with PDI ($P < .001$). In the ISMIE survey, coding costs amounted to approximately GBP 0.45 per code. (This estimate covers all coding done for the survey and is likely to be conservative to the extent that industry and occupation coding was more costly than other coding activities.) The average cost with INDI was therefore GBP 0.90 per employed respondent, compared to GBP 0.32 with PDI, reducing coding costs by 65%. The reduction in the number of open-ended

questions tended to reduce the combined duration of the economic activity related questions. The difference in administration time between PDI respondents in employment and similar INDI respondents was however not significant (Table 3).

Additional savings could be achieved by routing respondents who report working for the same employer and in the same occupation as in the previous year around subsequent questions on the nature of their work, for example whether they were an employee or self-employed, whether they had managerial duties or the size of the workforce.

4.4. Effects of PDI: Income Sources

In the sections where questions were repeated as indeterminate loops, the net effect of PDI on burden depended on the effect on under-reporting. In the income sources section, PDI respondents answered on average eight questions more than INDI respondents. This is not, however, because PDI added many questions per se (for each income source reported in the previous interview, one question was added). The initial interpretation was that this increase was due to a reduction of under-reporting of income sources, since for each source reported, five follow-up questions were asked. On inspection of the data, however, it became clear that the increase in the average number of answers was due to the PDI design offering respondents a chance to report some income sources twice. Nearly 50% of PDI respondents who answered this section reported at least one source twice, first when asked about a previous income source and then in the INDI follow-up question, when respondents were shown showcards and asked whether they had received any other sources. (Duplicate reports were recorded by nearly all interviewers, but prevailed among respondents who reported three or more different income sources. This could perhaps be avoided by placing more emphasis on the need to exclude sources that have already been mentioned, both in the question wording and in the interviewer training.)

Ignoring duplicate reports, the reporting of income sources hardly increased with PDI: INDI respondents reported on average 1.9 sources, compared to 2.1 sources with PDI (2.7 compared to 2.9 among respondents who reported at least one source). Including duplicate reports, the number of sources reported with PDI was 3.0 (4.1 among respondents who answered the income source questions). Although duplicate reporting increased the number of answers by 50%, the time to administer this section did not increase compared to INDI. Presumably respondents who were reporting on a source for the second time did not have to think much about the answers; nonetheless one would expect the timing to increase. This suggests that the income source questions were faster to administer with PDI, possibly because INDI respondents spent a lot of time at the first stage, sorting out which sources they received, and that this time was reduced when they were reminded of their previous answers.

4.5. Effects of PDI: Labour Market History Spells

In this section questions were also repeated as indeterminate loops. Eliminating the redundancy in reporting the previous current activity meant that efficiency gains should be expected. An increase in questioning would however also be possible, if PDI were to reduce under-reporting of activity spells. Since the number of loop questions was larger for employment spells, gains should be larger if employment was the prevalent activity at the previous interview.

The mean number of answers was reduced from 14.8 with INDI to 6.6 with PDI ($P < .001$), while the number of coded answers was reduced from 2.1 to 0.4 ($P < .001$). Differences in coding costs for the activity history questions were consequently even larger than for the current employment questions, with PDI reducing costs by 81%. The average cost for respondents who answered the labour market activity history questions was GBP 0.95 with INDI, compared to GBP 0.18 with PDI. Table 3 indicates the effect of reporting retrospective employment and nonemployment spells on the combined administration time. Compared to INDI respondents who did not report any changes in their labour market activity, INDI respondents who did report changes took on average 5.7 minutes longer to complete the section; PDI respondents on average only took 2.9 minutes longer. Completing the labour market activity history was therefore on average 2.8 minutes faster with PDI than INDI.

The large reduction in the number of questions indicates that employment was indeed a prevalent type of activity at the time of the former interview. Reminding respondents of their previous activity did not appear to increase reporting, since the average number of activity spells reported by INDI and PDI respondents was no different (0.4 among all respondents and 1.6 and 1.5 respectively among respondents who answered the activity history section). On the other hand, the average recall period for the PDI sample was one month shorter than for the INDI and RDI samples (17 instead of 18 months), because PDI respondents were only asked about their retrospective activities until the date of the previous interview, while INDI and RDI respondents were asked about their activities until the start of fieldwork for the previous wave. Whether the reminder and the shorter reference period had opposing effects on the number of spells reported is impossible to distinguish.

5. Summary and Conclusions

This article has provided a systematic comparison of the effects of different DI designs on the efficiency of data collection and respondent burden. In the present study gains were mainly achieved by PDI for questions about labour market activities. PDI reduced coding time by 65% in the current employment section and by 80% in the labour market activity history. For a sample of 10,000, assuming an employment rate of 60% and given the coding costs described earlier, this would represent savings in coding costs of approximately GBP 8,100 per wave of data collection. PDI in addition reduced the estimated duration of the labour market activity history by nearly three minutes.

