Methods for Addressing Nonresponse in Establishment Surveys

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Table of Contents

List of Main Tables

List of Main Figures

Chapter 1

Introduction

1.1 Importance of Establishment Surveys

Establishments with better management practices have higher productivity, operating profits, R&D spending, and more patents (Bloom et al., 2019). The introduction of the minimum wage in Germany led to an increase in average wages between 3.8% and 6.7% but only to a modest reduction in employment for establishments affected by the minimum wage (Bossler & Gerner, 2020). Approximately one-third of the increase in unemployment in the U.S. during the Great Recession between 2006-2009 could be attributed to county, industry, and occupational mismatch between unemployed persons and job openings (Şahin et al., 2014). Without evidence from establishment surveys, these and many other scientific findings would be impossible to obtain. However, data collection by means of establishment surveys faces major challenges in generating high-quality data that can be used to produce substantive research. This thesis explores methodological challenges of establishment surveys by investigating establishment unit- as well as item-nonresponse, their consequences, and methods counteracting nonresponse.

The importance of establishment surveys arises from the large number and diversity of use cases. Conducted among private firms, organizations, institutions, and government agencies, surveys yield valuable insights into the structure and performance of establishments, providing, for instance, information on establishment size, industry, employment indicators, prices, wages, and revenues. Establishment surveys serve as one of the most important data sources for official statistics (Snijkers et al., 2023a). For example, the accuracy and scope of national accounts depend heavily on data derived from establishment surveys, which makes these data essential for measuring the size and growth of the economy (e.g., Destatis, 2022a; U.S. Census Bureau, 2023a). Moreover, establishment surveys play a key role in generating several other significant macroeconomic indicators, ranging from producer prices (e.g., Destatis, 2019; Office for National Statistics, 2022a) to the number of tourist stays in accommodation (e.g., Destatis, 2022b; National Institute of Statistics and Economic Studies, 2024). Additionally, establishment surveys are crucial for providing official statistics related to the labor market, such as job vacancies (e.g., Bossler et al., 2020; Statistics Canada, 2023), the development of working hours (e.g., Wanger et al., 2022), wages and non-wage labor costs (e.g., Destatis, 2022c; Statistics Canada, 2023). They can also be used to measure the economic activity of specific industries or sectors, thereby enabling the monitoring of economic trends, identifying emerging industries or markets, and informing economic forecasting. These indicators form an integral part of the official statistics toolkit, facilitating the monitoring of various aspects of the economy for analysts and policymakers (Snijkers et al., 2023a).

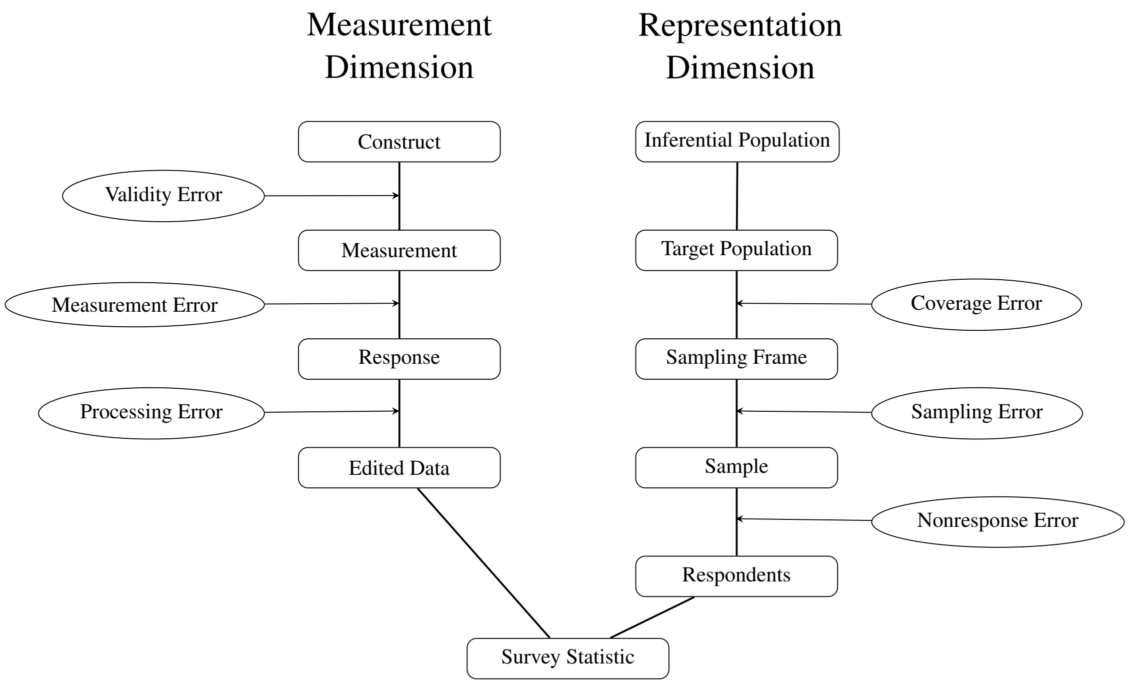
Apart from their use in official statistics, establishment surveys are data sources for researchers across a wide range of disciplines, including economics, sociology, psychology, and management. They offer immense potential for various applications in different empirical settings, exemplified here by their use in analyzing human resources and labor market dynamics. For instance, economists frequently combine establishment survey data with additional sources (e.g., administrative records) to delve into topics such as recruitment processes, the employer-employee match (Lochner & Merkl, 2022) or the impact of corporate tax rates (Fuest et al., 2018). An additional application of establishment surveys is their use for conducting vignette experiments, which sociologists often use, for example, to study the hiring preferences of employers (Di Stasio, 2014; Fossati et al., 2020). In organizational psychology, researchers collect data, for instance, on recruiting processes of employers (e.g., Jackson et al., 2000; Zibarras & Woods, 2010), and in business studies, establishment survey data are used to evaluate the effectiveness of several management practices, such as human resource management instruments (e.g., Bal & Dorenbosch, 2015; Grund & Titz, 2022). Moreover, establishment survey data finds application in various other disciplines, such as medicine (e.g., A. B. Cohen et al., 2008), political science (e.g., Barber et al., 2014), and even museum science (e.g., Fletcher & Lee, 2012).

In summary, establishment surveys are an important tool for understanding the welfare of an economy and serve as a basis for developing effective policy measures. In addition, these surveys help to study the activities of and within establishments in various scientific contexts.

1.2 Methodological Challenges in Establishment Surveys

Given the importance of establishment surveys, it is critical to understand and address the methodological challenges associated with data collection among establishments. In the following, I identify major challenges in surveying establishments using the Total Survey Error framework (see Figure 1.1) differing between challenges on the measurement dimension (validity error, measurement error, and processing error) and the representation dimension (coverage error, sampling error, nonresponse error) (e.g., Biemer & Lyberg, 2003; Groves et al., 2011; Haraldsen, 2013a).

