

Linking survey data with administrative employment data: The case of the German ALWA survey

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Abstract

This study evaluates the linkage of the ALWA survey with administrative labor market data from the German Federal Employment Agency. Exact, probabilistic or manual matches could be found for 86% of those respondents who consented to the linkage. Both the consent bias and the selectivity in linkage success are comprehensively examined based on survey and paradata. The results are informative for potential data users, for survey practice as well as for practitioners of data linkage. The highest consent rates are achieved by older, female and more experienced interviewers. The implementation of probabilistic record linkage after exact matching substantially increases the number of observations without introducing additional selectivity to the linked sample. Manual matching further increases the number of observation at the cost of more pronounced selectivity of the resulting sample. Selectivity of the linked data is mainly driven by the age, the immigrant background and the employment status of the respondents.

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1 Introduction

For various research questions and methods of inference in the social sciences, rich data sets are required. Since survey and administrative data sets have their respective comparative advantages, a combination of both data sources enhances the potential for research. Furthermore, record linkage has several advantages from a survey methodological perspective. By omitting aspects from the interview that can be supplemented from other data sources, the length of the questionnaire can be reduced in advance. This saves interview time and reduces survey costs as well as the burden for respondents. This in turn might make interview terminations or panel attrition less likely. Record linkage may also lead to improved data quality (cf. Sala et al., 2010), for instance by validation studies regarding measurement error in the survey data (cf. Sakshaug and Kreuter, 2011).

These potentials can only be realized fully if we understand and are able to control for possible selectivity that may arise at different stages of the record linkage process. First, the consent of respondents to the linkage, which is necessary in many countries, might be refused. Second, the success of the actual record linkage crucially depends on the available information to identify a respondent in administrative records and on the quality of such identifiers. Both the consent to and the success of record linkage may vary substantially by the individual characteristics of the respondent. Consent to record linkage may also be influenced by characteristics of the interviewer and of the interview situation.

This has implications for potential data users, for the survey practice and finally for the linkage of the data itself. The goal of the study thus is threefold. First, the research potential for data users is demonstrated by giving an account of the information available in both data sets and by answering the following questions: Does a sufficient number of observations remain in the linked data set for substantial research? Is there selectivity in the linked data compared to the overall survey population, and if so, in which way is the sample selective? Second, implications for survey design and field administration are shown by examining how the interviewer staff may be composed to maximize consent rates, and how field management may be optimized to assert high and stable consent rates. Finally, advice for institutions and researchers linking survey data to register data are provided by showing what can be gained from probabilistic and manual linkage compared to exact record linkage in terms of numbers of observations, and if and how this additional effort influences the selectivity of the linked sample.

Apart from answering these questions, the study contributes to the literature in several ways. Not only was the consent rate to record linkage in the ALWA¹ survey well above the average of comparable surveys (cf. Sakshaug and Kreuter, 2011), but its wealth of respondent characteristics also allows to control for several variables that could not be considered in existing studies, such as self-reported cognitive skills or the native language of the respondents. Furthermore, this is the first German study to examine record linkage selectivity and success

¹The acronym is derived from the study's German name 'Arbeiten und Lernen im Wandel'

based on personal and address data of the respondents instead of based on previously known and unique identifiers like social security numbers. The analysis also benefits from exceedingly rich paradata to control for characteristics of the interview situation and the interviewers.

2 Data sets and their linkage

The two data sets linked in this project are the ALWA survey and the Integrated Employment Biographies of the Institute for Employment Research (IAB).² Taken by themselves, both are suitable to address numerous research questions in the social sciences. Both have their relative advantages, which will be demonstrated in the following sections.

2.1 ALWA survey

The ALWA survey³ was conducted from August 2007 up to and including April 2008 and included more than 10,000 retrospective, computer-assisted telephone interviews (CATI) with people born between 1956 and 1988. Longitudinal information was gathered on residential, educational, employment and partnership histories as well as on children and times of parental leave. All these events are measured detailed to the month. Aided recall techniques were used during the interviews (cf. Drasch and Matthes, forthcoming) to reduce recall error in longitudinal aspects.

This data is complemented by a rich set of cross-sectional variables. The interview covered topics such as place and date of birth, immigrant background, religiousness, language skills, family background, importance of different domains of life as well as informal learning and cultural activities.

2.2 Administrative data

The administrative data of the German Federal Employment Agency have been a major data source for labor market research in Germany for several years (cf. Heining, 2010). These data contain daily information on employment histories beginning with the year 1975 (cf. Jacobebbinghaus and Seth, 2007). They include information on transfer payments and wages, which are measured with high accuracy as they are related to social security contributions. From the year 2000 on, information on the participation in several active labor market programs is included. With each new version of the data, information from additional data sources of the Federal Employment Agency is made available as research data.

²The combined data are available as a single data product under the name of "ALWA survey data linked to administrative data of the IAB" (ALWA-ADIAB). Access to the data is provided via on-site use and subsequent remote data access by the Research Data Center (FDZ) of the German Federal Employment Agency at the IAB. See <http://fdz.iab.de/en.aspx> for details on the FDZ and its available data sets.

³See Kleinert et al. (2011) for an overview of the study or Antoni et al. (2010) and http://fdz.iab.de/en/FDZ_Individual_Data/ALWA.aspx for more detailed information on the available data.

Employment spells include information on the economic sector of the firm, the qualification and age structure of its employees as well as its wage distribution. This can be supplemented by information on worker flows for different subgroups of employees as well as on the founding and closing of firms under consideration. These data draw from the Establishment History Panel of the IAB (cf. Hethy-Maier and Seth, 2011; Spengler, 2008).

2.3 The process of record linkage

Records from different data sources can either be matched by means of a unique identifier such as the social security number or on the basis of a combination of ambiguous identifiers. As the population of interest in the ALWA survey consisted of individuals living in Germany regardless of their labor market status or nationality, the sample was drawn from registers of the residents' registration offices of 250 German municipalities. The result is a sample of addresses without a unique identifier related to the administrative records of the Federal Employment Agency. Record linkage is therefore performed on the basis of the following identifiers:

- first names and last name
- gender
- day, month and year of birth
- postal code
- place name
- street name
- house number

This information was provided by the survey institute for those respondents which have consented to record linkage. The corresponding data from the administrative records were provided by the IAB department IT Services and Information Management. Data retrieval considered all people who had been registered in any data source of the Federal Employment Agency at any time during the year 2007, the year in which the ALWA sample was drawn and the field phase started. Given the considerable amount of data that resulted from this procedure, the data from the administrative records were restricted beforehand to the birth cohorts of the survey population.

Before the records from both data sources are actually compared, extensive preprocessing was conducted to clean up typographical errors, to minimize the amount of different spellings of names, places and street names as well as to fill in missing information in postal codes or place names. These steps of standardization are done consistently for both the administrative records and the survey data by clearly defined decision rules. This leads to exact matches on all

Table 1: Number of observations during the stages of record linkage

| | N | $\frac{N}{N_c}$ | $\frac{N}{N_r}$ |
|--|-------|-----------------|-----------------|
| CATI respondents (N_r) | 10404 | | 100.00% |
| Consenting CATI respondents (N_c) | 9531 | 100.00% | 91.61% |
| Exact matches | 5035 | 52.83% | 48.39% |
| Exact and probabilistic matches (Jaro-Winkler) | 7919 | 83.09% | 76.11% |
| Exact, probabilistic and manual matches | 8243 | 86.49% | 79.23% |

variables mentioned above for about 53% of those survey respondents who gave their consent for record linkage.

To increase the amount of successful matches probabilistic record linkage was used (cf. Herzog et al., 2007; Winkler, 2009). It computes the degree of similarity between two records from different data sources over all identifiers.⁴ Based on the decision rule proposed by Fellegi and Sunter (1969) pairs of records are classified into links, potential links and non-links after comparison. Pairs that are classified as links are directly used for the retrieval of administrative data. Those that are classified as possible links are subsequently coded as either links or non-links by hand.

During each of these steps, some of the observations are lost for the final research data due to lack of consent or of success in record linkage. The remaining number of observations on each stage is documented in Table 1. Consent for record linkage was given by 9,531 (92%) of the respondents. For 53% of the consenters, exact matches on all the variables mentioned above could be found. Together with matches that could successfully be identified by probabilistic record linkage, this figure reaches 83%. When considering manual matches as well, 86% of all consenters and 79% of all respondents are included in the linked data. Descriptive statistics for the whole survey population on all explanatory variables considered later on are given in Table A.1 in the appendix.

Other than Table 1, all tables and analyses below do not include the 227 cases of foreign language interviews, leading to a total of 10,177 observations. If interviews could not be conducted in German, shorter Turkish and Russian interviews were done instead. These questionnaires also included the question of consent, but they lack several aspects that are important for the following analyses.

⁴The matching parameters for the Jaro-Winkler string comparator metric have been chosen according to prior experience with IAB data (cf. Bachteler, 2008). The comparison with blocking on the postal code was done by using the software Merge ToolBox (MTB), version 0.7. MTB can be retrieved from http://www.uni-due.de/soziologie/schnell_forschung_safelink_mtb.php and is documented by Schnell et al. (2005).

3 Sources of selectivity: State of research and hypotheses

Selective success in linking different data sources may arise on different stages. First, for any attempt to link survey data with other data sources, it is crucial whether data protection regulations make the consent of respondents necessary. If that is the case, interviewers are legally bound to inform respondents about the nature of information that is going to be matched and ask for consent to that procedure explicitly. This is the case in Germany.

Second, even when consent for record linkage has been acquired, it might be impossible to find the corresponding records in the administrative data for some of the respondents. These are, for instance, people that have never experienced an employment spell or have never been registered as unemployed up to the time of interview. Linkage based on personal information as identifiers rather than on unique identifiers such as the social security number may also fail due to wrong or partially missing address information in one of the data sources. Both consent and linkage are prone to be selective in ways that are described in the following sections.

