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Nonresponse in PIAAC Germany

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Abstract

Nonresponse is of concern for the quality of survey data, because it may introduce bias into the collected sample. To date, only few studies deal with nonresponse in skills or educational surveys. This paper aims at contributing to this field by identifying the main factors that influenced participation in the first wave of PIAAC Germany, a survey assessing skills of the adult population, conducted in 2011/2012. Using bi- and multivariate analyses, we found that age, citizenship, the level of education, the type of house the sampled persons live in, and municipality size were the main factors influencing response to PIAAC Germany. Our findings suggest that, for the effective reduction of nonresponse in skills or education studies, researchers should target persons with a low level of education, foreigners, those living in larger housing units, and big-city dwellers by using appropriate measures at the different stages of the survey process.

Keywords: Nonresponse bias, PIAAC, Germany, skills, education

1 Introduction

The full drop out or underrepresentation of certain groups of sample persons, because of nonresponse, may cause bias in the achieved sample data (Groves, 2006). Survey researchers have several possibilities to tackle nonresponse at different stages of the survey process. A common approach is to apply weighting techniques after data collection, thus alleviating nonresponse bias in the resulting sample (Lynn, 1996). However, it is just as important to avoid nonresponse right from the outset with the help of specific survey design features and fieldwork strategies. Exploring factors that influence nonresponse is thus useful for choosing suitable strategies in future waves of PIAAC, the "Programme for the Assessment of Adult Competencies"[1], or similar survey projects.

Although, to date, a multitude of studies on nonresponse across countries, survey topics, and designs has been published (e.g., Blom, 2012; Blom, de Leeuw, & Hox, 2011; de Leeuw & de Heer, 2002; Groves, 2006; Groves & Couper, 1998), publications on nonresponse in skills and education surveys are scarce (e.g., Kleinert, Ruland, & Trahms, 2013; Darcovich, Binkley & Cohen et al., 1998; Van de Kerckhove, Krenzke, & Mohadjer, 2009). However, if a survey includes the assessment of competencies or knowledge, nonresponse might be different because the greater time and cognitive burden associated with the assessment could yield a specific profile of nonrespondents. This article aims at contributing to this field of research by analyzing survey participation in the first wave of PIAAC in Germany, conducted in 2011/2012.

Our research objective is to identify the main factors influencing survey participation in PIAAC Germany. First, we provide a review of theories on survey participation, in order to identify potential correlates of nonresponse in PIAAC, and derive hypotheses on survey participation across different groups. Among the multitude of potential influencing factors, we will focus on socio-demographic, economic, and geographic characteristics of the sample persons. They are not directly causal for survey participation, but influence the latent social and psychological constructs driving the response process (Groves & Couper, 1998). However, nonresponse is only of concern if nonrespondents differ from respondents in terms of the central study outcome(s). The characteristics identified thus need to be significantly related to both response status and the central study outcome(s) (See Section 2). Hence, in order to identify those characteristics with the potential to introduce bias

1 A description of the aim and methodology of the study is given by Rammstedt & Maehler in this volume.

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in the data set, we subsequently explore these relationships at the bivariate level. Next, we fit multivariate models of survey participation and isolate the main factors influencing participation in PIAAC Germany. The results could be useful for researchers in other skills and education surveys attempting to reduce nonresponse bias from the outset of their studies.

2 Nonresponse and its Effects on Sample Quality

Nonresponse constitutes one of several sources of error that can arise during the design and implementation of a survey (Groves & Lyberg, 2011). "…[It] occurs when a sampled unit does not respond to the request to be surveyed or to particular survey questions" (Dillman, Eltinge, & Groves et al., 2002, p. 3). As the definition implies, two types of nonresponse exist: "Unit nonresponse occurs when a selected element does not provide information at all, that is, the questionnaire form remains empty. Item nonresponse occurs when some questions have been answered but no answer is obtained for some other, possibly sensitive questions" (Betlehem 2009, p. 209). Because this article deals with unit nonresponse only, "nonresponse" will always refer to unit nonresponse here.

Under certain conditions, nonresponse can yield biased survey estimates. According to Betlehem (2002), every member of the survey population has a certain propensity to respond to a survey. As the following formula shows, nonresponse bias in the respondent mean $\left(\overline{y}_r\right)$ can be approximated by the ratio of the covariance between the response propensity (p) and the survey variable (y), and the mean response propensity $\left(\overline{p}\right)$:

$$Bias\left(\overline{y}_r\right) \approx \frac{\acute{o}_{yp}}{\overline{p}}$$

The formula implies that nonresponse bias in the respondent mean depends not only on the response rate (the mean response propensity), but also on the strength of the relationship between the response propensity and the variables measured in the survey. Indeed, "… [t]he stronger the relationship between the target variable and response behavior, the larger the bias" (Betlehem, 2002, p. 276). As described by Groves (2006) in the "survey variable cause model", the most severe case of nonresponse bias is given in the case of a perfect correlation between the survey variable of interest and response propensity. Here, the survey variable is the cause of nonresponse and groups that differ from respondents, in terms of the survey variable, are completely missing from the sample. This type of nonresponse is also called "nonignorable nonresponse" (Little & Rubin, 2002), because nonresponse adjustment techniques may not be successful (Betlehem et al., 2011). Described by Groves (2006) as the "common cause model", nonresponse bias can also occur if

response propensity and survey variable arise from the same variable or set of variables. Here, the covariance between the survey variable (y) and response propensity (p) is due to a common cause of both variables. However, if the nonresponse adjustment techniques are based on the variables that caused both y and p, correction of the bias is possible (Betlehem et al., 2011).