With regard to the measurement dimension, *errors in validity* occur less frequently in establish-



Note: Figure marginally adapted from Groves et al. (2011) and Groves and Lyberg (2010)

Figure 1.1: Total Survey Error Framework

ment surveys than in household surveys. The reason for this is that establishment surveys typically collect data on factual issues and not on underlying abstract, latent, or theoretical concepts that must be captured with complex item scales (Haraldsen, 2013a). In contrast, avoiding *measurement errors* that occur when the observed value deviates from the true value poses a major challenge in establishment surveys. In addition to the typical sources of measurement error, including poorly trained survey personnel or poorly designed questionnaires, complex response processes with multiple interactions between departments increase the likelihood of measurement errors. A mismatch between establishment records and the information requested in the questionnaire (e.g., different definitions, different reference dates, or overaggregated data) is another common source of measurement error (e.g., Bavdaž, 2010a; Edwards & Cantor, 2004; Lorenc, 2007). As with any survey, *processing errors* can occur in different post data collection steps, including data entry, data coding, data imputation, or creation of tables and figures (e.g., Biemer, 2010; Haraldsen, 2013a).

Errors in the representation dimension can lead to selective results that cannot be transferred to a target population. *Coverage error* is defined as the discrepancy between the sampling frame and the population. For establishment surveys, researchers often rely on sampling frames from official sources; however, maintaining these sampling frames could be challenging because establishments are a fast-evolving and volatile population. New establishments emerge, others cease to exist, others merge together, and others split up or change their names and legal forms (e.g., Haraldsen, 2013a). Establishments could switch industries or establishment size classes over time, which could also negatively impact the drawing of precise conclusions on the population. *Sampling error* arises from using a sample-based survey instead of a census because only a random subsample of the sampling frame is surveyed. The true value of the population remains unknown in a sampling approach, for which the value of the sample is taken as a substitute, but the uncertainty of the sampling process must be considered. In establishment surveys, larger establishments and establishments in certain industries are often drawn with an inclusion probability of one because of their importance for the target estimate. If this is the case, these establishments do not contribute to the sampling error and the sampling error arises only to surveying smaller and medium-sized establishments (Haraldsen, 2013a).

Finally and the focus of this thesis, *nonresponse error* can negatively impact the accuracy of estimates. Nonresponse errror emerges if a selective subgroup of the sample participates in the survey. As evidenced by low and declining response rates (see Information Box 1 on the prevalence and development of response rates in establishment surveys), minimizing nonresponse is a big challenge in collecting data from establishments. Establishments, especially private firms, conduct comprehensive cost-benefit analyses to achieve their objectives (e.g., generating revenue).

Information Box 1: Prevalence and Development of Response Rates in Establishment Surveys

Key Facts

1. Response rates in establishment surveys range from almost 100% to single-digit numbers.
2. Response rates in establishment surveys around the world are decreasing.
3. Response rates in voluntary establishments surveys are more affected by nonresponse and declining response rates than in mandatory establishment surveys.
4. In Germany, response rates in establishment surveys tend to be low.
5. The COVID-19 pandemic led to a dip in response rates of establishment surveys.