The main contribution of this study is to highlight the effect of different design features, both of the DI questions and the survey. In general, the effects firstly depend on whether DI is used to route around redundant questions (as "remind, still" questions may do), or whether DI merely adds questions (as all RDI follow-ups and the PDI "remind, confirm" questions do). The effects secondly depend on whether reminding the respondent of previous answers has any effect on the difficulty of the question. If DI is used as an opportunity for additional routing through "remind, still" questions, the effect depends on the degree of stability in the characteristics measured, which is largely determined by two general features of the survey: the length of the reference period and the nature of the characteristics of interest.

The findings suggest that while RDI always implies additional questions, it does not necessarily have much negative effect if the additional questions are only asked of subsamples of respondents. This is the case with "follow-up if inconsistent" or "follow-up with threshold" DI designs.

Similarly, PDI does not offer any gains if previous information is used for "remind, confirm" or "remind, continue" DI designs, which imply additional or longer questions for all sample members. Such designs may, however, not have any negative effects either, if the questions are easier than the original INDI questions. PDI offers the largest scope for improving efficiency and reducing burden if previous information is used in "remind, still" questions and applied:

1. to route around open-ended questions which are subsequently coded, in which case both interview and coding time can be reduced,
2. to route around multiple follow-up questions, or loops,
3. to difficult questions where the reminder significantly accelerates respondent recall and reporting,
4. to simplify the nature of required answers, in particular by asking yes/no instead of open-ended questions,
5. to questions about relatively stable characteristics,
6. in surveys with short intervals between interviews.

The extent to which the gains estimated for this study generalise to other settings depends on differences in the characteristics in 1. to 6. above between the items, DI designs and surveys under consideration. Three caveats with regard to this study should also be mentioned. Firstly, the definition of efficiency in terms of administration and coding time ignores other aspects such as additional costs of preparing substantive data to be fed forward and costs of programming and testing complex DI questionnaires in CAPI or CATI. Programming costs are fixed, so the cost per respondent decreases with the size of the sample, while feed-forward costs are proportional to the sample size. Given the savings in coding and administration costs, the initial development costs for DI may be offset by efficiency gains at each wave, especially for large sample surveys. For the present experiment data about the costs of implementing DI were unfortunately not available. Secondly, the definition of respondent burden in terms of administration times and number of questions ignores issues of perceived burden, about which no information was available for this study. Thirdly, the information about administration time was not ideal, as it covered entire questionnaire sections, of which only some questions were experimental. Keystroke data on the timing of individual questions would provide a more informative test.

Finally, aspects other than efficiency and burden need to be taken into account when making decisions about the use of DI. The scope for efficiency gains through skipping questions also depends on the reliability of data collected at the initial wave. The use of dependent interviewing at subsequent waves may therefore warrant more care and time at the initial wave. Ultimately the decision whether to adopt DI techniques should weigh net costs against effects on data quality, including effects on accuracy (e.g., Lynn et al. 2004), reliability of estimates of change (e.g., Jäckle and Lynn 2007), item nonresponse and attrition (e.g., Moore et al. 2004).

Appendix 1. Experimental Questions – Topic Content, Response Format and Routing

INDI				RDI				PDI			
Routing	Item	Topic	Response	Routing	Item	Topic	Response	Routing	Item	Topic	Response
Current employment (all in work during past 7 days)											
All	I-j1	Occupation	Open (text)	All	I-j1	Occupation	Open (text)	All	P-j1	Previous <occupation>, still?	Yes/no
				All	R-j1	Same?	Yes/no	If 'no'	I-j1	Occupation	Open (text)
All	I-j2	Industry	Open (text)	All	I-j2	Industry	Open (text)	All	P-j2	Previous <employer>, still?	Yes/no
All	I-j3	Employer name	Open (text)	All	I-j3	Employer name	Open (text)	If 'no'	I-j2	Industry	Open (text)
				All	R-j2	Same?	Yes/no	If 'no'	I-j3	Employer name	Open (text)
All	I-j4	Employment status	2 Cat.	All	I-j4	Employment status	2 Cat.	All	P-j3	Previous <employment status>, still?	Yes/no
				If inconsistent	R-j3	Changed from. . .to . . .?	Yes/no	If 'no'	I-j4	Employment status	2 Cat.
				If 'no'	R-j4	Clarify	Open (text)				
All	I-j5	Managerial duties	3 Cat.	All	I-j5	Managerial duties	3 Cat.	All	P-j4	Previous <managerial duties>, still?	Yes/no
				If inconsistent	R-j5	Changed from. . .to . . .?	Yes/no	If 'no'	I-j5	Managerial duties	3 Cat.
				If 'no'	R-j6	Clarify	Open (text)				
All	I-j6	Size of workforce	9 Cat.	All	I-j6	Size of workforce	9 Cat.	All	P-j5	Previous <workforce>, still?	Yes/no