3.1 Determinants of consent

The consent of respondents to record linkage may be influenced by a wealth of factors. There is a considerable amount of literature on this topic, but the majority of previous studies considers surveys that ask for consent to the linkage of health records. Dunn et al. (2004), Huang et al. (2007) and Kho et al. (2009) provide recent overviews of results on record linkage in the context of specific epidemiological or health studies, whereas Knies et al. (forthcoming) examine consent to health record linkage in a general population survey. Although these topics could be considered as equally if not more sensitive as employment or income information, it is an open question whether the results from these studies can be transferred to the survey population and topic of the ALWA study. The following sections will summarize results of studies that did have comparable populations and which also linked survey data with administrative employment data; it will assess their relevance for the question at hand and include own hypotheses. A quick overview of all results of the relevant studies is given in Table 2.

Respondent characteristics

The most commonly examined potential drivers of consent bias are the characteristics of the respondent. However, the different results on respondent characteristics often contradict each other. This is best exemplified by the relationship of respondents being female with linkage consent, which is reported to be either positive (Haider and Solon, 2000), negative (Hartmann and Krug, 2009; Sala et al., 2010), or non-existent (Beste, 2011; Gustman and Steinmeier, 1999; Jenkins et al., 2006; Olson, 1999; Singer et al., 2003)—sometimes with contradicting results for the very same survey. Therefore, an analysis regarding the characteristics of consenting respondents is in order. The following characteristics will be included as control variables

Table 2: Existing results on determinants of consent to record linkage with employment-related register data

| | Beste (2011) | Gustman and Steinmeier (1999) | Haider and Solon (2000) | Hartmann and Krug (2009) | Jenkins et al. (2006) | Olson (1999) | Sakshaug and Kreuter (2011) | Sala et al. (2010) | Singer et al. (2003) |
|---|--------------|-------------------------------|-------------------------|--------------------------|-----------------------|--------------|-----------------------------|--------------------|----------------------|
| Respondent | | | | | | | | | |
| Male | ns | ns | ns | + | ns | ns | | + | ns |
| Foreign, ethnic minority | - | - | - | - | | - | - | - | - |
| Native language | | | | | | | | | |
| Region of residence | ns | | | sig | sig | ns | | sig | ns |
| Age | ns | | | ns | sig | ns | + | - | + |
| Qualification | ns | - | ns | ns | ns | - | | + | ns |
| Cognitive skills | | | | | | | | | |
| Labor market status | ns | | sig | ns | sig | ns | ns | | |
| Income | + | | + | + | ns | + | | ns | + |
| Refused income information | - | - | | - | ns | | | - | |
| Wealth, assets | | - | - | | | - | | | |
| Existing relationship/marriage | | + | | ns | + | + | | ns | |
| Children | | ns | | | + | | | ns | |
| Interviewer | | | | | | | | | |
| Male | + | | | ns | | | | ns | |
| Age | + | | | + | | | | ns | |
| Qualification | - | | | + | | | | ns | |
| Experience before study | | | | | | | | ns | |
| Prior interviews within actual study | ns | | | | | | | - | |
| Similarity of respondent and interviewer | | | | | | | | | |
| Sex | | | | ns | | | | | |
| Age | | | | ns | | | | | |
| Qualification | ns | | | | | | | | |
| Interview situation | | | | | | | | | |
| Weekday/time of interview | | | | | | | | | |
| Share of refused answers | | | | | | | | | |
| Share of answers like "don't know" | | | | | | | | | |
| Duration of interview | | | | ns | + | | | | |
| Disturbances/problems during interview | | | | | - | | | | |
| Cooperation in other consent questions | + | | | | | | | | |

Notes: +/-/ns/sig denote significantly positive/significantly negative/no significant/overall significant influence on consent, respectively.

without explicit hypotheses on their influence: the respondent's sex, the existence of a partner and that of children in the household.

More consideration will be given to characteristics which, if they are in fact related to selective consent, have a high potential of biasing estimation results based on the linked data. These are, for one thing, groups that are only weakly represented in the survey from the outset, such as ethnic minority groups. For another thing, I will examine variables that will most likely be of central interest for future data users. Given the core themes of the ALWA survey, these are mainly educational and employment related variables.

The relevant studies so far produce inconclusive results on the respondent's age. In the given context, the amount of register data that is available on a person is positively related to her labor market experience, thus usually also to her age. If one assumes that the reluctance of providing consent for data linkage grows with this amount of data due to privacy concerns, consent should be negatively related to age.

Cognitive aspects may be relevant for the first step of the response process, the comprehension of the question for consent (cf. Tourangeau and Bradburn, 2010, p. 317). First, German language problems on behalf of the respondent might prevent him from fully understanding the meaning of the question. The comprehension of either the importance of the linked data for research or the extent of information that is to be matched might be insufficient. It is not clear from the outset how this should influence the likelihood of consent, both directions are possible. A comprehensive understanding of the amount of data that can be matched might well lead to a rejection of consent.

Second, even when the question of consent is fully understood, a lack of experience with or understanding of the function or functioning of the Federal Employment Agency and its local offices might impede full comprehension of the consequences of record linkage. This might be the case for foreign respondents, whose residence in Germany and contact with its institutions so far have been limited. Again, it is unclear whether this would make consent more or less likely. Someone who would have refused consent given full comprehension of its consequences might provide consent when comprehension is deficient and vice versa. Studies that include an ethnic minority or foreign background as a control variable unanimously agree on its negative relationship with consent. To investigate this matter in more detail the dummy variable for foreign nationality is supplemented by an indicator for German as the native language of the respondent.

These considerations do not imply a general lack of cognitive abilities as a source for selective consent, though these might be relevant as well. Apart from a potential language barrier, deficient comprehension of what the linking of different data sources implies technically or for the richness of the resulting data might trigger different responses to consent questions. For instance, the risk of a breach of data confidentiality might be under- or overestimated, leading to a higher or lower likelihood of consent, respectively. The expected influence on consent is

thus ambiguous. Apart from educational levels or income as proxy variables, no study so far has considered the direct influence of the respondent's cognition on consent to record linkage. To achieve this, scores for self-reported prose and document literacy as well as for numeracy are computed with principal component analyses (cf. Jolliffe, 2002) based on several 5-point items.

Instead of being a possible proxy for cognitive abilities the educational level may also influence the respondent's attitude towards the survey. An interview with numerous questions on educational success might be regarded as important and worthwhile by well educated respondents, whereas it might be experienced as unpleasant if not embarrassing by poorly educated respondents. I thus expect a positive relationship between the educational level and consent to record linkage. Insignificant or unclear results on that matter are presented by Haider and Solon (2000), Hartmann and Krug (2009), Olson (1999) and Singer et al. (2003), whereas Gustman and Steinmeier (1999) reports a negative relationship.

Low cognitive abilities or educational achievements may also be considered as proxy variables for recall problems. Respondents with low cognitive sophistication (cf. Krosnick, 1991) may have problems to retrieve dates or other information on past events. To compensate for their lack of recall, they might be inclined to allow such data to be supplemented from other sources. Assuming that this motivation is relevant during a telephone interview, cognitive abilities and educational levels should be negatively related to consent. Because this statement contradicts the hypothesis stated in the former paragraph, the influence of the respondent's education remains ambiguous.

Since longitudinal earnings information are one of the main advantages of administrative employment data, selectivity regarding the income of respondents could be a major problem when empirical inference is based on the linked data. The reported personal net income of the respondent across all income sources at the time of the interview will therefore be included in the analysis. I expect consent to record linkage to be positively related to income. That is because respondents with very low or no own income might be unwilling to grant access to additional information on their actual or previous labor market success—or lack thereof. Existing results mainly agree that income is positively related to linkage consent. This is only contradicted by Jenkins et al. (2006) who find a higher willingness to consent among respondents that were eligible for means-tested benefits, which by definition means that they have a low income or none at all.

Lack of trust towards the interviewer, towards the specific survey or towards surveys in general might be an important driver for refused consent. Respondents who explicitly express privacy concerns during the interview would therefore be less inclined to allow record linkage. This hypothesis is supported by the results of Sala et al. (2010) and Singer et al. (2003). In the absence of an actual measure of trust or privacy concerns, the refusal of income information is included as a separate income category.

Instead of or in addition to actual income, some existing studies include the respondents'

wealth or monetary assets in their analyses. The implications for consent are different from those of actual income as the accumulated wealth may be considered as sensible if not secret. The hypothetical influence is negative, which is corroborated by the results of Gustman and Steinmeier (1999), Haider and Solon (2000) and Olson (1999). As the ALWA questionnaire does not consider the wealth of the respondent or his household, I use the degree of participation in high-cultural activities as a proxy measure. This is calculated by means of principal component analysis. I argue that activities such as visits to theaters or operas or the number of books in the household are strongly correlated with wealth as they make considerable monetary resources necessary.⁵ I therefore expect people with a high score in high-cultural activity to be less willing to consent to record linkage.

Another characteristic potentially related to privacy concerns and trust that is specific to German surveys is whether a respondent was born in East Germany. Given the birth cohorts included in the ALWA sample, any respondent that reports of being born in East Germany (without West-Berlin) is very likely to have grown up in the former German Democratic Republic. Recent empirical evidence shows that, even nearly two decades after the German reunification, East Germans still show more social distrust than West Germans (Heineck and Süßmuth, 2010). People born in East Germany should therefore be less inclined to provide consent, regardless of their place of residence at the time of the interview. Beste (2011) finds no influence of residence in East Germany whereas Hartmann and Krug (2009) find a significant positive relationship. Both analyses though do not account for potential mobility of respondents, as they do not control for the respondent's place of residence before the German reunification.

Finally, consent might depend on the relevance of the survey's main topics or the data that are to be matched for the current situation of the respondent, including the labor market status. Respondents that are satisfied with their employment situation might be more willing to provide consent, as the information in the register data are favorable for them. On the other hand, one could argue, a study on employment histories has a higher relevance for unemployed respondents or those with benefit receipt of some kind, as they might expect the research based on the linked data to lead to political actions that improve their labor market chances. They should have higher incentives to provide the necessary information, even by giving consent to linkage with additional data sources. The majority of existing results corroborates this hypothesis, the exceptions being the studies from Beste (2011) and Hartmann and Krug (2009), which are both related to Germany. As one of the main topics of the ALWA survey were educational activities, a similar reasoning applies for people currently in formal education. They should have a strong interest in the survey, which would imply high consent rates among these respondents.