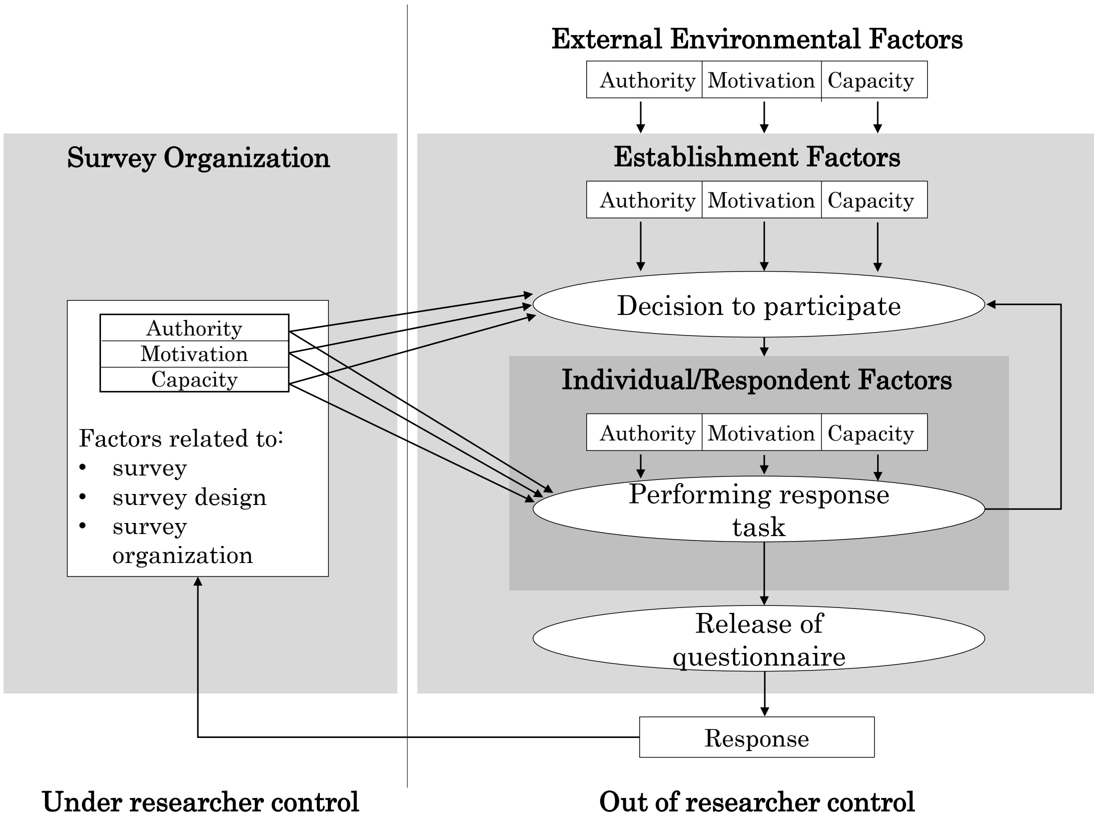
Details

The U.S. Bureau of Labor Statistics (BLS) shows the evolution of response rates to its surveys over the past ten years. The response rates decreased consistently between 2013 and 2023 for all establishment surveys, including the Current Employment Statistics Survey (2013: 64.0% and 2023: 43.9%) and the Employment Cost Index (2013: 74.9% and 2023: 48.0%). It is also evident from these data that the COVID-19 pandemic had a negative impact on response rates, as seen by the fact that many surveys no longer achieve their pre-pandemic levels. For instance, a 14%-point decline in the response rate of the Consumer Price Index for commodities and services was observed between February and March 2020. The BLS overview also demonstrates that mandatory surveys (e.g., Survey of Occupational Injuries and Illnesses) are less affected by increasing nonparticipation than voluntary surveys (e.g., Job Openings and Labor Turnover Survey), as nonparticipation could lead to penalties (U.S. Bureau of Labor Statistics, 2023a). In Germany, response rates steadily declined from an already low starting level. For example, the response rate of the refreshment sample of the IAB Establishment Panel decreased from 50.1% in 2001 to 34.5% in 2017, with an average decline of 1%-point per year. Refusals account for a larger share of this decline than noncontacts (König et al., 2021). Similarly, the panel response rates in the IAB Establishment Panel declined (Gensicke et al., 2022). The response rate for refreshment samples of the voluntary and telephone-administered IAB-ZEW-Start-Up-Panel decreased from 25.5% in 2008 to 12.3% in 2021 (Egeln et al., 2022; Gude et al., 2008). The German Business Panel only attained a response rate of 3.1% in 2020 (Bischof et al., 2023), and the response rates of the Bundesbank Online Panel Firms range between 15% and 20% in 2022 (Boddin & Köhler, 2023). Pielsticker and Hiebl (2020) conducted a meta-analysis of 126 family business surveys between 1988 and 2017 to analyze the trend of response rates over the observation period. Their results showed that the average response rate across all studies was 21.0%, with a significant decrease over the years: Starting with an average response rate of 29.7% between 1988-1990 and falling to 15.9% between 2015-2017. Another meta-analysis of surveys in the organizational context by Anseel et al. (2010) also provided evidence that response rates declined between 1995 and 2008, despite the increased use of response enhancement measures.

Participation in establishment surveys is associated with significant costs as it is a time-consuming task that does not contribute to the establishment's goals (e.g., Willimack & Nichols, 2010; Willimack & Snijkers, 2013). Consequently, it makes it generally difficult to motivate establishments to participate in surveys, especially voluntary surveys, without the possibility of fines for not responding. Furthermore, the complex participation processes mentioned above also contribute to higher participation costs compared to individual surveys, in which a person can decide on participation and answer the questionnaire on his or her own. Additionally, the number of establishments in the population is relatively small. Hence, establishments might frequently be included in samples, particularly if they are large, resulting in a large survey burden due to repeated survey requests on various topics (Haraldsen, 2013a). Survey participation processes in establishment surveys differ strongly from those in household and individual surveys, which is why independent theoretical considerations are devoted to that topic (see Information Box 2 for more details on the theoretical framework of participation in establishment surveys). In the following chapter, I introduce the basic definitions and concepts of nonresponse, its consequences, and the methodological possibilities to avoid and address nonresponse.

Information Box 2: Theoretical Framework of Survey Participation Processes in Establishment Surveys

Figure



Note: Figure marginally adapted from Willimack and Snijkers (2013)

Figure 1.2: Survey Participation Processes in Establishment Surveys

Details

To provide a theoretical basis for survey participation processes in establishments, I mainly refer to the theoretical model of factors influencing survey participation in establishment surveys proposed by Willimack and Snijkers (2013), which is strongly influenced by earlier theoretical considerations (e.g., Bavdaž, 2010b; Tomaskovic-Devey et al., 1994; Willimack et al., 2002). Willimack and Snijkers (2013) distinguish between elements that are under control of the survey researcher – all factors of the survey itself, the survey design, and the organization of the survey – and elements that are out of control. Willimack and Snijkers (2013) differentiate between two important, but also interdependent steps of the survey participation process: the decision to participate and performing the response task. While the first mainly affects nonresponse errors and the second affects measurement errors and item nonresponse, both can influence each other. For example, an establishment that initially wanted to participate may decide not to take part in the survey due to a burdensome response process. In total, the model encompasses a nested three-level structure (external environment, establishment, and individual), where external environmental factors (white area) influence the establishment (bright gray area) and the establishment in turn affects the individuals within the establishment (dark gray area). Hence, the decision to participate and the response task are impacted by factors of the external environment, establishment, and individual respondent. In line with Tomaskovic-Devey et al. (1994), at each level the authority to respond, the motivation to respond, and the capacity to respond shape the survey participation process and the actions of the lower level. Similarly, Willimack and Snijkers (2013) indicate that the authority, motivation, and capacity of the survey organization and the survey itself affect the decision to participate and the performance of the response task. For example, a legal mandate to conduct the survey, increases the likelihood of participation, and the capacity of the survey organization in terms of skills and financial resources affects the quality of the survey and the burden of participation. A key difference to household and individual surveys is the influence of the establishment as the social context of individual respondents within the establishment, which significantly affects the decision to participate or not in an establishment survey.

1.3 Nonresponse in Establishment Surveys

1.3.1 Unit Nonresponse

Unit nonresponse is a prevalent challenge in various types of surveys, including establishment surveys. It occurs when the survey organization fails to obtain a valid response from the target unit, resulting in the absence of survey data for that particular unit (e.g., Dillman et al., 2002). Unit nonresponse can generally be attributed to one of three reasons: failure to establish contact with the target unit, refusal of the target unit to participate, and other factors (Brick, 2013). The first reason for unit nonresponse can arise when the survey organization encounters difficulties in contacting the target unit, which may be attributed to invalid contact information (noncontact). The second reason is that the target unit declines to participate in the survey (refusal). The third reason encompasses other situations in which no successful response is obtained, such as language barriers (American Association for Public Opinion Research, 2023). As discussed in Information Box 2, the decision to participate in establishment surveys is influenced by multiple factors, not all of which are captured by quantitative data. Hence, understanding the reasons for nonresponse in establishment surveys benefits explicitly from mixed methods approaches, which combine qualitative and quantitative evidence. These are, however, rarely applied due to the large research effort.

1.3.2 Item Nonresponse

Item nonresponse occurs in almost all types of surveys and is defined as unavailable data for specific questions in a questionnaire (e.g., De Leeuw et al., 2003; Dillman et al., 2002). Unlike unit nonresponse, where a target unit fails to provide any response, item nonresponse occurs when a target unit participates in the survey, but does not provide data for all questions. De Leeuw et al. (2003) distinguish three forms of item nonresponse. First, the target unit does not provide information on that question (e.g., question is overlooked by accident, the target unit refuses to answer the question or answers "don't know"). Second, the target unit provides invalid answers to the questions (e.g., implausible values or unreadable answers). Third the information provided by the target unit is lost (e.g., by a technical error). Survey research mostly concentrates on the first two reasons, as they occur during the data collection phase (De Leeuw et al., 2003). Although a number of recommendations exist, there is little quantitative evidence on how questions and all relevant information should be designed in establishment surveys to reduce the likelihood of item nonresponse.

1.3.3 Consequences of Nonresponse

Unit and item nonresponse can have critical consequences for surveys. The three main consequences of nonresponse are nonresponse bias, loss of precision, and increased survey costs. Other consequences are also discussed in the literature, including the fact that focusing on nonresponse errors could lead to neglecting of other types of errors (Peytchev, 2013). Moreover, in reaction to nonresponse, survey researchers often increase the complexity of the study design (e.g., by using an adaptive design), which in turn requires more documentation and more skilled personnel and increases the risk of errors (Peytchev, 2013). In addition, response rates are often considered a quality indicator for a survey and low response rates could negatively impact the chances of getting a survey-based article published in a scientific journal (Carley-Baxter et al., 2009).