3 Factors Influencing Survey Participation

In the following section, we provide an overview of theoretical approaches to survey participation. The aim of this synopsis is to identify common correlates of nonresponse and develop hypotheses for factors influencing participation in PIAAC in Germany.

3.1 Rational Choice Approaches

Most theories that try to explain survey participation have their roots in rational choice theory; for instance, the "opportunity cost hypothesis" (Groves & Couper, 1998) or the social exchange theory (e.g., Dillman, 1978; Goyder, 1987). Rational choice approaches assume that, when confronted with a survey request by an interviewer, sample persons weigh up all potential benefits of a survey against their costs and base their decision on the outcome of the calculation. Although rational choice approaches, in their strictest sense, assume that sample persons take their time for a careful consideration of the pros and cons of participation, Groves and Couper (1998) specify that this is rarely the case in survey practice. For example, most refusals in telephone surveys take no longer than 30 seconds (Groves et al., 2009). Instead, they suggest that the decision to participate is a heuristic act based on a superficial and quick cost-benefit analysis that is influenced by a variety of external and situational factors (Groves & Couper, 1998). In their "leverage-saliency-theory", Groves, Singer, and Corning (2000) specified that costs and benefits are not static across sample persons and that individuals differ in the "leverages" they attach to the various design features. This means that sample persons can have different perceptions about whether specific survey characteristics are benefits or costs and can differ in their evaluation of how high the respective costs and benefits of participation are.

The costs and benefits of a survey depend on its specific design features. For example, many surveys aim to encourage participation with monetary or nonmonetary incentives, which can be paid either conditionally upon participation or unconditionally to each household or sample person (Groves & Couper, 1998). Even if the type and value of the incentives differ across survey projects, types, and countries, some indisputable effects of incentives have been repeatedly demonstrated:

Incentives do increase response rates, monetary incentives are more effective than non-cash incentives, and prepaid incentives are more effective than conditional incentives (e.g., Singer, Van Hoewyk, Gebler, Raghunathan, & McGonagle, 1999; Singer & Ye, 2013). Obviously, the topic of a survey can also be seen as a cost or a benefit of participation. From a rational choice perspective, sample persons might expect greater benefits for themselves when participating in a study that is of interest to them (Groves & Couper, 1998). In an experiment on differences in response rates among various interest groups, Groves, Presser, & Dipko (2004) did indeed find higher response rates among groups interested in a topic, such as school teachers on educational topics, than in the general population. Furthermore, interview burdens are supposed to play a part in the sample persons' cost-benefit analyses. Surveys can show enormous variation regarding the time requested for completion of the questionnaire, the cognitive burden imposed by answering the questions, and the emotional burden that opening up to a stranger on sensitive topics might imply (Groves & Couper, 1998). In addition, the survey sponsor influences the decision to participate. As discussed below, surveys conducted by public authorities generally achieve higher response rates than those organized by private companies (e.g., Lyberg & Dean, 1992). Furthermore, a design feature that might positively impact the cost-benefit analysis is sending advance letters. In addition to informing the household or specific sample persons that they have been selected for participation, these letters also generally aim at encouraging cooperation by highlighting the most attractive benefits of participation (Groves & Couper, 1998).

The notion that sample persons perceive costs and benefits differently implies that some socio-demographic groups might be more attracted by specific survey design features than others. For example, rational choice approaches would assume that those with little discretionary time available, such as those in employment, should consider the time needed for completion as a greater burden than those with more available time. However, empirical tests either failed to verify the hypothesis that the amount of discretionary time available is related to survey cooperation (Groves & Couper, 1998) or found that the unemployed are more likely to refuse (Durrant & Steele, 2009). Furthermore, costs and benefits should be perceived differently across different levels of education. For example, the less educated could perceive the cognitive burden stemming from the need to complete a test such as administered in PIAAC as a higher cost than the highly educated. Furthermore, the latter might see a greater benefit in contributing to a study such as PIAAC, which informs policy makers on educational policy topics, because they are probably more interested and are better informed about the matter. Indeed, research on nonresponse repeatedly found less educated groups to be prone to nonresponse (Koch, 1998; Watson & Wooden, 2009). However, research on nonresponse in skills and educational studies report mixed results. Whereas Kleinert et al. (2013) could confirm, for an educational study conducted in Germany - "Arbeiten und

Lernen im Wandel" (ALWA), that groups with a low level of education were underrepresented, Van de Kerckhove et al. (2009) did not find a significant relationship between response status and the level of education in the US-American section of the Adult Literacy and Lifeskills Survey (ALL) in 2003. Furthermore, Darcovich et al. (1998) found, for the International Adult Literacy Survey (IALS) conducted in the US in 1994, the highest response rates among both the lowest and highest educational groups.

The question of whether specific survey design features might even introduce bias into the sample data has predominantly been discussed with reference to incentives (e.g., Singer & Ye, 2013). For example, rational choice approaches would assume that low-income groups and groups with correlated characteristics, such as a low level of education, consider incentives as a greater benefit, compared to high-income groups. However, research has found few consistent effects of incentives on the sample composition. Although a relationship between income and the attractiveness of incentives was verified by several studies (Juster & Suzman, 1995; Singer & Kulka, 2002), results regarding the level of education are mixed. Indeed, both Petrolia and Bhattacharjee (2009) and Berlin et al. (1992) reported that incentives were particularly successful in attracting less educated respondents, but Jäckle and Lynn (2008), found no such effect when studying different achievement groups among 16-17-year-old students. Analyses of an incentive experiment conducted during the PIAAC field test indicate that the payment of an incentive of 50€ in the German PIAAC main study may have had some effect on the sample composition. In the field test, the 50€-incentive was more successful in attracting the 16-25-year-olds, German citizens, and persons living in small and medium-sized towns than the other incentives (see Martin, Helmschrott & Rammstedt in this volume). The distributions of the level of education, gender and household size were not significantly different across the incentives (Pforr et al., forthcoming).