⁵One might argue that these activities are also related to the actual income. However, as the actual income is directly controlled for by information on the personal net income and indirectly by the educational level, the variable on high-cultural activities should only capture the influence of previous earnings and existing wealth. A test on Cramer's V indeed shows that there is only a weak correlation between high-cultural activities and the personal net income.

Interviewer characteristics

A successful interaction between interviewer and respondent is crucial to achieving cooperation by the respondent. Thus, consent should be strongly influenced by characteristics of the interviewer. The time-invariant socio-demographic information included in the analysis was provided by the survey institute, whereas variables that potentially change between interviews are computed from the paradata.

The sex of the interviewer in itself does not necessarily lend itself for a specific hypothesis. This changes when it is considered in interaction with the sex of the respondent, which so far has not been done in many studies. Hartmann and Krug (2009) include a dummy variable that indicates a male respondent that is interviewed by a younger female interviewer. The consent rate in this constellation does not significantly differ from that in others. One possible hypothesis states that an interviewer of the opposite sex might unconsciously be considered as a candidate for a romantic relationship. In that case, respondents' answers might be influenced by considerations of social desirability, with the socially more desirable behavior being the provision of consent. Consent would be more likely if the sex of the interviewer differs from that of the respondent. However, given that ALWA interviews were conducted as computer-assisted telephone interviews, the rationale might prove irrelevant in the given study.

Experience of the interviewer, be it life or job experience, is expected to positively influence his success in creating cooperation of respondents. I therefore control for the interviewer's age, the years of experience as an interviewer before the ALWA study and the number of ALWA interviews before the actual interview. The interviewer-specific consent rate up to the actual interview measures the interviewer's prior success in achieving respondent cooperation. Previous studies have included similar experience-related variables, though never as comprehensive as in the work in hand. Beste (2011) and Hartmann and Krug (2009) corroborate a positive relationship of consent with the age of the interviewer, a relationship that is missing in the results of Sala et al. (2010). While Beste (2011) finds no significant relationship with the number of previous interviews, Sala et al. (2010) find a positive one.

An interviewer's qualification is related to his rhetoric abilities, thereby influencing his ability to convey the importance of the data linkage and to convince respondents to cooperate. Linkage consent should thus be positively related to the educational level of the interviewer, which is measured by dummy variables regarding general schooling and training certificates. Existing studies find inconclusive results, they range from significantly negative Beste (2011), over non-existent (Sala et al., 2010) to significantly positive (Hartmann and Krug, 2009).

To consider the degree of similarity between interviewer and respondent, a number of interaction variables are added in an alternative model. Age of the interviewer is included in relation to the age of the respondent to take into consideration that strong differences may have adverse effects on cooperation. Dummy variables indicate whether the interviewer is more than ten years younger or more than ten years older than the respondent, respectively. Differences in

general schooling levels are also measured by dummy variables. Potential interactions between the sex of the respondent and that of the interviewer will be examined by estimating separate models for female and male respondents.

Interview situation

Characteristics of the survey in general are important, such as its topic, the nature and amount of the information that is going to be matched from other data sources, the context of the question of consent in the course of the interview, the purported usage of the combined data or the client of the survey institute. This enumeration is far from conclusive, but it shows that findings of other studies with similar topics might not be applicable to different survey contexts. These characteristics are specific to each study and their respective influence on matching consent cannot be examined on the basis of a single survey.

Several aspects of a specific interview situation might also influence the willingness of a person to consent to record linkage. The duration of the interview until the question for consent is asked may affect the willingness to cooperate in different ways. On the one hand, the respondent might be dissatisfied with the length of the interview so far, in which case a long interview duration might increase the reluctance to give consent to linkage. On the other hand, the willingness of the respondent might increase with duration as he considers the length of the conversation so far as a sign of the high importance of the employment information. In that case, he would be more willing to consent in order to give more meaning to what he already reported. Existing results on the influence of the elapsed interview duration are as inconclusive as the hypothetical expectations. Hartmann and Krug (2009) find no significant effects, whereas Jenkins et al. (2006) find a positive relationship with the duration of the previous interview. To establish a detailed analysis of this topic, my analysis considers the elapsed duration of the interview until the consent questions exact to the minute.

The general attitude towards the survey at hand might influence consent as well. The more sympathetic the respondent feels towards the survey and the more interested he is in its topics, the more likely will he cooperate when it comes to the consent question. Singer et al. (2003) indeed find a positive relationship between the respondents' feeling of obligation to cooperate and their consent to linkage. Sala et al. (2010) on the other hand find a negative relationship between the amount of prior waves of the given survey and linkage consent. Beste (2011) uses the willingness to participate in subsequent panel waves as a proxy variable and does find a positive relationship with consent. This strategy is also applied here as I include questions on the willingness to participate in later survey waves and in subsequent cognitive tests as control variables. I assume there to be a positive relationship between both questions and consent to linkage. However, when using these proxy variables, it is hard to distinguish between a lack of interest in the survey and a potentially underlying attitude of distrust.

As the survey did not include explicit measures of privacy attitudes, the amount of refused

answers is used as a proxy variable for distrust or privacy concerns. While Beste (2011) and Hartmann and Krug (2009) indeed find a negative relationship between the amount of refused sensitive questions and consent to record linkage. The results from Jenkins et al. (2006) are ambiguous as they show no significant relationship between item non-response in income questions and consent to linkage with administrative record, but a negative relationship with consent to contact the employer for further information. As the ALWA survey did not contain questions explicitly related to trust, I include the share of refused answers in my analyses in addition to the indicator for refusal of income information mentioned above.

The relationship of problems or disturbances during the interview and linkage consent is not clear from the outset. Problems may be caused by a general or growing dissatisfaction of the respondent over the course of the interview, which would lead to a lower probability of consent. I might also be due to external sources of disturbance that are not related to the cooperation of the respondent. There would thus be no influence on the provision of consent. The evidence on this issues so far is rather scarce, which might be due to a lack of paradata. Jenkins et al. (2006) report that problems are negatively related to consent probability, though problems are only measured for the previous interview with the given respondent. I examine this issue by including different indicators of problems or disturbances during the interview that have been reported by the interviewers.

3.2 Determinants of record linkage success

When examining linkage success, the aforementioned considerations no longer apply. So far, hypotheses were based on factors that influence the respondent's decision regarding consent to record linkage. The following hypotheses are related to the technical procedure of identifying and linking records of a given person in different data sources. Important in this context are the availability and validity of identifier variables common to both data sources. Since a valid address is necessary to contact potential respondents before and during the survey, the personal information available to the survey institute are to be considered as rather valid. This is not necessarily true for all variables in the administrative address data. Given that record linkage in other surveys with a labor market context is usually done by means of unique identifiers like the social security number, the results from most of the studies mentioned above are not informative for the following hypotheses.

Labor market related events such as employment, registered unemployment, job search or participation in active labor market measures usually lead to the registration of the address of the person in question. All characteristics influencing the labor market status of the respondent during or before the interview thus indirectly influence matching success. For instance, the older a respondent, the more likely will he have entered the labor market at some time. This makes it more likely for him to be represented in the administrative employment data and therefor also in the address data. Only respondents that are near the retirement age might be

less likely to be registered in the register data, as the Federal Employment Agency usually no longer gathers information on people once they are retired. This is in line with the results from Beste (2011) who finds an inversely u-shaped relationship of age and linkage success. Since the age range of ALWA ends at 52 years, early retirement should play no major role in this analysis.

The nationality of the respondent might influence linkage success for several reasons, though the direction of the influence is not clear from the outset. On the one hand, foreign names might be misunderstood or misspelled more likely during the survey process or even in the offices of the employment agencies; foreigners or fugitives might sometimes provide inaccurate birth dates to the authorities, either because they do not know the exact date or because they refrain from revealing it to authorities or employers. On the other hand, precisely because names that are uncommon in Germany have a higher risk of being misspelled, either the person providing the name or the person asking for it might be more inclined to have the name spelled letter by letter during its registration. Being born in East Germany should not influence linkage success as names from native citizens of East and West Germany ordinarily do not differ much.

The employment status of the respondent at the time of interview or during the months before is important since that determines whether and what kind of administrative records exist for the year 2007. People who are or have recently been unemployed should have accurate address information in the administrative records because this is necessary to mail them job offers or information on benefit receipt. This is not the case for people that are out of the labor force but not registered as unemployed in the administrative data. People currently in formal education are not covered by the data of the Federal Employment Agency, which should make them harder to find during the linkage procedure. However, this only applies to those in general schools or higher education, as people in dual vocational training are registered by their training company. To sum up, the highest success in record linkage should be found for unemployed respondents, the lowest success for those outside the labor force, including those in formal education. The results from Beste (2011) support these hypotheses.

If the educational level exhibits any influence on linkage success, it should be indirectly through its impact on the labor market status, which is controlled for with the respective variables. The same applies for measures of cognitive ability.

Employees are registered in administrative data regardless of their level of income as long as this income comes from dependent, legal employment. All income groups should thus be represented equally well in the linked data. As self-employed respondents are not included in the register data, and as it can be assumed that they are more likely to be part of the upper income brackets,⁶ these brackets are likely to be linked with less success than the lower income groups. This is also in line with Beste (2011).

⁶This is corroborated by the correlation between reported income and the labor market status. Self-employed are over-represented among the two highest income classes.

4 Empirical analyses

4.1 Descriptive results

To get a first impression of eventual selectivity of consent and matching success rates in ALWA, a descriptive analysis is in order. While multivariate analyses in Section 4.2 allow *ceteris-paribus* statements regarding the influence of single variables, the following descriptive results are informative in terms of how certain groups from the overall survey population are represented in the data set on each step. Table 3 compares those rates over different subgroups of respondents. The p-values resulting from Pearson χ^2 -tests indicate significant differences between groups. Consent rates are computed based on all German language interviews, whereas match rates are computed based on consenting respondents only. That way any selectivity that may arise from the second stage onward can be distinguished more clearly from an eventual consent bias.

As the process of linkage itself can be subdivided into the different stages of exact, probabilistic and manual record linkage, their resulting matches may yield different selectivity. The respective results for these stages are depicted in separate columns to discern whether subsequent steps of the linkage process introduce additional selectivity compared to the previous one or vice versa. The second column shows exact match rates by subgroup; the third column shows rates of successful matches by either exact or probabilistic record linkage; the final column shows all matches by adding the manual matches as well.