Nonresponse Bias. First, the most extensively discussed consequence is nonresponse bias, which may arise when only a selective subsample of eligible units responds. In a deterministic framework, nonresponse bias is defined as the difference in population parameters of the variable of interest between respondents and the full sample, as demonstrated by the following formula for the nonresponse bias of a sample mean based on a simple random sample:

$$\text{NR bias}(\bar{Y}_r) = (\frac{M}{N})(\bar{Y}_r - \bar{Y}_M), \tag{1.1}$$

where $\bar{Y}_r$ denotes the mean of the respondent population, $\bar{Y}_M$ denotes the mean of the nonrespondent population, M denotes the number of nonrespondents in the population, and N denotes the size of the population.

Similarly, in a stochastic framework, nonresponse bias is influenced by the covariance between the response propensity and the target variable (Bethlehem, 2002). In other words, the expected value of the estimators based on the net (respondent) sample differs from the expected value of the estimators based on the full sample. These conceptual approaches as well as empirical findings (e.g., Groves, 2006) illustrate that using response rates as the only indicator of nonresponse bias is insufficient, as it only covers a necessary but not sufficient component of nonresponse bias. Instead, more sophisticated nonresponse bias analyses are required to examine the selectivity of the responding units (Wagner, 2012). The primary concern with nonresponse bias is that it can result in biased estimates of population parameters. Thus, inaccurate conclusions about the population may be drawn. In establishment surveys, the risk of nonresponse bias is high if respondents and nonrespondents differ in important characteristics such as establishment size, industry, or year of foundation (see Information Box 3 on empirical evidence on nonresponse bias in establishment surveys). For instance, if larger establishments are less likely to respond to a job vacancy survey, the net sample may overrepresent smaller establishments and underestimate the number of job vacancies. While various studies have explored nonresponse bias concerning establishment characteristics, the extent to which participating establishments exhibit selectivity based on workforce attributes remains largely unknown. This knowledge gap is attributed to the focus of most nonresponse bias analyses on a restricted set of variables obtainable within the sampling frame. Many of these studies were unable to investigate further data sources, such as administrative records, which offer additional information on responding and nonresponding establishments. Moreover, the establishment survey literature lacks nonresponse bias analyses with respect to different survey design elements.

Information Box 3: Empirical Evidence on Nonresponse Bias in Establishment Surveys

Selective survey participation and its analysed or expected impact on statistics of interest has been extensively studied. Importantly, there is evidence that larger establishments are less likely to participate in surveys (Earp et al., 2018; Janik & Kohaut, 2012; König et al., 2021; Phipps & Toth, 2012; Tomaskovic-Devey et al., 1995). Correlations between other establishment characteristics and participation have also been documented. Tomaskovic-Devey et al. (1995) report selective survey participation based on industries, i.e., industries with high research and development expenditures and industries in competitive markets with low average profits are more likely to participate. Phipps and Jones (2007) show, for instance, that establishments in the information industry are less likely to participate than those in the local government (reference group). König et al. (2021) illustrate that establishments in the transport and communication industry are less likely to participate than those in the manufacturing industry. Moreover, single-unit (as opposed to multi-unit) (Phipps & Jones, 2007; Phipps & Toth, 2012) and older establishments are more likely to participate (Phipps & Jones, 2007). The probability to respond is lower among establishments offering higher wages (Phipps & Toth, 2012). In addition, the region in which the establishment is located can matter in terms of survey participation (Janik & Kohaut, 2012; König et al., 2021; Phipps & Jones, 2007). Concerning employee characteristics of the establishments, only marginal nonresponse biases can be observed (König et al., 2021).

Loss of Precision. Second, even in the theoretical absence of nonresponse bias – if the variables included in the analysis are independent of the response process/mechanism – nonresponse leads to a reduction in the precision of the survey estimates. This reduction is driven by two factors: a smaller net sample size and an additional second selection step as only a subset of the sample responds, which introduces additional uncertainty. Hence, the variance of the survey estimates increases (Särndal & Lundström, 2005). In other words, as the number of nonresponding establishments increases, the level of uncertainty associated with the estimates also increases. Consequently, the confidence intervals around the estimates may become wider, making it more challenging to draw precise conclusions about the population parameters. This limitation can restrict the scope of analyses that can be performed and the conclusions that can be derived from the data.

Increased Survey Costs. A third consequence of nonresponse is the potential increase in survey costs (e.g., Peytchev, 2013). To mitigate the limitations imposed by nonresponse, survey researchers are required to allocate additional resources to address and handle nonresponse. This may involve sending additional reminders to nonrespondents, providing incentives for participation, or deploying field staff to persuade establishments. Furthermore, additional nonresponse follow-up surveys or the development of statistical methods to adjust for nonresponse may be necessary. All of these efforts are both time-consuming and expensive. The increased costs associated with nonresponse could reduce the available resources for other aspects of the research project, including substantive analyses. Although this is a very important issue for survey organizations, it has received less attention in the survey literature as a whole (Olson, Wagner, & Anderson, 2021) but also explicitly with respect to establishment surveys. For example, the cost implications of design choices, i.e., the choice of the data collection mode, are unclear when planning a new establishment survey or altering an existing one, because published evidence is missing.

1.3.4 Methods for Reducing and Addressing Nonresponse

To reduce and counteract nonresponse in establishment surveys, survey researchers distinguish between methods before and during data collection – focusing on the design of the survey – as well as after data collection – focusing on statistical methods to adjust for nonresponse bias (e.g., Dillman et al., 2002; Peytchev, 2013; Särndal & Lundström, 2005).

Prior to data collection, a number of measures can be used in establishment surveys to improve response rates and, most importantly, to design a survey tailored to the target population. Therefore, it is important to make the survey as simple and pleasant as possible for the respondents so that the anticipated burden of participation is minimized; and thus, the probability of participation is maximized (Dillman et al., 2014). This starts with the design of the questions themselves, which should be clearly formulated and unambiguous in terms of content and appearance, but also embedded in the questionnaire in a visually appealing manner (e.g., Haraldsen, 2013b; Tourangeau, 1984). Another design choice is the mode of data collection, which best suits the target population and lowers the response burden for most target units. Multiple modes can be offered concurrently with the rationale that establishments can choose which mode is most appropriate and accessible for participation in the survey based on their individual preferences (e.g., De Leeuw, 2005, 2018; Haraldsen, 2013b). Despite being an important topic, this has so far been understudied in establishment surveys. For example, the existing research on establishment surveys does not provide conclusive evidence regarding the most effective use of mail and web modes to maximize survey participation. Furthermore, no studies exploring the impact of switching mode designs between two consecutive waves of panel studies are available.

Another important factor to increase the response rate is a well-designed and targeted communication strategy. Such a communication strategy could encompass a public-relationship strategy, prenotification letters, invitations, various types of reminders in different modes, additional information on data privacy, information on support and contact addresses, timing strategy of contacts, and the recommendation letters of important stakeholders or incentives (e.g., Snijkers & Jones, 2013). These different design aspects can also be applied in tailored or adaptive designs, where data collection and any response enhancement strategies are adapted to increase the response of specific subgroups of the sample (e.g., Dillman et al., 2014; Peytchev et al., 2022; Schouten et al., 2017). For example, national statistical institutes (NSI) often implement special departments, which are responsible for collecting data from large establishments and employ data collection strategies tailored to the needs of these establishments (Giesen et al., 2018).