Another approach to explain nonresponse based on notions of rational choice is the application of social exchange theories to survey participation (Dillman, 1978; Dillman, Smyth, & Christian, 2009; Goyder, 1987). They assume that individuals are in constant social interaction with other individuals or institutions and expect long-term rewards from those relationships if they are equal with respect to favors (Blau, 1964). In the survey context, this concept is particularly useful when applied to governmental surveys. These are characterized by a special relationship between the sample person and the survey sponsor, including mutual rights and duties. When confronted with such a survey request, the reaction of the sample persons is supposed to depend on their past and expected future relationship with the governmental institutions, for example, with respect to government services (Groves & Couper, 1998).

Because government services vary between socio-economic groups, indicators reflecting the sample persons' socio-economic status (SES) have been used

to test the theory. However, two opposing hypotheses have developed: The first hypothesis suggests a negative linear relationship between survey participation and SES. According to the hypothesis, low SES groups feel more bound to participate as a sort of repayment, because they might receive governmental benefits, while high SES groups do not feel this obligation, because they pay more than they receive. The second hypothesis suggests a curvilinear relationship, with both the low and the high SES groups refraining from participation. The suggested explanation is that the low SES groups constantly feel unjustly disadvantaged in society, and survey interviewers – as agents of the more fortunate – might evoke memories of their disadvantages (Groves & Couper, 1998).

However, research has failed to find consistent support for either of these hypotheses. For example, Groves and Couper (1998) found support for greater cooperation among lower SES groups, as proposed by the first hypothesis, whereas Durrant and Steele (2009) and Demarest et al. (2012) found lower participation rates among households with a low SES. By contrast, Smith (1983) reported that middle SES groups were more likely to refuse than low or high SES categories. These inconsistencies might be explained by variations in the operationalization of socio-economic status. While some studies rely only on a single indicator for SES, such as income (Smith, 1983) or education (Demarest et al., 2012), others use combinations of various proxy indicators (Groves & Couper, 1998). Furthermore, it should be difficult to find consistent effects of SES on survey participation in studies conducted in different countries, because the type and magnitude of duties towards the government, such as taxes and government services, vary considerably across countries.

The application of this approach to PIAAC might be limited by the fact that it is not a "government survey", in its strictest sense. Even though the study was funded by two federal ministries, fieldwork has been conducted by a commercial survey organization. Thus, the interviewers might not have been perceived as agents of the government. However, as suggested by the social exchange theory, mentioning the survey sponsors might evoke memories of past exchanges with the government, in its broadest sense, and encourage participation as a reciprocal act for any kind of received benefits.

3.2 Social Isolation Theories

Social isolation theories are closely related to social exchange theories. They suggests that individuals or groups with a long history of negative exchange experiences with society feel socially isolated. The repeated frustration of such groups, e.g. due to unequal treatment, leads to the deliberate denial of mainstream societal norms. In the context of survey participation, this could restrain potential participants from seeing their participation as their "civic duty" (Groves & Couper, 1998).

In the literature, the theory has been tested extensively with socio-demographic proxy indicators for social isolation. For example, it is conceivable that persons living in a single-person household show lower response rates, due to less social integration, whereas households with children have higher response rates because they are highly integrated into the community, e.g., through school networks. The theory also implies that sample persons living in large, multiunit structures are less inclined to participate, due to weaker ties with neighbors and the local community (Groves & Couper, 1998). Indeed, a multitude of studies found lower response propensities for single-person households (e.g., Ekholm & Laaksonen; Groves & Couper, 1998; Smith, 1983) and households in multiunit structures (e.g., Goyder, Lock, & McNair, 1992; Groves & Couper, 1998), while there is consistent proof of higher response rates from households with children (e.g., Groves & Couper, 1998).

Furthermore, the theory suggests that immigrants and ethnic minorities have lower response rates than native citizens or the ethnic majority group. Prior research has found that these groups are less likely to be respondents (Blohm & Diehl, 2001; Feskens, Hox, Lensvelt-Mulders, & Schmeets, 2007). However, some studies failed to find differences (e.g., DeMaio, 1980; Smith, 1983) or reported above-average response rates among minority groups (Groves & Couper, 1998). This might be due to the fact that both of these groups are very different across and within countries and may thus show large variations in response behavior. In addition, lower participation rates by the elderly have been explained by their stronger disengagement from society, compared to younger age groups (Krause, 1993). However, results are inconsistent, with other studies finding either higher response rates for the elderly (Groves & Couper, 1998) or no age effect (Nicoletti & Peracchi, 2003). Regarding gender, some researchers claim that men are less likely to participate in surveys than women, because women more often take over the role of maintaining social interaction with friends, relatives, or neighbors (Groves & Couper, 1998). Also here, results are mixed, with most studies reporting higher response rates for women or failing to find a gender effect (e.g., Brehm 1993; Smith, 1983).

3.3 Further Factors Influencing Survey Participation

The theories presented above introduced useful notions about the mechanisms underlying the decision to participate in a survey and specific factors influencing the propensity to respond to a survey. However, with their respective focus, they fail to fully grasp the complexity of the survey participation process and its various influence levels.