Overall, 92% of the German language interview respondents gave consent. Among those, 53% could be matched to the register data by exact record linkage and 80% either by exact or probabilistic record linkage. This figure increases to 86% when including the manual matches as well. These values slightly differ from those in Table 1 because at this stage only those cases are included that are part of the estimation sample used in Section 4.2.

The results for subgroups show that the youngest respondents and those born in East Germany are significantly over-represented among the consenters as well as on all stages of the matching process. The gender structure is similar to that of the overall survey population up to the step of probabilistic linkage. Manual matches seem to have added more matches for female respondents relative to male respondents. Although Germans and foreigners are about equally represented among the consenters and the exact matches, foreigners show significantly higher probabilistic linkage rates than the Germans, with 85% compared to 80%. This is even more pronounced after adding the manual matches. Respondents with a native language other than German are matched with significantly higher rates than German native speakers. The relative scarcity of foreign names in the address data seems to have led to a higher manual linkage success for foreigners compared to that for native Germans. No selectivity of consent is found when considering the qualification, the relationship status and existence of children in the households of respondents, but some significant structural differences emerge on the stages of matching success.

Table 3: Consent and linkage success rate by subgroups, expressed as percentages

| | consenters | exact matches | exact+probabil. matches | all matches |
|-------------------------------|------------|------------------|----------------------------|----------------|
| Total | 92.1 | 53.1 | 80.1 | 86.4 |
| 18-24 | 93.9 | 59.9 | 84.1 | 90.0 |
| 25-34 | 91.6 | 58.3 | 82.9 | 90.7 |
| 35-44 | 92.0 | 50.4 | 79.0 | 85.5 |
| 45-52 | 91.5 | 48.8 | 77.1 | 82.7 |
| | (0.014) | (0.000) | (0.000) | (0.000) |
| Female | 92.1 | 52.5 | 80.2 | 87.1 |
| Male | 92.2 | 53.7 | 80.0 | 85.7 |
| | (0.879) | (0.243) | (0.867) | (0.050) |
| German nationality | 92.1 | 53.0 | 80.0 | 86.2 |
| Foreign nationality | 90.9 | 55.3 | 85.4 | 95.5 |
| | (0.489) | (0.532) | (0.057) | (0.000) |
| Native language not German | 92.1 | 65.8 | 84.2 | 93.8 |
| Native language German | 92.1 | 52.6 | 80.0 | 86.2 |
| | (0.991) | (0.000) | (0.068) | (0.000) |
| Born in West Germany | 91.7 | 52.3 | 79.8 | 85.8 |
| Born in East Germany | 93.8 | 56.5 | 81.6 | 89.1 |
| | (0.003) | (0.002) | (0.088) | (0.000) |
| No training | 93.3 | 57.9 | 82.2 | 87.1 |
| Training + lower secondary | 92.0 | 58.9 | 85.9 | 92.4 |
| Training + intermediate | 91.8 | 57.6 | 83.7 | 90.1 |
| Training + upper secondary | 93.1 | 53.5 | 82.1 | 88.9 |
| Master craftsman | 92.5 | 48.0 | 73.1 | 79.0 |
| Higher Education | 91.0 | 41.8 | 71.8 | 79.0 |
| | (0.106) | (0.000) | (0.000) | (0.000) |
| Self employed | 89.2 | 42.4 | 64.8 | 72.6 |
| Freelancer | 93.8 | 52.9 | 82.6 | 87.4 |
| In dependent employment | 92.1 | 56.3 | 86.8 | 92.9 |
| Civil servant | 93.3 | 13.1 | 20.9 | 25.7 |
| Unemployed | 89.3 | 68.4 | 86.9 | 94.2 |
| In formal education | 94.7 | 56.6 | 80.0 | 84.9 |
| Other activity | 92.3 | 47.5 | 73.5 | 82.4 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| No partner in household | 92.3 | 58.3 | 83.3 | 88.6 |
| Partner in household | 92.0 | 50.0 | 78.2 | 85.1 |
| | (0.641) | (0.000) | (0.000) | (0.000) |
| No children in household | 92.2 | 56.3 | 81.6 | 87.3 |
| Children in household (dummy) | 92.0 | 49.9 | 78.7 | 85.5 |
| | (0.684) | (0.000) | (0.001) | (0.015) |
| Personal net income <500EUR | 93.2 | 54.7 | 80.8 | 86.5 |
| 500-999EUR | 92.7 | 59.4 | 85.6 | 92.5 |
| 1000-1499EUR | 92.6 | 56.4 | 82.3 | 90.4 |
| 1500-1999EUR | 92.8 | 57.2 | 83.0 | 88.9 |
| 2000-2999EUR | 92.9 | 46.1 | 75.6 | 81.3 |
| more than 3000EUR | 92.5 | 40.2 | 69.2 | 74.4 |
| Income refused | 63.6 | 47.3 | 80.0 | 86.7 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| N | 9790 | 9024 | 9024 | 9024 |

Note: ALWA, own calculations, p-values of Pearson χ^2 -test in parantheses. Percentages in columns related to linkage success are based on consenters.

When considering the labor market status of the respondent the picture is even less clear. Self-employed and unemployed are the least likely to provide consent (both with 89%), but whereas self-employed are still weakly represented among all linked respondents (73%), unemployed consistently are the most successfully matched respondents on any stage of linkage (68%, 87% and 94%). This implies that the selective processes at different stages counteract each other for some groups of respondents while they amplify each other for other groups.

Table 4 compares mean values of characteristics of the interviewer and the interview situation for non-consenting and consenting respondents. Column 3 shows test statistics of t-tests on significant differences of these means. They indicate significant differences between both groups in several variables. Most results are in line with the hypotheses stated in Section 3.

Table 4: Mean characteristics of interviewers and interview situation by consent status, t-test of difference

| | No consent | Consent | Diff. | t |
|--|------------|---------|-----------|-----------|
| Int: male | 0.624 | 0.556 | -0.068*** | (-3.664) |
| Int: aged up to 24 | 0.183 | 0.119 | -0.063*** | (-5.125) |
| Int: aged 25-34 | 0.180 | 0.172 | -0.008 | (-0.569) |
| Int: aged 35-44 | 0.209 | 0.199 | -0.010 | (-0.634) |
| Int: aged 45-54 | 0.299 | 0.364 | 0.065*** | (3.624) |
| Int: aged 55 and more | 0.130 | 0.145 | 0.016 | (1.195) |
| Int: no training | 0.150 | 0.171 | 0.021 | (1.497) |
| Int: training, below upp. secondary | 0.140 | 0.162 | 0.022 | (1.585) |
| Int: training, upper secondary | 0.149 | 0.165 | 0.016 | (1.125) |
| Int: higher education | 0.354 | 0.333 | -0.021 | (-1.191) |
| Int: education unknown | 0.207 | 0.170 | -0.037*** | (-2.636) |
| Experience as interviewer (years) | 1.684 | 1.828 | 0.144*** | (3.898) |
| No. of previous interviews 0-25 | 0.325 | 0.353 | 0.028 | (1.567) |
| No. of previous interviews 26-50 | 0.171 | 0.164 | -0.007 | (-0.470) |
| No. of previous interviews 51-100 | 0.234 | 0.219 | -0.015 | (-0.965) |
| No. of previous interviews >100 | 0.269 | 0.263 | -0.007 | (-0.394) |
| Int: consent rate in previous interviews | 0.888 | 0.904 | 0.016*** | (2.813) |
| Interview on weekend | 0.194 | 0.196 | 0.001 | (0.095) |
| Share of refused answers as percentage | 0.175 | 0.040 | -0.135*** | (-14.595) |
| Share of 'dont't know' as percentage | 0.937 | 0.598 | -0.339*** | (-7.377) |
| Duration before consent quest. (m) | 26.026 | 25.461 | -0.565 | (-1.109) |
| Disturbance during int. | 0.071 | 0.058 | -0.013 | (-1.471) |
| Comprehension problems during int. | 0.060 | 0.050 | -0.010 | (-1.178) |
| Other problems during int. | 0.124 | 0.081 | -0.043*** | (-4.168) |
| Consent to follow-up survey | 0.778 | 0.949 | 0.171*** | (18.873) |
| Consent to cognitive tests | 0.332 | 0.585 | 0.254*** | (13.776) |

Notes: ALWA, own unweighted calculations. 9790 observations. ***,**,* denote significant difference at 1%, 5%, 10%.

The most notable deviation from the hypotheses is related to the number of previous interviews within the ALWA survey. Other than expected, interviewers with more experience with the specific survey are not more likely to achieve consent. The expected positive relationship between interviewers' education and consent is not corroborated by the descriptive results.

Hypothetical considerations regarding privacy concerns or trust of the respondents find support in the results. Consenters exhibit less refused answers or recall problems than non-consenters. Consent to record linkage is positively related to the general attitude of the respondent towards the survey, as people who consented to record linkage are also more willing to participate in subsequent cognitive paper-and-pencil tests or in later panel waves. Problems during the interviews coincide with a lower probability of consent, but a causal relationship on this matter can not be examined as these interviewer-reported problems could also have occurred sometime after the consent question.

4.2 Multivariate results

The descriptive analyses of possible selectivity of consent and linkage success are now complemented by multivariate analyses. As the research questions aim at the determinants of consent to and technical success of record linkage, separate probit regressions with different dichotomous dependent variables are estimated. Since the two stages of the process happen sequentially and consent on the first stage is a prerequisite for success on the second stage, any models considering the linkage success as the dependent variable will be based on the sample of consenters rather than the whole survey population.

Results are shown as odds ratios instead of coefficients. To account for the potential influence of unobserved interviewer characteristics that are common over all interviews of single interviewers, cluster-robust standard errors are computed for all models with consent as dependent variable. Without taking this into account, standard errors might be underestimated and statistical inference is impossible (Moulton, 1990). As interviewer characteristics are no longer relevant on the stage of record linkage, the variance-covariance matrices in models concerning linkage success are not modified to account for interviewer-clustering.⁷ All models are estimated without survey weights. To infer whether this decision influences the results, the main specifications are re-estimated including weights in the sensitivity analyses.