Appendix 1. Continued

INDI				RDI				PDI			
Routing	Item	Topic	Response	Routing	Item	Topic	Response	Routing	Item	Topic	Response
				If inconsistent	R-j7	Changed from. . .to . . .?	Yes/no	If 'no'	I-j6	Size of workforce	9 Cat.
				If 'no'	R-j8	Clarify	Open (text)				
Earnings from employment (all employees)											
All	I-e1	Gross pay	Open (no.)	All	I-e1	Gross pay	Open (no.)	All	P-e1	Previous <pay>, still?	Yes/no
All	I-e2	Period covered	6 Cat.	All	I-e2	Period covered	6 Cat.	All	I-e1	Gross pay	Open (no.)
All	I-e3	Net pay	Open (no.)	All	I-e3	Net pay	Open (no.)	All	I-e2	Period covered	6 Cat.
All	I-e4	Period covered	6 Cat.	All	I-e4	Period covered	6 Cat.	All	I-e3	Net pay	Open (no.)
				Threshold	R-e1	Changed from. . .to. . .?	Yes/no	All	I-e4	Period covered	6 Cat.
				If 'no'	R-e2	Clarify	Open (text)				
Unearned income sources (all)								(All who reported any sources in previous interview)			
All	I-i1	Any income sources	Yes/no	All	I-i1	Any income sources	Yes/no	All	P-i1	Previous<source>, which months?	Tick all
If 'yes'	I-i2	Which sources	Tick all	If 'yes'	I-i2	Which sources	Tick all	Loop	I-i4	Still receiving	Yes/no
Loop	I-i3	For which months	Tick all	Loop	I-i3	For which months	Tick all		I-i5	Last amount	Open (no.)
for	I-i4	Still receiving	Yes/no		I-i4	Still receiving	Yes/no		I-i6	Period covered	6 Cat.
each	I-i5	Last amount	Open (no.)		I-i5	Last amount	Open (no.)		I-i7	Sole or joint receipt	2 Cat.
source	I-i6	Period covered	6 Cat.		I-i6	Period covered	6 Cat.	All	P-i2	Any other sources	Yes/no

Appendix 1. Continued

INDI				RDI				PDI			
Routing	Item	Topic	Response	Routing	Item	Topic	Response	Routing	Item	Topic	Response
listed	I-i7	Sole or joint receipt	2 Cat.		I-i7	Sole or joint receipt	2 Cat.	If 'yes'	Repeat I-i2 to I-i7		
				If inconsistent (all who did not report a sources reported at prior interview)							
					R-i1	Received <source> ?	Yes/no				
				If 'yes'	Repeat I-i3 to I-i7						
Labour market activity history (if activity change in ref. period)											
All	I-h1	Prior activity	10 Cat.	All	I-h1	Prior activity	10 Cat.	All	P-h1	Previous <activity>, correct?	Yes/no
All	I-h2	Start date	D/M/Y	All	I-h2	Start date	D/M/Y	If 'no'	P-h2	Previous activity	10 Cat.
If work . . .		Job chars. (15 Qs)		If work	. . .	Job chars. (15 Qs)		All	P-h3	End date of previous activity	D/M/Y
If I-h2 in reference period: Repeat I-h1 and I-h2				If I-h2 in reference period: Repeat I-h1 and I-h2				All	P-h4	Subsequent activity	10 Cat.
				If inconsistent	R-h1	Clarify	Open (text)	If work and not current activity: Job chars. (15 Qs) Repeat from P-h3 until current activity reported			
School-based qualifications (all)											
All	I-q1	Any ft schooling	Yes/no	All	I-q1	Any ft schooling	Yes/no	All	P-q1	Previous <qualification>, correct?	Yes/no
If 'yes' . . .		(Details of courses)		If 'yes'	. . .	(Details of courses)		If 'no'	P-q2	Which qualifications	Tick all
If 'yes'	I-q2	Gained qualification	Yes/no	If 'yes'	I-q2	Gained qualification	Yes/no	for each	I-q4	Number of subjects	Open (no.)
If 'yes'	I-q3	Which qualification	Tick all	If 'yes'	I-q3	Which qualification	Tick all		I-q5	Gained during reference period	Yes/no

Appendix 1. Continued

INDI				RDI				PDI			
Routing	Item	Topic	Response	Routing	Item	Topic	Response	Routing	Item	Topic	Response
for	I-q4	Number of subjects	Open (no.)	for each course	I-q4	Number of subjects	Open (no.)	If 'yes'	P-q3	Which during reference period	Tick all
each	I-q5	During reference period	Yes/no		I-q5	During reference period	Yes/no	For each	P-q4	Number of subjects	Open (no.)
course	I-q6	Other ft schooling	Yes/no		I-q6	Other ft schooling	Yes/no	All	I-q1	Any ft schooling	Yes/no
If 'yes'	Repeat I-q2 to I-q6			If 'yes'	Repeat I-q2 to I-q6			If 'yes'	. . .	(Details of courses)	
				Each new qual.	R-q1	Now. . .plus. . . qualifications?	Yes/no		I-q6	Other ft schooling	Yes/no
				If 'no'	R-q2	Clarify	Open (text)	If 'yes'	Repeat I-q1 and I-q6		

Notes: Routing conditional on being routed into the relevant section; Cat. = categories, Tick all = tick all that apply, D/M/Y = day/month/year, ft = full-time, ref. = reference.

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