First of all, they focus on that stage of the survey process at which the interviewer is already in contact with the sample person. However, as outlined by Groves and Couper (1998), nonresponse can already arise at an earlier stage: when the interviewer tries to locate or contact the sample person. The success of establishing

contact depends on the variability of the interviewers' contact attempts throughout the day and the week and on the at-home patterns of the sample persons. This implies that the reason for the low participation rates of some groups is that they spend little time at home. Research has repeatedly found that persons in employment and younger respondents (Lynn, 2003), single-person households, big-city dwellers, high-income, and well-educated groups are more difficult to contact than the elderly or households with children (Durrant & Steele, 2009; Goyder, 1987). It has also been assumed that women might, overall, be met more often at home than men. They more often take care of young children without holding a paid job, in comparison to men, or only have a teleworking or part-time job (Groves & Couper, 1998). In addition, research has found that lower participation rates of immigrants can be largely explained by their low contact rates (Koch, 1997). Reasons for this could be that immigrants spend prolonged time periods in their home countries (Blohm & Diehl, 2001) or that they are more likely to live in urban areas where contact difficulties are more pronounced (Feskens et al., 2007).

Moreover, an important reason for nonresponse at the cooperation stage that has not been reflected by the theories is the inability to participate in a survey. For example, immigrants and ethnic minority groups may simply not be able to participate because they do not speak the survey language and no interpreter is provided by the survey organization. Moreover, persons with a disability or health problems might not participate because their physical or mental problems impede them from understanding, reading, or correctly answering the survey questions (Groves, 2009; Stoop, 2005).

In addition, the theories focus on reasons related to the sample persons and their reactions to specific survey design features. However, Groves and Couper (1998) stress that the survey process is more complex and additional factors play a role in the decision to participate or not. One such factor is the social environment, which may be negatively influenced when privacy concerns are widely shared in society, or when citizens are often confronted with survey requests ("over-surveying effect") (Groves & Couper, 1998). Another environmental factor that has consistently proven to be related to survey participation is urbanicity. Residents of small towns and rural areas are generally more likely to be respondents, whereas big-city dwellers are usually both less cooperative and harder to contact (Blom, 2012; Stoop, Billiet, Koch, & Fitzgerald, 2010). Furthermore, Groves and Couper (1998) stress that the interviewers play an important role in gaining both contact and cooperation in interviewer-administered surveys, which has been widely acknowledged in the literature (Blom et al., 2011; Jäckle, Lynn, Sinibaldi, & Tipping, 2013; Pickery & Loosveldt, 2004).

3.4 Hypotheses on Factors Influencing Survey Participation in PIAAC Germany

Based on the literature review above, we derive the following hypotheses on survey participation in PIAAC Germany.

Regarding *age*, we assume that the youngest age group was most likely to respond (Hypothesis 1). Even though, in empirical studies, young respondents have been found to be difficult to contact, the incentive experiment conducted during the German field test showed that the 50€-incentive was particularly successful in attracting the 16-25-year-olds. Hypotheses proposed by the theories for other age groups seem to be hardly applicable to PIAAC. For example, theories on social isolation suggest lower response rates among the elderly because of their disengagement from society. Rational choice approaches propose that they feared a higher cognitive burden from the skills assessment than younger sample persons. In addition, they are supposed to be more likely to suffer from a reading and/or writing difficulty or an impairment.

However, the oldest age group in PIAAC comprises the 55-65-year-olds, who are generally still active members of society and in good health. Hence, we expect their willingness to respond to be similar to that of other age groups. Furthermore, we expect *women* to show higher response rates than men (Hypothesis 2), largely because empirical studies found them to be more often met at home than men.

Several reasons make us expect that *non-Germans* were less likely to participate than Germans (Hypothesis 3). First, they have been shown to be difficult to contact. Second, according to social isolation theories, as non-citizens, they could have felt less obliged to contribute to a study that is useful for the German society. Third, rational choice approaches would assume that non-Germans who are not proficient in German might have refrained from participation because they feared higher cognitive and time burdens than Germans. This is due to the fact that the skills assessment was conducted solely in German; an interpreter could be used only for the completion of the background questionnaire. Fourth, those non-Germans without German language skills might not have seen the benefit of completing a questionnaire without being able to participate in the skill assessment, and thus refrained from participation. Finally, the incentive experiment of the German field test has shown that the 50€-incentive was less attractive for non-Germans than for Germans.

Furthermore, we expect that persons with *lower levels of education* were less willing to participate in PIAAC than those with a high level of education (Hypothesis 4). Rational choice approaches suggest that those with lower educational attainment feared higher costs, in the form of cognitive survey burden, due to the need to complete a skills assessment. Those with a high level of education might have been more interested in the topic and more curious about completing a skills assessment.

Moreover, they probably expected lower costs from the cognitive survey burden and a higher personal benefit from being part of a study whose results serve policy makers.

Regarding *urbanicity*, we expect big-city dwellers to have lower response rates than those living in smaller cities (Hypothesis 5). This might be related to the hypothesis of social isolation theories that big-city dwellers live more anonymous lives and avoid contact with strangers, and also because they are less likely to be reached at home, due to busy life-styles. Furthermore, the results of the incentive experiment of the German field test indicate that the 50€-incentive was more successful in convincing residents of smaller and medium-sized cities to participate. Closely related to urbanicity, we also expect that sample persons living in large *multiunit houses* were less likely to participate (Hypothesis 6), in keeping with the social isolation theories.