Results on determinants of consent

The results of different specifications of probit regressions with consent to record linkage as dependent variables are shown in Table 5. Model 1 includes all potential determinants of consent mentioned in Section 3 excluding respondent-interviewer interactions. These interactions are controlled for in Model 2. The results for most of the control variables common to both models are unaffected by the additional variables in Model 2. Deviations from that pattern will be considered specifically below.

⁷The interviewer effects on the first stage have not been analysed within a multilevel framework to keep the modeling strategy consistent across all stages of the linkage process.

Table 5: Determinants of consent to record linkage, probit regression models with and without respondent-interviewer interactions, respectively

| | without interactions | | with interactions | |
|--|----------------------|---------|-------------------|---------|
| | (1) | | (2) | |
| Male | 0.991 | (0.048) | 0.997 | (0.049) |
| 25-34 | 0.846* | (0.079) | 0.832* | (0.079) |
| 35-44 | 0.909 | (0.086) | 0.847 | (0.087) |
| 45-52 | 0.879 | (0.089) | 0.794** | (0.092) |
| Foreign nationality | 0.872 | (0.101) | 0.869 | (0.101) |
| Native language German | 0.834 | (0.101) | 0.835 | (0.101) |
| Born in East Germany | 1.192*** | (0.074) | 1.188*** | (0.075) |
| Partner in household | 1.084 | (0.054) | 1.087* | (0.053) |
| Children in household (dummy) | 0.991 | (0.055) | 0.987 | (0.055) |
| Training + lower secondary | 1.045 | (0.101) | 1.017 | (0.100) |
| Training + intermediate | 0.999 | (0.082) | 0.984 | (0.084) |
| Training + upper secondary | 1.114 | (0.104) | 1.137 | (0.108) |
| Master craftsman | 1.065 | (0.128) | 1.057 | (0.128) |
| Higher Education | 1.015 | (0.088) | 1.033 | (0.090) |
| Prose literacy score | 0.969 | (0.022) | 0.971 | (0.023) |
| Document literacy score | 0.969 | (0.019) | 0.972 | (0.019) |
| Numeracy score | 0.965 | (0.022) | 0.966 | (0.022) |
| High-cultural activity | 0.927*** | (0.018) | 0.929*** | (0.018) |
| Self employed | 1.136 | (0.128) | 1.135 | (0.129) |
| Freelancer | 1.503*** | (0.214) | 1.497*** | (0.215) |
| In dependent employment | 1.316*** | (0.113) | 1.320*** | (0.114) |
| Civil servant | 1.482*** | (0.196) | 1.493*** | (0.199) |
| In formal education | 1.474*** | (0.163) | 1.485*** | (0.165) |
| Other activity | 1.327*** | (0.141) | 1.336*** | (0.142) |
| Personal net income below 500EUR | 1.010 | (0.078) | 1.009 | (0.079) |
| 500-999EUR | 0.936 | (0.070) | 0.935 | (0.069) |
| 1000-1499EUR | 0.961 | (0.064) | 0.963 | (0.064) |
| 2000-2999EUR | 1.002 | (0.075) | 1.003 | (0.075) |
| more than 3000EUR | 1.064 | (0.085) | 1.065 | (0.085) |
| Income refused | 0.524*** | (0.053) | 0.526*** | (0.053) |
| Int: male | 0.886** | (0.053) | 0.885** | (0.052) |
| Int: aged 25-34 | 1.118 | (0.122) | 1.113 | (0.113) |
| Int: aged 35-44 | 1.131 | (0.138) | 1.192 | (0.165) |
| Int: aged 45-54 | 1.211** | (0.117) | 1.317** | (0.160) |
| Int: aged 55 and more | 1.207 | (0.145) | 1.394** | (0.213) |
| Int: training, below upp. secondary | 1.017 | (0.108) | 1.074 | (0.124) |
| Int: training, upper secondary | 1.062 | (0.111) | 1.062 | (0.114) |
| Int: higher education | 0.889 | (0.082) | 0.892 | (0.083) |
| Int: education unknown | 0.937 | (0.107) | 0.952 | (0.120) |
| Experience as interviewer (years) | 1.078*** | (0.031) | 1.077*** | (0.031) |
| No. of previous interviews 26-50 | 0.849** | (0.054) | 0.849** | (0.055) |
| No. of previous interviews 51-100 | 0.870** | (0.059) | 0.868** | (0.056) |
| No. of previous interviews above 100 | 0.859** | (0.057) | 0.860** | (0.056) |
| Int: consent rate in previous interviews | 1.164 | (0.164) | 1.151 | (0.162) |
| Interview on weekend | 1.056 | (0.062) | 1.054 | (0.061) |
| Share of refused answers as percentage | 0.745*** | (0.056) | 0.745*** | (0.056) |

(table continued on following page)

| | without interactions | | with interactions | |
|---------------------------------------|----------------------|---------|-------------------|---------|
| | (1) | | (2) | |
| Share of 'dont't know' as percentage | 0.950*** | (0.014) | 0.950*** | (0.014) |
| Duration before consent quest. (m) | 0.998 | (0.002) | 0.998 | (0.002) |
| Disturbance during int. | 0.998 | (0.076) | 0.998 | (0.076) |
| Comprehension problems during int. | 1.001 | (0.080) | 1.002 | (0.080) |
| Other problems during int. | 0.821*** | (0.055) | 0.818*** | (0.055) |
| Consent to follow-up survey | 1.916*** | (0.132) | 1.914*** | (0.131) |
| Consent to cognitive tests | 1.510*** | (0.075) | 1.511*** | (0.074) |
| Int: different sex than respondent | | | 1.029 | (0.040) |
| Int. at least 10 years younger | | | 1.033 | (0.082) |
| Int. at least 10 years older | | | 0.866* | (0.068) |
| Same schooling level | | | 1.084 | (0.131) |
| Higher schooling than respondent | | | 1.128 | (0.157) |
| Unknown relation of schooling levels | | | 1.080 | (0.206) |
| Constant | 1.706** | (0.438) | 1.603 | (0.498) |
| Wald-statistic (χ^2) [p-value] | 1295 | [0.000] | 1416 | [0.000] |
| AIC | 4896 | | 4902 | |
| pseudo R^2 | 0.114 | | 0.115 | |
| Observations | 9790 | | 9790 | |

Notes: ALWA, own calculations. Exponentiated coefficients. Robust standard errors in parentheses based on 210 interviewers as clusters. ***, **, * denote significance at 1%, 5%, 10%. Reference categories in both specifications: respondent aged 18-24, no training, unemployed, net household income of 1500-1999 EUR, interviewer aged up to 24, no training, 0-25 previous ALWA interviews. Additional reference categories in interacted specification: interviewer aged the same (+/-10 years) and same schooling level as respondent.

In line with the inconclusive hypotheses on foreign nationality or native language, these characteristics show no significant influence on a respondent's consent decision. This result contradicts those from all existing studies which unanimously find a negative impact of foreign or ethnic minority background. I argue that this is a result of omitted variable bias on behalf of some of those studies. They obviously failed to control for important respondent characteristics that are often correlated with nationality or ethnicity such as the native language or labor market and educational success.

The hypothetical considerations on cognitive skills also did not allow a clear-cut prediction on their influence on consent, and results indeed show no significant impact of literacy or numeracy skills. The same is true for the educational level of the respondent. Contrary to the hypothesis of high consent among the well educated respondents, they seem not to show greater interest in the goals and success of a survey strongly focusing on educational activities. Alternatively, a lack of education might have lead to low cognitive sophistication in terms of reporting and dating past events. In that case, respondents could have been inclined to make up for insufficient recall by allowing the register data to be linked. These two contradicting processes might have counterbalanced each other over the whole survey population.

In contradiction to existing results and to my hypothesis, reported personal net income

is not positively related to linkage consent. However, caution is in order when interpreting this result. It is possible that groups of respondents who refrain from providing consent are over-represented among those who refuse income information. The possibility that the refusal of income information is not evenly distributed over all income classes cannot be ruled out with the data at hand. However, descriptive analyses of the distribution of educational levels—a common proxy for earnings potential—among those who refuse the answer on personal income shows no clear relationship. A small Cramér’s V test statistic of 0.05 corroborates that finding.

Another result potentially related to privacy concerns is that of a negative relationship of consent and the degree of participation in high-cultural activities, at least when one is willing to accept that the latter is a valid proxy variable for monetary wealth. In that case, the result is in line with both the relevant hypothesis and the existing literature.

In contrast to the respective hypothesis, respondents born in East Germany are significantly more likely to consent to the linkage of their data than those born in West Germany. This is mostly in line with the result of other German studies, but is hard to be explained theoretically. It is possible though that, after being obliged to cooperate with government agencies and their representatives for several decades, people born in East Germany are too accustomed to this situation to simply disregard it after a few years. The ALWA survey may have received above-average cooperation from East German-born respondents simply because the advance letter and the questionnaire stated that the IAB is the research institute of the Federal Employment Agency.

Finally, when considering the respondent’s labor market status, the group that is the least likely to provide linkage consent are the unemployed. The hypothesis seems to be sustained that unemployed respondents are reluctant to disclose more details of their potentially unflattering employment history to the data producer or user.

The results on interviewer characteristics first reveal that female interviewers fare better in terms of achieving consent than their male colleagues. If this holds for both male and female respondents will be examined in Section 4.3. Success in achieving linkage consent also increases with the age and the survey experience of the interviewer but is unaffected by his educational level. The latter result is as unexpected as the finding that likelihood of consent decreases with the number of interviews an interviewer has already conducted. This might imply that interviewers wear off over the course of a study. Variables indicating the interaction between respondent and interviewer are mostly insignificant. We learn, however, that it may have averse effects on consent when the interviewer is much older than his interview partner.

Characteristics of the interview situation mostly show the expected outcomes. Consent decreases with the share refused answers, which hints at an underlying lack of trust that also fosters the refusal of linkage consent. Cooperation with regard to other consent decisions during the interview correlates positively with linkage consent. This signifies a latent propensity of the respondent to cooperate with the interviewer. This matter will be examined in more detail

in Section 4.3. The inconclusive hypotheses regarding the elapsed duration of the interview before the consent question are mirrored in a insignificant result in the model. The burden of the retrospective interview up to the consent decision was obviously not big enough to make the respondents reluctant to give consent to record linkage.