After data collection, nonresponse bias caused by selective participation in the survey can be addressed using weighting and imputation techniques. To adjust for unit nonresponse bias, survey statisticians typically use weighting methods, which can be divided into two main approaches: propensity score adjustments (e.g., Bethlehem, 2002; Little & Vartivarian, 2003, 2005) and calibration (e.g., Bethlehem, 2002; Deville & Särndal, 1992). Response propensity adjustments are one possible approach to counter nonresponse bias, if auxiliary information on respondents and nonrespondents are available. These additional information can be used to estimate response propensities for the sampled units, and then the inverse of these response propensities can be employed as nonresponse weights. Alternatively, weighting classes can be formed based on the predicted response propensities (e.g., Bethlehem, 2002; Little & Vartivarian, 2003, 2005). The stronger the auxiliary variables are related to survey participation and the survey variables, the better the nonresponse weighting accounts for nonresponse bias (Little & Vartivarian, 2005). If survey participation can be explained by the variables available for both respondents and nonrespondents, these approaches lead to unbiased estimates. An emerging area is the use of machine learning and large data sources to model response propensities, allowing for high-level interactions and flexible correlations between predictors (e.g., Earp et al., 2014, 2018; Kern et al., 2019). However, the performance of the new methods to generate nonresponse weights for establishment surveys is so far unknown.

To adjust for unit nonresponse bias using calibration, data from official sources on population counts serve as reference statistics, and weights are then constructed to ensure that the weighted sample estimates replicate these (known) population statistics (e.g., Bethlehem, 2002; Deville & Särndal, 1992). Applying calibration approaches, including post-stratification or raking, can be effective in reducing nonresponse bias if no unit-level information on nonrespondents are available. In order to adjust for item nonresponse, imputation procedures are usually implemented. Therefore, predicted values based on the models estimated with the observed data replace missing information on different items. Prominent examples of imputation techniques include mean imputation, hot-deck imputation, or regression imputation (e.g., Carpenter & Kenward, 2012; Little & Rubin, 2019; Schafer & Graham, 2002).

1.4 Why this Dissertation?

Despite the crucial role establishment surveys play in addressing research and policy questions, there is a significant gap in empirical evaluations of the methodology employed in these surveys, including nonresponse weighting schemes, mode designs, and question wording. Snijkers et al. (2013) acknowledge the scarcity of empirical evaluations in their preface of the standard book for establishment surveys:

> *"When writing the book, we found many issues that still require additional research. The field of business surveys needs more documentation describing practices (practices that both do and do not work), case studies, pilots, and experiments to identify and isolate best practices. So, we encourage the readers to do more research and to share the results with colleagues around the world. Also, we believe that our field would benefit from new multidisciplinary perspectives for building relevant theoretical models that provide a basis for understanding and improving the processes in business surveys, in order to reduce response burden, improve data quality, and generate relevant, reliable statistical products."*

Similarly, Thompson et al. (2018) highlight in the preface of the special issue from the Fifth International Conference on Establishment Surveys in the Journal for Official Statistics the lack of experimental evidence in establishment surveys: "*as opposed to household surveys, experimentation in establishment surveys is scarce*".

Unlike many household surveys, most establishment surveys are conducted by NSIs rather than research organizations. In contrast to the employees of research organizations, experts in NSIs have much less incentive to publish their research in scientific journals, which may explain the lack of scientific journal articles on the methodology of establishment surveys. Thus, it is worth emphasizing that special issues (e.g., by the Journal of Official Statistics in 2014 and 2018), conference proceedings (e.g., conference proceedings of the ICES or AAPOR Conference), handbook articles (e.g., the new handbook on "Advances in Business Statistics, Methods and Data Collection" edited by Snijkers et al. (2023b)) have emerged as effective outlets to enable professionals to disseminate their research. In addition, methodological approaches are documented in brief technical reports (e.g., field reports released by survey organizations) or internal documents (e.g., unpublished reports from NSIs), but these do not always contain the desired level of detail to assess the validity of the methodological findings. In summary, the methodology of establishment surveys is not as extensively documented and studied as the methodology of individual and household surveys, which is deeply analysed in numerous journal publications.

The lack of empirical evidence concerning the methodological aspects of establishment surveys is particularly relevant to the issue of nonresponse. One of the main challenges is that establishment surveys have unique characteristics that make it difficult or even impossible to directly apply findings from nonresponse analyses conducted in household surveys (see also Information Box 2 on theoretical information on participation processes in establishment surveys). These distinct characteristics include the involvement of multiple persons and departments within establishments in the survey participation process (e.g., Bavdaž, 2010a, 2010b), the potential for different individuals to decide whether or not to participate and complete the questionnaire (e.g., Tomaskovic-Devey et al., 1994; Willimack & Snijkers, 2013), and the reliance on proxy-respondents within establishments (e.g., Willimack & Snijkers, 2013).

This thesis contributes to the limited body of empirical evidence on nonresponse in establishment surveys by examining unit and item nonresponse, their consequences, and the methods used to address nonresponse before, during, and after data collection. The main objectives are to investigate the prevalence of nonresponse, nonresponse bias, and subgroup participation patterns. Furthermore, the thesis explores the potential of different mode designs and question clarification information to questions in mitigating unit respectively item nonresponse and nonresponse bias. Further, it evaluates the effectiveness of nonresponse adjustment procedures based on innovative big data and machine learning techniques in reducing nonresponse bias.

To this end, my co-authors and I conducted a longitudinal analysis and three experiments using the IAB-Job Vacancy Survey (IAB-JVS) in Germany. This nationwide establishment survey is voluntary, following an annual repeated cross-sectional design, with subsequent follow-up interviews in the three quarters that follow (Bossler et al., 2020).

Table 1.1: Overview of Dissertation Chapters

Dimensions \ Chapter	**Chapter 2** Analyzing Establishment Survey Nonresponse Using Administrative Data and Machine Learning	**Chapter 3** The Impact of Mail, Web, and Mixed-Mode Data Collection on Participation in Establishment Surveys	**Chapter 4** Effects of Replacing Telephone with Web, Mail, and Mixed-Mode Data Collection in an Establishment Follow-Up Survey	**Chapter 5** More Clarification, Less Item Nonresponse in Establishment Surveys?
Area of Research	Response Trends & Nonresponse Adjustments	Survey Mode Designs		Question Design
Level of Nonresponse	Unit Nonresponse			Item Nonresponse
Theoretical Background	Survey Participation Processes in Business Surveys			Cognitive Model of the Survey Response Process
Quantitative Outcomes	Unit Response Nonresponse Bias Survey Participation	Unit Response Nonresponse Bias Survey Participation Survey Costs	Unit Response Nonresponse Bias Survey Participation Survey Costs	Item Response Item Duration Data Quality
Quantitative Method	Longitudinal Analysis	Survey Experiment		
Qualitative Interviews	None	Short Interviews & In-Depth Interviews		None
Unit of Observation	Establishments			
Survey	IAB Job Vacancy Survey			
Auxiliary Administrative Data	BHP & AWFP	BHP		None
Observation Years	2010 – 2019	2020	2020 – 2021	2019
Co-Authors	Joseph W. Sakshaug & Stefan Zins	Joseph W. Sakshaug & Stefan Zins & Claudia Globisch		Joseph W. Sakshaug & Stefan Zins
Publication Stage	Published: Journal of the Royal Statistical Society: Series A	Revise & Resubmit: Journal for Survey Statistics and Methodology	In Preparation for: Survey Research Methods	Published: Survey Research Methods