Additionally, we assume that persons with a low *socio-economic status*[2] have lower response rates (Hypothesis 7). The curvilinear hypothesis of the social exchange theories and the social isolation theories would suggest that this is due to a reduced feeling of civic obligation to contribute to a research project benefitting society. Even though the curvilinear hypothesis of the social exchange theory would also predict low response rates for groups with high socio-economic status, we expect that these groups were more likely to respond. Those with a high socio-economic status tend to have a high level of education; as outlined above, we expect the highly educated to be more inclined to participate.

Regarding the sample persons' *work status* (Hypothesis 8), we can derive two hypotheses from the theory. Notions of social isolation or social exchange theories suggest that the unemployed and those out of the labor force are less interested in participating in a study useful for a society they do not feel to be a part of. Furthermore, rational choice theory proposes that they might fear higher survey burdens by having their skills tested, because they could be afraid of having lower skills, compared to respondents holding a job. However, rational choice theory also assumes that those in employment and the self-employed are less likely to respond because they fear higher costs from the time burden imposed by a survey. Furthermore, they are probably more difficult to be contacted, because they are met at home less often.

With regard to *household size*, the theories predict that sample persons living in single-person households were less inclined to participate than persons living in multi-person households with children (Hypothesis 9). Social isolation theories assume that the former are more isolated from society than the latter and thus are less willing to contribute to a survey beneficial for society. Furthermore, single-person households are more difficult to contact.

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2 To test this hypothesis, we use the variables "socio-economic status", "condition of the house" and "purchasing power". The variable "socio-economic status" is a combination of the level of income and the level of education in the area the sample person lives in.

4 Nonresponse in PIAAC Germany

Following a description of the data and the analyses we used, we explore in this section, which of the described characteristics are the main factors influencing the decision to participate in PIAAC or not. Since the non-contact rate in PIAAC Germany was only 3.4% (Zabal et al., 2014), we focused on overall nonresponse, rather than explicitly distinguishing between non-contact and non-cooperation.

4.1 Data Description

To analyze nonresponse, auxiliary variables are needed that are available for both respondents and nonrespondents. As described in Zabal et al. (2014), the basic socio-demographic and geographic information we had at our disposal (age, gender, citizenship and municipality size) is part of the sample frames provided by the Federal Statistical Office and local population registries. Furthermore, interviewers were required to assess the sample persons' level of education and social class, type and condition of the house they lived in, and whether an intercom existed, and provide this information in their contact protocols. This evaluation had to be done prior to the first contact with the sample person. Finally, we used a commercial consumer-marketing database provided by Microm, which includes further socio-demographic and economic information on sample units at an area level. The data we used from this source are unemployment rate, socio-economic status (a combined variable of the level of education and income), purchasing power per household, and the prevailing family structure (i.e., the share of single households and households with children) in an area (Microm, 2011).

4.1.1 Quality of the data

Among these sources, the information provided by the sample frames is assumed to be of the highest quality. These data are regularly updated by the administrative authorities, are available at the individual level and rarely contain missing values. The contact protocol information also contained only few missing values. However, these data are prone to error, because interviewers were advised to collect them prior to their first contact with the sample persons, in order to make the data from respondents and nonrespondents comparable. This instruction might have had little effect on questions such as the type and condition of the house or whether an intercom existed (Sinibaldi, Durrant, & Kreuter, 2013). However, interviewers' evaluations of social class and level of education are potentially subject to measurement error, because they are based solely on environmental factors such as the neighborhood or features of the housing (Olson, 2013; West, 2013). We assessed the accuracy of the interviewers' judgments of the sample persons' level of educa-

tion; for this variable, we had comparable data available from the PIAAC interview. By calculating the percentage of correct estimations[3], we found that, overall, only approximately half of assessments were correct (48.4%). However, only very few interviewers gave a completely wrong assessment by assigning a low level of education when, in fact, the respondent had a high level of education, and vice versa (5.5%). We thus conclude that the interviewers' assessments of the respondents' level of education were reasonably accurate. However, the results have to be treated with caution, because comparable data were not available for nonrespondents and only the interviewer evaluations of the respondents' level of education could be verified.

Microm data also have quality limitations, because they are aggregated over an area comprising between five and approximately 500 households, with an average of about eight households (Microm, 2011). In addition, for about 5% of the sampled units, Microm data were not available (Zabal et al., 2014).

4.1.2 Definition of response status and sample size

Participants in PIAAC first had to complete a questionnaire collecting background information that was administered by the interviewers on a laptop computer. The questionnaire was followed by an assessment that respondents performed in the domains literacy, numeracy, or problem solving in technology-rich environments[4] (Zabal et al., 2014). We defined *respondents* as participants who completed the PIAAC background questionnaire or had answered a sufficient proportion of the questionnaire, as defined in OECD (2013). *Nonrespondents* were defined as sample persons who did not start the interview because they were, for example, not able to be contacted, refused, did not respond due to literacy-related reasons or due to a disability, or broke off the interview before reaching the designated threshold[5]. Literacy-related reasons are language problems, difficulties with reading or writ-

3 The interviewers had to assess whether the sample person's level of education was "low", "medium" or "high". For the comparison, the information on the respondent's ISCED level (International Standard Qualification of Education) collected during the interview was recoded as "low": below ISCED 1, ISCED 1 & 2, "medium": ISCED 3 & 4, and "high": ISCED 5 & 6.

4 The assessment comprised, generally, a combination of two of the domains mentioned. However, one sixth of respondents received only items in problem solving in technology-rich environments.