Results on determinants of record linkage success

At the stage of the actual record linkage neither the interviewer nor the process of the interview play any role for the linkage outcome. Linkage success is only determined by characteristics of the respondent. The model depicted in Table 6 thus only includes control variables regarding the respondent; they are identical to those included in Model 1. As non-consenting respondents may not be linked to their register data, the following models only includes consenters and the number of observations differs from that of previous models. That way, only the selectivity that emerges at this second stage is captured by the model. To examine differences in matching success between the subsequent steps of linkage described in Section 2.3, Model 3 uses an indicator for a exact match as the dependent variable, and Model 4 uses an indicator for a successful match by either exact or probabilistic record linkage.⁸

In contrast to the hypothesis, linkage success is negatively related to the age of the respondent. The selectivity regarding age at the stage of consent is amplified at the stage of exact matches and even more so among the probabilistic matches. A counterintuitive picture also emerges when considering the nationality and native language of the respondent. Both influence exact matching success but do not exhibit any significant influence on probabilistic linkage success. The hypothesis on the influence of the labor market status is mainly corroborated by the results. Respondents that actually were in labor market states that are registered in the data of the Federal Employment Agency, i.e. unemployed or those in dependent employment, are linked most successfully. As expected, the highest income class shows the lowest likelihood of being linked, whereas all other groups show no differences. The most likely explanation is that self-employed respondents with above-average income misreported their actual employment status as dependent employment or that they have been classified incorrectly during the process of data preparation.

When comparing the determinants of the sub-stages of linkage, the picture is ambivalent. The additional step of probabilistic record linkage did not counterbalance the influence of most of the control variables, but characteristics related to the migration background do no longer significantly influence linkage success. The latter finding is corroborated by a Wald test, which shows that foreign nationality and the German native language are not jointly significant in Model 4. The important message at this point is that probabilistic record linkage at least did not introduce additional selectivity for the linked respondents compared to the result of the

⁸A model also considering the manual matches in the multivariate analyses will be included in future versions of this paper.

Table 6: Determinants of exact and probabilistic record linkage success, separate probit regression models

| | exact (3) | | exact+probabil. (4) | |
|---------------------------------------|--------------|---------|------------------------|---------|
| Male | 1.057* | (0.035) | 1.041 | (0.040) |
| 25-34 | 1.041 | (0.058) | 0.973 | (0.066) |
| 35-44 | 0.927 | (0.054) | 0.893 | (0.064) |
| 45-52 | 0.899* | (0.054) | 0.840** | (0.061) |
| Foreign nationality | 0.819* | (0.084) | 1.082 | (0.136) |
| Native language German | 0.736*** | (0.064) | 1.028 | (0.105) |
| Born in East Germany | 1.051 | (0.038) | 0.968 | (0.042) |
| Partner in household | 0.909** | (0.034) | 0.882*** | (0.040) |
| Children in household (dummy) | 0.994 | (0.036) | 1.051 | (0.045) |
| Training + lower secondary | 1.077 | (0.066) | 1.123 | (0.085) |
| Training + intermediate | 1.061 | (0.056) | 1.064 | (0.068) |
| Training + upper secondary | 0.980 | (0.058) | 1.028 | (0.073) |
| Master craftsman | 0.937 | (0.069) | 0.868* | (0.074) |
| Higher Education | 0.860*** | (0.050) | 0.925 | (0.063) |
| Prose literacy score | 0.994 | (0.015) | 0.999 | (0.018) |
| Document literacy score | 1.004 | (0.014) | 0.970* | (0.017) |
| Numeracy score | 0.995 | (0.014) | 1.008 | (0.017) |
| High-cultural activity | 0.943*** | (0.015) | 0.960** | (0.018) |
| Self employed | 0.629*** | (0.051) | 0.576*** | (0.054) |
| Freelancer | 0.739*** | (0.069) | 0.913 | (0.103) |
| In dependent employment | 0.797*** | (0.055) | 1.091 | (0.091) |
| Civil servant | 0.260*** | (0.028) | 0.176*** | (0.020) |
| In formal education | 0.678*** | (0.054) | 0.683*** | (0.066) |
| Other activity | 0.632*** | (0.050) | 0.636*** | (0.059) |
| Personal net income below 500EUR | 0.921 | (0.050) | 0.986 | (0.065) |
| 500-999EUR | 1.018 | (0.053) | 1.096 | (0.070) |
| 1000-1499EUR | 0.929 | (0.045) | 0.907 | (0.054) |
| 2000-2999EUR | 0.871*** | (0.044) | 0.980 | (0.060) |
| more than 3000EUR | 0.819*** | (0.049) | 0.849** | (0.058) |
| Income refused | 0.800** | (0.088) | 0.938 | (0.121) |
| Constant | 2.370*** | (0.293) | 3.265*** | (0.479) |
| Wald-statistic (χ^2) [p-value] | 578 | [0.000] | 1017 | [0.000] |
| pseudoR ² | 0.046 | | 0.113 | |
| Observations | 9024 | | 9024 | |

Notes: ALWA, own calculations. Exponentiated coefficients. ***, **, * denote significance at 1%, 5%, 10%. Reference category: respondent aged 18-24, no training, unemployed, net household income of 1500-1999 EUR. Model 4 includes successful matches based on both exact and probabilistic record linkage.

exact linkage.

4.3 Sensitivity analyses

All models so far have been estimated without considering survey weights. However, as the ALWA survey, like any other survey, experienced some unit nonresponse (cf. Kleinert and Ruland, n.d.), its participants possibly had an above-average willingness to cooperate with the survey institute or the interviewers. Could this have influenced the results on consent? To examine this, both models from Table 5 are re-estimated with the calibration weight provided with the ALWA data set, the outcome of which is presented in Table A.2 in the appendix. With three exceptions, the results from the original models are unaffected. Both in Model 1a and in Model 2a, a foreign nationality shows a negative impact on linkage consent, which was not the case in prior models without the sample weights. This result is in line with both the relevant hypothesis and the findings from other studies. Moreover, respondents born in East Germany are no longer more likely to consent to linkage than those born in West Germany (Model 2a), although a weakly significant relationship remains in Model 1a. Finally, respondents with a partner in the household show a significantly higher willingness to consent compared to singles after the weights are taken into account. This is most likely an effect of unit nonresponse for which the calibration weight fails to correct, it will not be examined in more detail.

To examine the gender interaction of interviewer and respondent further, separate estimations for female and male respondents are conducted. Table A.3 in the appendix shows that male interviewers perform worse than female interviewers in achieving consent from both female and male respondents.

The previous section stated that single interviewers might wear off during after completing a high number of interviews. An alternative explanation is that a high number of previous interviews per interviewer rather indicates that the specific interview took place very late in the field phase. The declining consent rate would then reflect the fact that only the phone numbers of less cooperative respondents are left over for further contact attempts. This would consequently also decrease cooperation regarding record linkage. To investigate this I included the elapsed time since the given phone number had first entered the field management system and the number of contact attempts before the actual interview. Both show no significant influence on the respondents' consent to record linkage. Furthermore, the inclusion of these variables did not affect the results on the influence of the number of previous interviews per interviewer.⁹

In estimating separate univariate probit regression models for the different dependent variables, I deliberately choose a different strategy than Jenkins et al. (2006) or Sala et al. (2010). They estimate multivariate probit models to explicitly allow for correlation between the error terms of different equations. By doing so, they take into account that unobserved characteristics

⁹The results are not presented in this paper. They are available from the author upon request.

of respondents potentially co-determine different decisions regarding cooperation during the interview. In the study at hand, this rationale cannot be applied as only the consent decision is made by the respondent. The success of the actual record linkage can no longer be influenced by the survey participants.

To assert that this assumption is valid, a fourvariate probit regression is estimated with full correlation of all error terms. The dependent variables are linkage consent, the willingness to participate in a subsequent face-to-face interview including a test of cognitive skills, the willingness to participate in additional panel waves and the successful match of the data to the register data. As expected, while some of the relationships slightly vary in terms of their significance levels, none of the substantial results reported so far have to be revised.¹⁰

5 Summary and conclusions

5.1 Implications for data users

Linked survey and administrative data sets provide additional research opportunities by unifying their respective wealth of variables. In the case of the ALWA survey, this was achieved with a comparatively low loss of observations over the different stages of the process. The remaining number of observations should be sufficient for a multitude of research questions that are usually examined using survey data. This study demonstrated potential sources of bias related to respondent consent or to linkage success, thereby providing potential data users with the means to assess and counteract any influence on their own empirical work. The main drivers of selectivity in terms of linkage rates are the respondents' age and employment status.

5.2 Implications for survey methodology

Lessons for survey practice are related to the composition of the interviewer staff and to field administration. Female interviewers significantly outperform their male colleagues in achieving consent to record linkage, regardless of whether the respondent is male or female. This is not to say that survey institutes should only employ female interviewers. The sex of the interviewer may also be relevant for other dimensions of survey quality, and in some of them the relationship might be different. We can conclude that, first, female interviewers should at least not be underrepresented in the survey staff, as this might have adverse effects on overall consent rates. Second, female interviewers should be appointed specifically to respondent groups for which consent rates are known to be low. This decision might be based on studies such as this, or survey specific knowledge may be gained by an immediate monitoring of consent rates during the field phase. A strategy like this obviously involves a field management that is able to react quickly to experience from prior interviews as well as to assign specific interviewers to respondents with previously known characteristics such as age or sex.

¹⁰These results are not presented in this paper but are available from the author upon request.

High numbers of interviews per interviewer seem to have averse effects on their ability to achieve cooperation by the respondents. Thus, an effective field monitoring should notice and react to declining success rates of single interviewers over the field phase. An a priori limit on interviews per interviewer seems advisable to keep consent rates stable.

The results finally show that the older and more experienced the interviewers, the more likely do they achieve consent to record linkage. This offers implications for the recruiting practice of the survey institute. Field management should bear in mind that strong differences in age ought to be avoided, at least when the interviewer would be much older than the respondent.