Note: BHP = Establishment History Panel; AWFP = Administrative Wage and Labor Market Flow Panel

The theoretical framework of my papers includes survey participation processes in establishment surveys (e.g., Willimack & Snijkers, 2013) and survey response processes on specific questions in establishment surveys (Bavdaž, 2010b; Tourangeau, 1984; Willimack & Nichols, 2010). Table 1.1 provides an overview of the topics, methods, data, and formal properties of each paper.

Specifically, the first paper (Chapter 2) in this thesis conducts a comprehensive analysis of unit nonresponse and its consequences on nonresponse bias in the IAB-JVS over time. It studies the development of response rates and nonresponse bias over the past 10 years of an establishment survey. Furthermore, this paper contributes to the existing literature by exploring the previously known as well as so far unexplored relationships between establishment and employee characteristics and survey participation. Moreover, the paper aligns with the growing trend of machine learning and big data in survey research (e.g., Z. Chen et al., 2023; Earp et al., 2014, 2018; Kern et al., 2019) by evaluating their usefulness for reducing nonresponse bias with response propensity weighting schemes.

The second paper (Chapter 3) focuses on the impact of data collection mode designs (i.e., web, mail, and mixed-mode) on the different outcomes of survey participation – response rates, nonresponse bias, subgroup survey participation, and costs per respondent. In doing so, it provides an important research background for the global trend of transitioning from traditional mail data collection to web and mixed-mode approaches (e.g., Snijkers et al., 2018; U.S. Bureau of Labor Statistics, 2020a). A particular strength of this paper compared with others on that topic is the extent and multi-perspective scope with which the impact of web, mail, and web/mail mixed-mode desings are examined. In particular, this study uses a mixed methods approach that combines experimental and qualitative evidence.

The third paper (Chapter 4) explores survey mode designs across the first two waves of 2020 wave of the IAB-JVS. Specifically, our study explores the feasibility of replacing computer-assisted telephone interviewing (CATI) with self-administered data collection methods in the initial follow-up wave of the IAB-JVS. Our primary objective is to compare the effects on participation of maintaining a consistent self-administered mode design across the first two waves with the consequences of switching from self-administered mode designs to CATI from the first to the follow-up wave. Survey organizations anticipate that the consistent use of self-administered modes across survey waves will yield cost savings, minimize measurement mode effects between waves (e.g., Cernat & Sakshaug, 2021), and simplify data collection strategies. However, understanding how this mode design changes impact panel attrition and selection bias is of crucial importance, as it helps survey organizations in evaluating the associated risks regarding survey participation. While evidence already exists on the effects of replacing interviewer-administered survey modes with self-administered survey modes in successive household panel waves (e.g., Allum et al., 2018; Bianchi et al., 2017; Jäckle et al., 2015), my co-authors and I are the first to shed light on this topic for establishment surveys.

The fourth paper (Chapter 5) adds to the literature on how to assist establishments in the answering process of specific questions in self-administered surveys to mitigate item nonresponse. Establishment surveys often ask for data with specific definitions. These definitions, explanatory information, or guidelines are often presented in additional sheets, separate homepages, or further links in the web questionnaire. However, whether a large proportion of respondents recognize this additional information or consider it when answering the relevant questions is unclear. Therefore, current recommendations are to assist respondents in their answering process by making additional explanatory information as accessible as possible and implementing it close to the questions (Haraldsen, 2013b; Morrison et al., 2010). This paper tests these recommendations and examines whether clarifying information placed next to the question could reduce item nonresponse and increase data quality.

The primary goal of these studies is not only to contribute to the existing literature on establishment surveys, but also to offer guidance to survey practitioners in designing their own surveys, formulating survey questions, and addressing nonresponse bias. These papers can serve as blueprints for conducting similar experiments and investigations and offer reference estimates that may be transferable to other establishment surveys. Furthermore, the insights gained from the survey participation models can be utilized in other surveys to develop nonresponse adjustment models or adaptive survey designs. The accompanying qualitative interviews provide ideas for future improvement of the design of establishment surveys.

In summary, these four papers make significant contributions to the literature on establishment survey nonresponse, advancing the current understanding of survey participation, nonresponse adjustment methods, mode designs, and clarifying information on questions.

1.5 Extended Summary of Thesis Papers

Thesis Paper 1 (Chapter 2)

Chapter 2 and thus my first thesis paper is entitled "Analyzing Establishment Survey Nonresponse using Administrative Data and Machine Learning". The focus of the paper lies in the analysis of the development over time of response rates, nonresponse bias, and survey participation patterns in the IAB-JVS between 2010 and 2019. Furthermore, the paper examines the potential of using extensive administrative data and machine learning approaches in nonresponse weighting schemes to reduce nonresponse bias in this observation period. As discussed in Section 1.4, little is known about the magnitude of nonresponse bias and survey participation in voluntary establishment surveys. A comprehensive analysis with longitudinal data is also informative for practitioners in establishment surveys. Although the use of big data and machine learning are currently important and trending topics of survey research, this paper is the first that evaluates their potential for the improvement of nonresponse weights in a voluntary establishment survey.

My co-authors and I base our empirical evaluation on the theory of establishment survey participation processes. We derive hypotheses on survey participation take into account the impact of the relevance of the survey topic, establishment size, establishment age, average establishment wages of employees, workforce diversity, the interaction of establishment age and employee age, response history, and the development of the employee structure. For the empirical analysis of our research questions, we exploit a record linkage of the full sample of the IAB-JVS to two large-scale administrative datasets, which allow us to compare the characteristics of respondents and nonrespondents. First, analyses show that the response rate decreased slightly from 2010 (18.9%) to 2019 (14.7%), while the aggregate nonresponse bias across all administrative variables shows no noticeable trend over the time period. The hypothesis tests provide support that the likelihood of participation decreases with establishment size or prior survey contacts but increases with establishment age and if the establishment participated in the survey in the year before. We find mixed evidence for the hypothesised positive impact of the importance of the survey topic and the workforce diversity on willingness to participate. The hypothesis that the development of the employee structure affects survey participation is partially supported. Our hypotheses that younger establishments with a young workforce and establishments with higher wages are less likely to participate were not confirmed.