5 There were only three breakoffs in the PIAAC background questionnaire. Two cases were counted as respondents, one as nonrespondent.

ing and a learning or mental disability (Zabal et al., 2014). Ineligible cases were excluded.[6]

The gross sample in PIAAC Germany comprised n = 10,240 individuals, out of which n = 10,086 were eligible. According to the definition outlined above, n = 5,379 sample persons were counted as respondents, and n = 4,707 as nonrespondents.

4.1.3 Weights used for analyses and variance estimation

For all analyses presented, the PIAAC unknown eligibility weight was used. This is a base weight correcting for differential selection probabilities that occurred because of an erroneous selection algorithm used during sample selection in PIAAC Germany (Zabal et al. 2014). Moreover, this base weight adjusts for unknown eligibility: Those whose eligibility could not be verified, e.g., because they had moved and their new address could not be traced, were weighted down according to the proportion of ineligibles among those with known eligibility. In order to account for an increased variance due to the complex sample design, for each of the weights used in PIAAC, 80 replicate weights had been calculated by the international consortium (OECD, 2013). For the correct estimation of variance, the unknown eligibility weight was thus used, together with its 80 replicate weights.[7]

4.2 Main Factors Potentially Introducing Nonresponse Bias in PIAAC Germany

In this section, we examine which of the socio-demographic, economic, and geographic characteristics suggested by the literature are the main factors influencing survey participation in PIAAC Germany and test whether our hypotheses could be verified.

As outlined above, only those factors that are both related to the central study outcome(s) and response status have the potential to introduce bias into the data set (Groves, 2006). Thus, we first examined, at the bivariate level, whether the charac-

6 This definition differs slightly from the one used in the official PIAAC nonresponse bias analyses. In this paper, the literacy-related nonrespondents are coded as nonrespondents, because the inability to participate due to literacy-related reasons is considered as an important reason for nonresponse. Due to technical reasons related to the weighting process, the literacy-related nonrespondents were excluded from the analyses for the official PIAAC nonresponse bias analyses. The results presented here are thus not directly comparable to the results of similar analyses published in Zabal et al. (2014).

7 Weights exceeding $3.5^* \sqrt{1+CV^2}$ the median unknown eligibility weight were trimmed by the authors, in line with the trimming procedure for the PIAAC final weights (see OECD, 2013).

teristics frequently identified as drivers of nonresponse were significantly associated with both response status and the central study outcome, which is *proficiency*[8] in PIAAC. The variables not significantly related to proficiency and response status are irrelevant for nonresponse bias in PIAAC and were thus omitted from further analyses.

We used proficiency in literacy (in the following called "proficiency") as the key study outcome, because literacy can be regarded as a basic skill that is highly relevant for the acquisition of the other skills measured in PIAAC (Zabal et al., 2013). For the correct estimation of variance, due to both the complex sample design and the imputed plausible values, the "PIAACTOOLS"[9] that have been developed for Stata were used. Because these tools do not include Pearson's r correlation analyses, we ran linear regression models with proficiency as dependent variable and each variable investigated as individual predictor. The Pearson's r values were obtained by calculating the radical of the coefficient of determination of the regression models.

4.2.1 Factors with the potential to introduce nonresponse bias into the data set

As can be seen in Table 1, most explanatory variables were highly significantly correlated with proficiency at the 0.1% level. The strongest correlations were observed for the level of education and social class (both $r = 0.3$, $p = 0.000$), followed by age, citizenship, the condition of the house, socio-economic status, and purchasing power ($r = 0.2$, $p = 0.000$). The unemployment rate and the type of house (both $r = 0.1$, $p = 0.000$), gender, municipality size, and the family structure in the area (all $r < 0.1$, $p < 0.05$) showed the lowest correlations. Given that the correlation coefficients are only of a low to medium strength, the potential for bias in the proficiency score is only moderate. The presence of an intercom at the sample persons' houses showed no significant correlation with proficiency and was thus omitted from the logistic regression analysis below.

Results of the χ^2-tests of independence[10] between the explanatory variables and response status revealed that nearly all characteristics were significantly related

8 The proficiency scales in PIAAC have been modelled for each of the skill domains, based on Item Response Theory (IRT). This reflects both the difficulty of the task and the respondents' skill level on one scale. The scales range from 0-500; the higher the value on the scale, the higher the skill level needed to solve a task. For each respondent, 10 "plausible values" were estimated per scale, in order to improve the accuracy of the proficiency estimates for the subpopulations and the overall population (Zabal et al., 2013).

9 http://www.oecd.org/site/piaac/PIACTOOLS_16OCT_for_web.pdf (retrieved November 2014)

10 In order to account for the complex sample design, the Pearson's χ^2-statistic was corrected with the second-order correction of Rao and Scott (1981) and converted into an F-statistic.

Table 1 Associations of explanatory variables with proficiency and response status

	Proficiency		Response status	
Explanatory variable	Pearson's *r*	*p-value*	*F***	*p-value*
Registry				
Age	0.2	0.000	21.7	0.000
Gender	<0.1*	0.007	3.8	0.056
Citizenship	0.2	0.000	48.4	0.000
Municipality size	<0.1	0.02	5.7	0.000
Contact protocol				
Level of education	0.3	0.000	30.7	0.000
Social class	0.3	0.000	20.5	0.000
Intercom	<0.1	0.302	-	-
Type of house	0.1	0.000	27.9	0.000
Condition of house	0.2	0.000	16.2	0.000
Microm				
Socio-economic status in area	0.2	0.000	8.5	0.000
Unemployment in area	0.1	0.000	3.6	0.030
Purchasing power in area	0.2	0.000	6.2	0.003
Family structure in area	<0.1	0.024	22.1	0.000

* The output of the PIAACTOOL regression displays the R^2 only with two decimals after the point. In case the value of the displayed R^2 is 0.00, an exact result for *r* cannot be calculated.