5.3 Implications for the process of record linkage

The results show that the step of probabilistic record linkage after the standardization of addresses and the exact record linkage increased the number of matches between survey and administrative records. Linkage rates could be increased by 30 percentage points, nearly 3000 respondents could be added to the linked data set. Descriptive and multivariate analyses demonstrate that these additional observations overall did not increase selectivity of the resulting sample. Thus, the effort invested in the additional step of probabilistic record linkage has been worthwhile as it further increased the research potential of the linked data set.

5.4 Further avenues of research

There are further steps to be done in the ALWA project. The number of respondents for which administrative records can be found will be increased. Several labor market states are not registered in the data of the Federal Employment Agency. Respondents that have been in one of these states during the whole year of 2007 might have no administrative records available for the sampling period. However, spells may exist for earlier or subsequent years when other employment states may have applied. Therefore, addresses from administrative records from before and after the year 2007 will be drawn and submitted to the linkage procedure. Subsequent research will determine which influence this additional effort will have on the resulting sample, for instance whether it affects the selectivity of the linked data set.

Moreover, analyses of the validity of survey data can be conducted. The combined data sets have overlapping longitudinal information both from the view of the respondent and their representation in administrative records. By comparing these it is possible to identify deviations in terms of the dating and duration of events. This might facilitate methodological improvements regarding the gathering of longitudinal information.

ALWA participants which had been willing to participate in subsequent rounds were included in a sub-study of the German National Educational Panel Study (cf. Allmendinger et al., 2011). Those who did not provide consent to record linkage during the ALWA interview were asked for it again and new sample members were asked for the first time. Possible changes in consent

behavior of single respondents or between the different survey populations will be examined. This will provide methodological evidence on record linkage from a longitudinal perspective.

Section 3 made it obvious that research on record linkage would benefit from theoretical advances related to consent behavior. Hypotheses often had to build upon the results of previous record linkage studies or on theoretical concepts explaining item or unit nonresponse. The decision on providing consent to record linkage, however, does not necessarily follow the same rules as nonresponse. For instance, accurate information retrieval is less important in the context of record linkage than for retrospective questions on longitudinal information. On the other hand, consent to record linkage involves a higher level trust in data protection than answers to single items such as the actual personal or household income. A comprehensive theoretical framework for these specific matters has yet to be devised.

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Appendix

Table A.1: Sample statistics of independent variables

| | mean | s.d. | min | max |
|------------------------------------|------|--------|------|------|
| Male | 0.50 | (0.50) | 0.00 | 1.00 |
| 18-24 (dummy) | 0.19 | (0.39) | 0.00 | 1.00 |
| 25-34 (dummy) | 0.17 | (0.38) | 0.00 | 1.00 |
| 35-44 (dummy) | 0.35 | (0.48) | 0.00 | 1.00 |
| 45-52 (dummy) | 0.30 | (0.46) | 0.00 | 1.00 |
| Foreign nationality | 0.02 | (0.15) | 0.00 | 1.00 |
| Native language German | 0.97 | (0.18) | 0.00 | 1.00 |
| Born in East Germany | 0.19 | (0.39) | 0.00 | 1.00 |
| No training (dummy) | 0.18 | (0.39) | 0.00 | 1.00 |
| Training + lower secondary (dummy) | 0.12 | (0.33) | 0.00 | 1.00 |
| Training + intermediate (dummy) | 0.28 | (0.45) | 0.00 | 1.00 |
| Training + upper secondary (dummy) | 0.11 | (0.32) | 0.00 | 1.00 |
| Master craftsman (dummy) | 0.06 | (0.25) | 0.00 | 1.00 |
| Higher Education (dummy) | 0.23 | (0.42) | 0.00 | 1.00 |

(table continued on following page)

| | mean | s.d. | min | max |
|---|-------|---------|-------|--------|
| Prose literacy score | 0.00 | (1.00) | -4.53 | 2.14 |
| Document literacy score | 0.00 | (1.00) | -4.00 | 2.74 |
| Numeracy score | 0.00 | (1.00) | -3.59 | 2.39 |
| High-cultural activity | -0.00 | (1.00) | -2.17 | 3.67 |
| Self employed (dummy) | 0.09 | (0.29) | 0.00 | 1.00 |
| Freelancer (dummy) | 0.04 | (0.19) | 0.00 | 1.00 |
| In dependent employment (dummy) | 0.59 | (0.49) | 0.00 | 1.00 |
| Civil servant (dummy) | 0.04 | (0.20) | 0.00 | 1.00 |
| Unemployed (dummy) | 0.05 | (0.22) | 0.00 | 1.00 |
| In formal education (dummy) | 0.11 | (0.31) | 0.00 | 1.00 |
| Other activity (dummy) | 0.08 | (0.27) | 0.00 | 1.00 |
| Personal net income <500EUR (dummy) | 0.22 | (0.41) | 0.00 | 1.00 |
| 500-999EUR (dummy) | 0.17 | (0.38) | 0.00 | 1.00 |
| 1000-1499EUR (dummy) | 0.17 | (0.38) | 0.00 | 1.00 |
| 1500-1999EUR (dummy) | 0.14 | (0.35) | 0.00 | 1.00 |
| 2000-2999EUR (dummy) | 0.16 | (0.36) | 0.00 | 1.00 |
| more than 3000EUR (dummy) | 0.11 | (0.31) | 0.00 | 1.00 |
| Income refused (dummy) | 0.02 | (0.15) | 0.00 | 1.00 |
| Partner in household | 0.63 | (0.48) | 0.00 | 1.00 |
| Children in household (dummy) | 0.51 | (0.50) | 0.00 | 1.00 |
| Interview on weekend | 0.20 | (0.40) | 0.00 | 1.00 |
| Share of refused answers as percentage | 0.05 | (0.25) | 0.00 | 8.03 |
| Share of 'dont't know' as percentage | 0.62 | (1.23) | 0.00 | 20.41 |
| Duration before consent quest. (m) | 25.51 | (13.59) | 1.07 | 119.33 |
| Disturbance during int. | 0.06 | (0.24) | 0.00 | 1.00 |
| Comprehension problems during int. | 0.05 | (0.22) | 0.00 | 1.00 |
| Other problems during int. | 0.08 | (0.28) | 0.00 | 1.00 |
| Consent to follow-up survey | 0.94 | (0.25) | 0.00 | 1.00 |
| Consent to cognitive tests | 0.57 | (0.50) | 0.00 | 1.00 |
| Int: male | 0.56 | (0.50) | 0.00 | 1.00 |
| Int: aged up to 24 (dummy) | 0.12 | (0.33) | 0.00 | 1.00 |
| Int: aged 25-34 (dummy) | 0.17 | (0.38) | 0.00 | 1.00 |
| Int: aged 35-44 (dummy) | 0.20 | (0.40) | 0.00 | 1.00 |
| Int: aged 45-54 (dummy) | 0.36 | (0.48) | 0.00 | 1.00 |
| Int: aged 55 and more (dummy) | 0.14 | (0.35) | 0.00 | 1.00 |
| Int: no training (dummy) | 0.17 | (0.38) | 0.00 | 1.00 |
| Int: training, below upp. secondary (dummy) | 0.16 | (0.37) | 0.00 | 1.00 |
| Int: training, upper secondary (dummy) | 0.16 | (0.37) | 0.00 | 1.00 |
| Int: higher education (dummy) | 0.33 | (0.47) | 0.00 | 1.00 |
| Int: education unknown (dummy) | 0.17 | (0.38) | 0.00 | 1.00 |
| Experience as interviewer (years) | 1.82 | (0.99) | 1.00 | 4.00 |
| N of previous interviews 0-25 (dummy) | 0.35 | (0.48) | 0.00 | 1.00 |
| N of previous interviews 26-50 (dummy) | 0.16 | (0.37) | 0.00 | 1.00 |
| N of previous interviews 51-100 (dummy) | 0.22 | (0.41) | 0.00 | 1.00 |
| N of previous interviews >100 (dummy) | 0.26 | (0.44) | 0.00 | 1.00 |
| Int: consent rate in previous interviews | 0.90 | (0.15) | 0.00 | 1.00 |

Notes: ALWA, own unweighted calculations based on 9790 observations.

Table A.2: Determinants of consent to record linkage, probit regression models with and without respondent-interviewer interactions, respectively, weighting variables included

| | without interactions | | with interactions | |
|--|----------------------|---------|-------------------|---------|
| | (1a) | | (2a) | |
| Male | 0.958 | (0.062) | 0.968 | (0.065) |
| 25-34 | 0.847 | (0.091) | 0.835* | (0.091) |
| 35-44 | 0.952 | (0.113) | 0.885 | (0.112) |
| 45-52 | 0.854 | (0.105) | 0.772* | (0.108) |
| Foreign nationality | 0.756* | (0.111) | 0.753* | (0.111) |
| Native language German | 0.887 | (0.119) | 0.882 | (0.118) |
| Born in East Germany | 1.108* | (0.069) | 1.108 | (0.070) |
| Partner in household | 1.135** | (0.071) | 1.138** | (0.071) |
| Children in household (dummy) | 0.915 | (0.059) | 0.915 | (0.060) |
| Training + lower secondary | 1.056 | (0.110) | 1.071 | (0.113) |
| Training + intermediate | 0.975 | (0.085) | 0.979 | (0.087) |
| Training + upper secondary | 1.056 | (0.116) | 1.034 | (0.115) |
| Master craftsman | 1.025 | (0.172) | 1.019 | (0.169) |
| Higher Education | 0.960 | (0.099) | 0.944 | (0.098) |
| Prose literacy score | 0.959 | (0.027) | 0.959 | (0.028) |
| Document literacy score | 0.974 | (0.023) | 0.975 | (0.023) |
| Numeracy score | 0.967 | (0.026) | 0.968 | (0.026) |
| High-cultural activity | 0.944** | (0.021) | 0.941*** | (0.021) |
| Self employed | 1.122 | (0.127) | 1.127 | (0.128) |
| Freelancer | 1.538*** | (0.209) | 1.533*** | (0.212) |
| In dependent employment | 1.373*** | (0.131) | 1.375*** | (0.132) |
| Civil servant | 1.469** | (0.287) | 1.476** | (0.289) |
| In formal education | 1.546*** | (0.186) | 1.553*** | (0.188) |
| Other activity | 1.194 | (0.155) | 1.203 | (0.156) |
| Personal net income below 500EUR | 0.978 | (0.098) | 0.975 | (0.097) |
| 500-999EUR | 0.920 | (0.084) | 0.916 | (0.083) |
| 1000-1499EUR | 0.977 | (0.072) | 0.979 | (0.071) |
| 2000-2999EUR | 1.069 | (0.093) | 1.067 | (0.093) |
| more than 3000EUR | 1.087 | (0.093) | 1.084 | (0.094) |
| Income refused | 0.514*** | (0.066) | 0.513*** | (0.065) |
| Int: male | 0.877* | (0.064) | 0.878* | (0.064) |
| Int: aged 25-34 | 1.134 | (0.136) | 1.140 | (0.131) |
| Int: aged 35-44 | 1.170 | (0.150) | 1.261 | (0.186) |
| Int: aged 45-54 | 1.272** | (0.133) | 1.419** | (0.205) |
| Int: aged 55 and more | 1.186 | (0.153) | 1.393* | (0.247) |
| Int: training, below upp. secondary | 1.097 | (0.138) | 1.126 | (0.150) |
| Int: training, upper secondary | 1.075 | (0.137) | 1.077 | (0.139) |
| Int: higher education | 0.893 | (0.095) | 0.901 | (0.096) |
| Int: education unknown | 1.002 | (0.130) | 1.005 | (0.139) |
| Experience as interviewer (years) | 1.065** | (0.033) | 1.066** | (0.033) |
| No. of previous interviews 26-50 | 0.826** | (0.065) | 0.825** | (0.065) |
| No. of previous interviews 51-100 | 0.841** | (0.062) | 0.837** | (0.061) |
| No. of previous interviews above 100 | 0.842** | (0.064) | 0.845** | (0.064) |
| Int: consent rate in previous interviews | 1.176 | (0.180) | 1.167 | (0.178) |
| Interview on weekend | 1.040 | (0.066) | 1.040 | (0.066) |
| Share of refused answers as percentage | 0.729*** | (0.063) | 0.731*** | (0.062) |