In the final step of the paper, we investigate the extended use of administrative data and machine learning approaches to generate nonresponse adjustment weights, which are then evaluated based on nonresponse bias estimates derived from two separate administrative datasets. We consider the following statistical modeling and machine learning approaches: logistic regression, lasso regression, ridge regression, general additive model, general additive model selection, Cart, C-Tree, model-based recursive partitioning, random forest, extreme gradient boosting, and Bayesian additive regression trees. For the evaluation, we examine the individual and aggregate nonresponse bias on two different administrative datasets, the significance of the individual bias estimates after weighting, and the magnitude of the bias for a proxy variable for job vacancies, which is one of the most important IAB-JVS variables. The results show that in all years, the extended use of administrative data outperformed the standard set of auxiliary variables used to compute response propensity weights. With respect to the different modeling approaches, there has been no clear-cut winning modeling scheme over the years. However, the ensemble tree methods and the regression-based approaches work better than the single tree methods in nonresponse bias reduction. These results seem to underline that better auxiliary data is more important than the modeling scheme for generating effective nonresponse weights and hence reducing nonresponse bias.

Thesis Paper 2 (Chapter 3)

The second thesis paper (Chapter 3) entitled "The Impact of Mail, Web, and Mixed-Mode Data Collection on Participation in Establishment Surveys" investigates how single-mode web, single-mode mail, sequential web-to-mail, and concurrent mail-web mixed-mode designs impact unit nonresponse and its consequences in establishment surveys. Therefore, my co-authors and I examined a large-scale survey experiment conducted in the 2020 wave of the IAB-JVS and additional qualitative interviews with respondents and nonrespondents of this experiment.

This paper is rooted in the long-lasting trend of moving establishment surveys online. As early as the 1990s, survey organizations developed and utilized tools to enable establishment respondents to submit data via the Internet, and this trend has persisted and grown since the new millennium (e.g., Christianson & Tortora, 1995; S. B. Cohen et al., 2006; Erikson, 2007; Robertson & Hatch-Maxfield, 2012). Even today, the impact of web data collection on survey participation remains an important topic for establishment surveys (e.g., Gleiser et al., 2022; Haas et al., 2021; Haraldsen, 2023; Hole & Houben, 2023). While in the early days of web reporting in establishment surveys, web questionnaires were primarily applied in mixed-mode settings, the current trend clearly favors the adoption of web-only modes (e.g., Snijkers et al., 2018; U.S. Bureau of Labor Statistics, 2020a). Although this is an important trend, there are only a limited number of articles that examine the impact of different mode designs on participation in establishment surveys, and they tend to focus exclusively on response rates as the main outcome variable as well as on specific subpopulations (Bremner, 2011; Downey et al., 2007; Ellis et al., 2013; Erikson, 2007; Haas et al., 2021; Harris-Kojetin et al., 2013; Millar et al., 2018). Moreover, given the increased availability and use of the Internet in establishments and the recent changes in working schemes forced by the COVID-19 pandemic, such as increased use of remote work, more recent studies are needed to inform survey practitioners about the possible implications of their mode design choices.

To address this literature gap, we designed a survey experiment that was embedded in the 2020 IAB-JVS to compare a single-mode mail, a single-mode web, a sequential web-to-mail mixed-mode, and a concurrent mail-web mixed-mode design and to estimate the causal impact of mode designs on response rates with a nationally representative establishment survey. Moreover, we exploit administrative data on all sampled establishments to estimate nonresponse bias in each mode design. Based on theoretical considerations and empirical evidence, we derive and test hypotheses about the performance of web, mail, and mixed-mode designs on response rates, web/mail take-up rates, and nonresponse bias. In addition, we formulate hypotheses of the impact of establishment size and industry on survey participation in web and mail modes in single-mode designs and the concurrent mail-web mixed-mode design. Specifically, we assume that larger establishments and establishments in the information/communication and finance/insurance industries are more likely to participate in web surveys. Further, we posit that establishments in the agricultural, construction, and public administration are more likely to take part in mail surveys. Specifically, we derive hypotheses on cost efficiency and provide estimates for cost per respondent to guide survey practitioners with possible cost implications of applying one of the different mode designs. By conducting an accompanying qualitative study with representatives of the establishments participating in the experiment, this paper uses a mixed method approach to identify the advantages and disadvantages of web and mail modes and their impacts on participation processes.

Our results show that response rates and aggregate nonresponse biases do not differ substantially between the single-mode web, the single-mode mail, the sequential web-to-mail mixed-mode, and the concurrent mail-web mixed-mode designs. The results of the survey participation models support the hypothesis that larger establishments are more likely to participate in web surveys than in mail surveys, but only in single-mode designs. In the concurrent mail-web mixed method design, mail participation was more likely than web participation across all establishment size classes, with differences diminishing from the smallest to the largest establishments. In the concurrent mail-web mixed-mode approach, we found that establishments in the agriculture/forestry and construction sectors were more likely to choose mail participation. This pattern did not show up in the comparison of single-mode designs. There was no substantial evidence for a strong preference for web participation over mail among establishments in the information/communication, finance/insurance, and public administration industries, both in the concurrent mail-web mixed-mode and single-mode designs. Web-only and the sequential web-to-mail mixed-mode design prove to be more cost-efficient per respondent than the concurrent mail-web and the single-mode mail design. Insights from the qualitative part of this paper reveal a strong preference for web surveys due to their ease of use, enhanced collaboration among colleagues, avoidance of cumbersome mail returns, and perception as a modern and sustainable solution.

Thesis Paper 3 (Chapter 4)

The third paper (Chapter 4) entitled "Effects of Replacing Telephone with Web, Mail, and Mixed-Mode Data Collection in an Establishment Follow-Up Survey" explores survey mode designs, with a specific focus on panel data collection. In particular, the paper compares mode design continuation of self-administered modes with a mode design switch to CATI in the follow-up wave of the IAB-JVS. While the discussion on replacing interviewer-administered modes with self-administered mode designs – without introducing higher nonresponse rates and nonresponse bias – has primarily revolved around household panels (e.g., Allum et al., 2018; Bianchi et al., 2017; Jäckle et al., 2015), this paper extends the investigation to establishment panels. In establishment surveys, interviewers play a vital role in motivating respondents to participate (e.g., Haraldsen, 2013b, 2023), which is especially crucial in panel surveys where establishment representatives have to be motivated to participate repeatedly in the survey. However, interviewers are costly and interviewer-administered mode designs have resulted in lower response and contact rates in recent years (especially during the COVID-19 pandemic)(König et al., 2021; Küfner et al., 2022a), or were not feasible during the pandemic in the case of face-to-face modes (e.g., Sakshaug et al., 2020). Moreover, in panel surveys, changing the survey mode between waves poses a risk of selection biases and increased nonresponse (e.g., Cernat & Sakshaug, 2021).

With these considerations in mind, the third paper contributes to the literature by conducting a follow-up experiment in the second wave of the 2020 wave of the IAB-JVS, building on the findings from the second paper. It compares the continuation of the mode designs used in the first wave (i.e., mail-web mixed-mode, web-to-mail mixed-mode, single-mode web, and single-mode mail) with a mode design switch to CATI in the follow-up wave for each of the first wave mode designs. This paper not only assesses whether it is advisable to replace CATI modes completely with self-administered mode designs in a follow-up wave with regard to follow-up response rates, follow-up nonresponse bias, follow-up subgroup survey participation, and follow-up costs but also compares the outcomes cumulatively of the tested mode sequences over the first two panel waves. Additionally, we use a mixed method approach to provide further insights into the perception of mode design switches across waves and the use of CATI via an additional qualitative study with establishment respondents of both experimentally treated waves.