** See footnote No. 10.

to response status; most at the 0.1% level. Gender was not significantly related to response ($F = 3.78$, $p = 0.056$). However, because the 5% level of significance was only marginally missed and, in the multivariate setting, this covariate could be more significant, it was included in the regression analysis.

4.2.2 Main influencing factors on participation in PIAAC Germany

In this section, we analyze which of the characteristics significantly associated with proficiency and response status at the bivariate level had an effect on participation in PIAAC when controlled for by other covariates in logistic regression analyses predicting response. These characteristics are identified as the main factors influencing response to PIAAC in Germany. Results of the analyses serve to test whether our hypotheses on nonresponse in PIAAC Germany can be verified.

First, a full model was estimated that included all factors that had been shown to have the potential to introduce bias into the PIAAC data, with the exception of the dummy variables for social class. In an analysis of multicollinearity, they showed a high variance inflation factor, indicating that its inclusion might bias the results (low social class: VIF = 6.93, tolerance = 0.14, middle social class: VIF = 5.16, tolerance = 0.19). Subsequently, those variables without a significant contribution in the full model were removed and a final model was fitted.

As displayed in Table 2, results from the first full model showed that, when controlling for other factors, only age, citizenship, the level of education, the type of house, residence in a metropolitan area (500,000 inhabitants and more), and a high unemployment rate in the area had a significant influence on survey participation in PIAAC Germany. By contrast, gender, the condition of the house, the predominant socio-economic status, purchasing power and household size in the area the sample person lives in, proved not to be significant predictors of response. However, a goodness-of-fit test indicated a lack of fit of the full model ($p = 0.044$)[11]. We thus removed the insignificant covariates to estimate a final model that has an improved model fit ($p = 0.104$). In this final model, we see that the unemployment rate no longer had a significant influence on response, whereas the remaining effects were similar to those in the full model. Age, citizenship, a low level of education and the type of house the sample persons live in were highly significant predictors of response at the 0.1% level, and having a medium level of education and living in a metropolitan area were significant at the 5% level. Living in a smaller or medium-sized city did not have a significant effect.

The results of the multivariate analyses indicate that only some of our hypotheses on nonresponse to PIAAC in Germany were substantiated. Even though gender (Hypothesis 2), the predominant socio-economic status, the condition of the house and purchasing power (all Hypothesis 7), the unemployment rate (Hypothesis 8) and the household size in the area the sample person lives in (Hypothesis 9) were significantly related to response status at the bivariate level, in the multivariate setting they proved not to be significant predictors of response to PIAAC. However, a closer look at the results of the final model reveals that our hypotheses on age, citizenship, the level of education and urbanicity could be verified. As expected, the 16-25-year-olds were distinctly more likely to participate than the other age groups (Hypothesis 1). Moreover, non-Germans (Hypothesis 3), persons with lower levels of education (Hypothesis 4), big-city-dwellers (Hypothesis 5) and those living in larger housing units (Hypothesis 6) were less likely to participate than their respective counterparts.

11 As goodness-of-fit test, the F-adjusted mean residual test was used, which takes the complex sample design into account. A small p-value indicates a lack of fit (For details of the method, see Archer & Lemeshow, 2006).

Table 2 Logistic regression models predicting response

	Full model		Final model	
Variable	Coefficient	S.E.	Coefficient	S.E.
Age (*Reference = 16-25*)				
26-35	-0.460***	(0.085)	-0.466***	(0.082)
36-45	-0.526***	(0.081)	-0.532***	(0.079)
46-55	-0.631***	(0.068)	-0.613***	(0.068)
56-65	-0.633***	(0.096)	-0.645***	(0.093)
Gender (*Reference = Female*)				
Male	-0.063	(0.053)		
Citizenship (*Reference = German*)				
Non German	-0.368***	(0.096)	-0.379***	(0.094)
Level of education (*Reference = High level of education*)				
Low level of education	-0.332***	(0.084)	-0.389***	(0.068)
Medium level of education	-0.166*	(0.070)	-0.173*	(0.065)
Type of House (*Reference = Farmhouses, single and terrace houses*)				
House with three to eight flats	-0.193**	(0.061)	-0.225***	(0.057)
Houses with 9 flats and more	-0.337***	(0.072)	-0.379***	(0.068)
Municipality size (*Reference = 1-4,999 inhabitants*)				
5,000-49,999 inhabitants	0.026	(0.080)	-0.027	(0.076)
50,0000-499,999 inhabitants	-0.065	(0.091)	-0.055	(0.084)
500,000-99,999,999 inhabitants	-0.204*	(0.097)	-0.190*	(0.087)
Condition of the house (*Reference = Very good condition of the house*)				
Bad condition	-0.097	(0.090)		
Good condition	-0.011	(0.070)		
Unemployment rate (*Reference = below average unemployment rate*)				
Average unemployment rate	0.059	(0.065)	0.016	(0.059)
Above average unemployment rate	0.168*	(0.075)	0.059	(0.057)
Purchasing power per household (*continuous variable*)				
Purchasing Power	0.001	(0.002)		
Socio-economic status (*Reference = Above average status*)				
Below average status	-0.072	(0.091)		
Average status	0.006	(0.067)		
Family structure (*Reference = above average share of families with children*)				
Above average share of single HH	-0.061	(0.088)		
Mixed family structure	-0.078	(0.059)		

Table 2 Logistic regression models predicting response (cont.)