(table continued on following page)

| | without interactions | | with interactions | |
|---------------------------------------|----------------------|---------|-------------------|---------|
| | (1a) | | (2a) | |
| Share of 'dont't know' as percentage | 0.961** | (0.016) | 0.961** | (0.016) |
| Duration before consent quest. (m) | 1.000 | (0.002) | 1.000 | (0.002) |
| Disturbance during int. | 1.010 | (0.090) | 1.013 | (0.090) |
| Comprehension problems during int. | 1.090 | (0.095) | 1.092 | (0.095) |
| Other problems during int. | 0.839** | (0.066) | 0.834** | (0.065) |
| Consent to follow-up survey | 1.834*** | (0.156) | 1.841*** | (0.156) |
| Consent to cognitive tests | 1.495*** | (0.079) | 1.495*** | (0.078) |
| Int: different sex than respondent | | | 1.046 | (0.049) |
| Int. at least 10 years younger | | | 1.050 | (0.096) |
| Int. at least 10 years older | | | 0.860* | (0.079) |
| Same schooling level | | | 1.120 | (0.152) |
| Higher schooling than respondent | | | 1.050 | (0.152) |
| Unknown relation of schooling levels | | | 1.077 | (0.221) |
| Constant | 1.595* | (0.428) | 1.487 | (0.471) |
| Wald-statistic (χ^2) [p-value] | 1225 | [0.000] | 1379 | [0.000] |
| AIC | 4736 | | 4740 | |
| pseudoR ² | 0.110 | | 0.111 | |
| Observations | 9790 | | 9790 | |

Notes: ALWA, own calculations. Exponentiated coefficients. Robust standard errors in parentheses based on 210 interviewers as clusters. ***, **, * denote significance at 1%, 5%, 10%. Reference categories in both specifications: respondent aged 18-24, no training, unemployed, net household income of 1500-1999 EUR, interviewer aged up to 24, no training, 0-25 previous ALWA interviews. Additional reference categories in interacted specification: interviewer aged the same (+/-10 years) and same schooling level as respondent.

Table A.3: Determinants of consent to record linkage, separate probit regression models with respondent-interviewer interactions for female and male respondents, respectively

| | female respondents | | male respondents | |
|-------------------------------|--------------------|---------|------------------|---------|
| | (5a) | | (5b) | |
| 25-34 | 0.742** | (0.095) | 0.889 | (0.115) |
| 35-44 | 0.666*** | (0.100) | 1.001 | (0.145) |
| 45-52 | 0.575*** | (0.085) | 1.039 | (0.172) |
| Foreign nationality | 0.803 | (0.152) | 0.895 | (0.150) |
| Native language German | 0.641** | (0.116) | 1.004 | (0.164) |
| Born in East Germany | 1.204** | (0.105) | 1.170* | (0.099) |
| Partner in household | 1.217*** | (0.078) | 0.903 | (0.069) |
| Children in household (dummy) | 0.871* | (0.062) | 1.132 | (0.101) |
| Training + lower secondary | 0.963 | (0.128) | 0.991 | (0.117) |
| Training + intermediate | 1.013 | (0.126) | 0.917 | (0.096) |
| Training + upper secondary | 1.232* | (0.156) | 0.986 | (0.145) |
| Master craftsman | 1.390 | (0.403) | 0.938 | (0.130) |
| Higher Education | 1.063 | (0.133) | 0.951 | (0.104) |
| Prose literacy score | 0.977 | (0.029) | 0.967 | (0.031) |
| Document literacy score | 0.972 | (0.028) | 0.970 | (0.027) |

(table continued on following page)

| | female respondents | | male respondents | |
|--|--------------------|---------|------------------|---------|
| | (5a) | | (5b) | |
| Numeracy score | 0.951* | (0.029) | 0.986 | (0.027) |
| High-cultural activity | 0.933*** | (0.025) | 0.931** | (0.031) |
| Self employed | 1.217 | (0.191) | 1.075 | (0.158) |
| Freelancer | 1.472* | (0.291) | 1.462** | (0.250) |
| In dependent employment | 1.360*** | (0.155) | 1.250* | (0.169) |
| Civil servant | 1.246 | (0.210) | 1.917*** | (0.420) |
| In formal education | 1.181 | (0.188) | 1.668*** | (0.250) |
| Other activity | 1.478*** | (0.201) | 1.064 | (0.168) |
| Personal net income <500EUR | 1.067 | (0.108) | 0.858 | (0.126) |
| 500-999EUR | 0.962 | (0.097) | 0.853 | (0.116) |
| 1000-1499EUR | 0.973 | (0.098) | 0.960 | (0.093) |
| 2000-2999EUR | 1.011 | (0.136) | 0.966 | (0.093) |
| more than 3000EUR | 1.166 | (0.200) | 1.004 | (0.102) |
| Income refused | 0.458*** | (0.073) | 0.567*** | (0.097) |
| Interview on weekend | 1.111 | (0.102) | 1.008 | (0.064) |
| Share of refused answers as percentage | 0.743*** | (0.077) | 0.741*** | (0.084) |
| Share of 'dont't know' as percentage | 0.942*** | (0.018) | 0.962* | (0.022) |
| Duration before consent quest. (m) | 0.999 | (0.003) | 0.996 | (0.002) |
| Disturbance during int. | 1.012 | (0.116) | 0.969 | (0.128) |
| Comprehension problems during int. | 0.987 | (0.130) | 1.006 | (0.139) |
| Other problems during int. | 0.770*** | (0.074) | 0.878 | (0.084) |
| 1.Consent to follow-up survey | 1.921*** | (0.165) | 1.908*** | (0.190) |
| 1.Consent to cognitive tests | 1.639*** | (0.103) | 1.403*** | (0.084) |
| Int: male | 0.895* | (0.059) | 0.875* | (0.065) |
| Int: aged 25-34 | 1.164 | (0.124) | 1.070 | (0.148) |
| Int: aged 35-44 | 1.313* | (0.192) | 1.106 | (0.200) |
| Int: aged 45-54 | 1.447** | (0.222) | 1.213 | (0.192) |
| Int: aged 55 and more | 1.862*** | (0.331) | 1.102 | (0.222) |
| Int. at least 10 years younger | 1.029 | (0.125) | 1.053 | (0.110) |
| Int. at least 10 years older | 0.754*** | (0.072) | 0.971 | (0.096) |
| Int: training, below upp. secondary | 1.065 | (0.153) | 1.093 | (0.178) |
| Int: training, upper secondary | 1.080 | (0.110) | 1.040 | (0.159) |
| Int: higher education | 0.907 | (0.085) | 0.888 | (0.106) |
| Int: education unknown | 0.964 | (0.103) | 0.941 | (0.163) |
| Same schooling level | 1.155 | (0.212) | 1.027 | (0.116) |
| Higher schooling than respondent | 1.209 | (0.233) | 1.060 | (0.160) |
| Unknown relation of schooling levels | 0.981 | (0.216) | 1.214 | (0.282) |
| Experience as interviewer (years) | 1.089*** | (0.035) | 1.068* | (0.041) |
| N of previous interviews 26-50 | 0.893 | (0.083) | 0.812*** | (0.064) |
| N of previous interviews 51-100 | 0.821*** | (0.061) | 0.905 | (0.079) |
| N of previous interviews >100 | 0.876* | (0.063) | 0.840* | (0.078) |
| Int: consent rate in previous interviews | 1.139 | (0.184) | 1.192 | (0.222) |
| Constant | 2.057** | (0.724) | 1.645 | (0.642) |
| Wald-statistic (χ^2) [p-value] | 811 | [0.000] | 911 | [0.000] |
| pseudoR ² | 0.150 | | 0.104 | |
| Observations | 4920 | | 4870 | |

(table continued on following page)

| female respondents (5a) | male respondents (5b) |
|----------------------------|--------------------------|
|----------------------------|--------------------------|

Notes: ALWA, own calculations. Exponentiated coefficients. Robust standard errors in parentheses based on 197 and 203 interviewers as clusters, respectively. ***, **, * denote significance at 1%, 5%, 10%. Reference categories: respondent aged 18-24, no training, unemployed, net household income of 1500-1999 EUR, interviewer aged up to 24, no training, aged the same (+/-10 years) and same schooling level as respondent, 0-25 previous ALWA interviews.