	Full model		Final model	
Variable	Coefficient	S.E.	Coefficient	S.E.
Constant	0.912**	(0.278)	0.987***	(0.105)
N	9367		9832	
Nb. of Replicates	80		80	
Design df	79		79	
Prob > F	0.000		0.000	
P-value of the *F*-adjusted mean residual test	0.044		0.104	

Dependent variable: 1 = response 0 = nonresponse
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

5 Discussion

In multivariate analyses, we found that non-Germans, those with lower levels of education, those living in larger housing units, and big-city dwellers were significantly less likely to participate in PIAAC than their respective counterparts. Furthermore, we found that 16-25-year-olds were significantly more willing to take part in PIAAC than other age groups. Age, citizenship, the level of education, the type of house the sample person lives in, and municipality size can therefore be identified as main factors influencing participation in PIAAC Germany. However, given that the correlation coefficients of these variables with the central study outcome proficiency are only of weak to medium strength (r = 0.1-0.3), the potential for nonresponse bias in the data set is only moderate.

Our hypotheses about foreigners, big-city dwellers and those living in larger housing units being less likely to participate in PIAAC have been validated and thus confirm corresponding findings in the existing literature (DeMaio 1980; Feskens et al. 2007; Goyder et al., 1992; Groves & Couper, 1998). Theoretical approaches to survey participation, such as hypotheses on social isolation, suggest that these groups feel isolated from either their local communities or from society as a whole and thus lack the feeling of a "civic duty" to participate in surveys useful for society. In addition, a multitude of studies has shown that these groups are difficult to contact (Durrant & Steele, 2009; Koch, 1997). Furthermore, because the PIAAC skills assessment was conducted in German, we suppose that, among non-German citizens with little or no German language skills, the higher cognitive burden related to this assessment, or the inability to complete it, impeded participation.

Our expectation that those with lower levels of education were less willing to participate was met, too. This indicates that rational choice approaches, which sug-

gest these groups might fear higher survey burdens from the skills assessment and might be less interested in participating in an educational study, have good explanatory power to justify the reluctance of these groups to participate. Furthermore, we can confirm empirical studies that reported a similar effect of the level of education on response (Kleinert et al., 2013; Koch, 1998; Watson & Wooden, 2009).

Our hypotheses regarding gender, socio-economic status, work status, and the household size could not be verified because they proved not to be significantly related to response status, when controlled for by other covariates in the multivariate setting. However, because they are all significantly related to survey participation at the bivariate level, they could still be valid when tested separately.

Thanks to the rich information from three data sources, we were able to test which of the bivariately significant factors were the strongest predictors of participation at the multivariate level. However, it should be noted that the three data sources used are of different quality. Most of the variables that proved not to have a significant independent effect on survey participation contain information aggregated at an area level. These variables might not accurately describe the situation of all persons in the sample and they are thus weaker predictors of survey response than individual level data. Moreover, the information on the sample persons' level of education is prone to measurement error. The evaluation had to be performed prior to the first contact with the sample person and interviewers had to base their evaluation on neighborhood or housing characteristics. Even though we have demonstrated that the assessments of the level of education were reasonably accurate, a certain degree of error still remains.

6 Conclusion

The analyses presented in this paper aimed at identifying the main factors influencing survey participation in PIAAC Germany. Although a multitude of influence levels exists, we focused on socio-demographic, economic, and geographic characteristics of the sample persons. Because only few publications on nonresponse in skills and education studies exist, to date, this work yields valuable insights for researchers in this field when addressing nonresponse at different stages of the survey process.

In our analyses, we identified age, citizenship, the level of education, the type of the house the person lives, and municipality size as the main factors influencing participation in PIAAC Germany. We established that non-Germans, persons with lower levels of education, those living in larger housing units, and residents of metropolitan areas were less likely to participate.

These results indicate that skills and educational survey researchers can most effectively address nonresponse bias if they concentrate on these central factors.

In particular, the reluctance of those with the lowest level of education should be taken seriously, because this group can be expected to behave very differently with respect to educational topics, such as skills assessments or knowledge tests. This problem could be minimized by, for example, specifically addressing this group in tailored advance letters that might reduce potential fears about a test situation. The low participation of foreigners could be addressed by providing both the questionnaires and tests in the most common minority languages (Blohm & Diehl, 2001). Obviously, the usefulness and feasibility of the suggested measures depend on design features, such as the goals of the study or the study sample. For example, in PIAAC, a deliberate decision was made to conduct the skills assessment only in the official country language(s) or only in those languages of groups representing an important share of the population. This is due to the fact that the aim of the study was to measure skills that are needed for successful participation in the national society, which, in general, include speaking the country's language. Furthermore, the translation of tests and questionnaires or the use of interpreters for the questionnaires is costly. In countries without official information on the sample persons' level of education and citizenship, it will also be difficult to identify the relevant sample persons for targeted measures such as tailored advance letters.

Our analyses focused on overall nonresponse; the possibility of nonresponse due to contact difficulties was discussed only at the theoretical level. In addition, our analyses comprised only a selection of the various factors potentially influencing nonresponse. Future research could thus yield further valuable insights for the reduction of nonresponse in skills and educational studies by distinguishing between noncontacts and noncooperation and exploring the effects of other sources of influence, such as the interaction of interviewers with the sample persons or the countries' survey climates.

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