Our findings show that using self-administered mode designs in the follow-up wave resulted in higher response rates for groups starting in the first wave with concurrent mail-web mixed-mode and single-mode mail designs. For groups starting with sequential web-to-mail and single-mode web mode designs, the follow-up response rates were similar for the continuation of the mode design and the switch to CATI mode design groups. Cumulative response rates over the first and follow-up waves show the same pattern, i.e., higher cumulative response rates in the mixed-mode mail-web and single-mode mail designs and similar cumulative response rates in the mixed-mode web-to-mail and single-mode web designs. We do not observe meaningful differences in average absolute bias estimates between the different groups. In addition, we use survey participation models to show that the follow-up response probabilities in the mode continuation groups are higher or similar to those in the mode switching groups. Thus, there is no negative effect of forgoing CATI in the follow-up wave. The models for cumulative survey participation show no meaningful differences when CATI is replaced by a self-administrated mode design in the follow-up wave. The cost analysis reveals that replacing CATI with self-administered mode designs leads to substantial savings in follow-up costs of up to 67%-points. The cumulative costs are only marginally lower, between 3%-points and 9%-points, for the mode design continuation groups than for the mode switch groups. Participants in the qualitative study expressed a preference for a consistent mode design across panel contacts, as this would allow establishments to replicate their already existing participation processes.

Thesis Paper 4 (Chapter 5)

Chapter 5 "More Clarification, Less Item Nonresponse In Establishment Surveys? A Split-Ballot Experiment" tackles nonresponse on the item level in the IAB-JVS. Hence, this paper shifts the focus from unit nonresponse to item nonresponse. In this work, my co-authors and I analyze the effects of clarifying information on item nonresponse, item duration, and data quality in an establishment survey. In particular, we run a split-ballot experiment with clarifying information next to the question itself to assist respondents in the answering process of job vacancy duration questions.

These questions have been suffering from comparatively high item nonresponse rates in previous years. Based on a theoretical analysis using the cognitive response process model by Tourangeau (1984) and the adaptions to the establishment context by Bavdaž (2010b) and Willimack and Nichols (2010), we identify multiple reasons for item nonresponse in the vacancy duration questions. The provided clarifying information was designed to improve the comprehension of these questions, facilitation of the retrieval of requested data in internal records, and the judgment of the right answer by assisting with the selection of the most adequate data. To evaluate the effectiveness of the provided clarifying information, we ran an experiment in 2019 with an additional web survey of the IAB-JVS comparing respondents with and without this additional information. The results show that respondents likely noticed the clarifying information, as respondents in the experimental group spent significantly more time answering the questions than respondents in the control group. Surprisingly, the clarifying information led to an increase of item nonresponse instead of decreasing it. The data quality measure indicates lower data quality in the experimental group than in the control group. Furthermore, we show evidence for a spill-over effect on a non-treated vacancy duration question, which shows more item nonresponse in the experimental group. The paper concludes with a discussion of possible reasons for these unexpected results and how future research could benefit from a combination of qualitative research and experimental evidence.

Conclusion (Chapter 6)

This dissertation concludes with a summary of the main results of each paper, where I point out one main implication of each paper for survey practice or future research. Further, I highlight a common limitation of all papers and emphasize the importance of further methodological research on establishment surveys.

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Chapter 2

Analyzing Establishment Survey Nonresponse Using Administrative Data and Machine Learning[1]

2.1 Abstract, Keywords, Acknowledgements

Abstract: Declining participation in voluntary establishment surveys poses a risk of increasing nonresponse bias over time. In this paper, response rates and nonresponse bias are examined for the 2010–2019 IAB Job Vacancy Survey. Using comprehensive administrative data, we formulate and test several theory-driven hypotheses on survey participation and evaluate the potential of various machine learning algorithms for nonresponse bias adjustment. The analysis revealed that while the response rate decreased during the decade, no concomitant increase in aggregate nonresponse bias was observed. Several hypotheses of participation were at least partially supported. Lastly, the expanded use of administrative data reduced nonresponse bias over the standard weighting variables, but only limited evidence was found for further nonresponse bias reduction through the use of machine learning methods.

Keywords: data quality, IAB Job Vacancy Survey, nonresponse bias, survey participation, weighting adjustment

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2.2 Introduction

Official statistics are based to a large extent on establishment surveys, which produce estimates that flow into price indices (e.g., the Producer Price Index Survey at the US Bureau of Labor Statistics[2]), gross domestic products (e.g., the Purchase Survey at the UK Office for National Statistics[3]), and wage statistics (e.g., Survey of Employment, Payrolls and Hours at Statistics Canada[4]). Establishment surveys play an instrumental role in assessing the state of the economy and thus inform the development of economic policies. In addition, establishment survey data are widely used by researchers in various fields, including organizational behaviour (e.g., Bal & Dorenbosch, 2015), environmental studies (e.g., Ghisetti & Rennings, 2014), personnel economics (e.g., Houseman, 2001; M. White & Bryson, 2013), and labor economics (e.g., Bachmann et al., 2013). The demand for establishment data has increased in recent years as illustrated by a growing number of publications (e.g., Mercan & Schoefer, 2020), workshop series (e.g., ifo conference on macroeconomics and survey data), and new establishment surveys (e.g., the BeCovid study in Germany[5], the Decision Maker Panel in the UK[6]).

A prominent example of an official statistic captured by establishment surveys is the number and structure of job vacancies. Vacancy statistics describe the unfilled labor demand and are key economic indicators that provide insights into job matching efficiency and labor market tightness. In Germany, the Institute for Employment Research (IAB) collects vacancy data through the IAB Job Vacancy Survey (IAB-JVS), a voluntary survey which started in 1989. Since then, it has become one of the largest establishment surveys in Germany, annually collecting vacancy data from up to 15,000 establishments of all sizes and industry sectors. Its data are regularly used by Eurostat to compile European-wide vacancy statistics.

Similar to household surveys, voluntary establishment surveys face decreasing survey participation rates (Pielsticker & Hiebl, 2020). As stakeholders and researchers often see response rates as an important survey quality indicator, a decreasing response rate can undermine the reputation of a survey and increase costs as sample sizes must be increased to meet precision requirements. A comprehensive analysis of establishment survey nonresponse is essential not only for assessing survey quality, but also for understanding which subgroups are more prone to nonresponse and may benefit from interventions (e.g., tailored designs) or adjustment strategies (e.g., weighting) that mitigate the risk of nonresponse bias. The increasing use of large auxiliary data sources, such as administrative data, coupled with an expanding set of data-driven (e.g., machine learning) modeling tools offer a promising means of ascertaining mechanisms of establishment survey nonresponse, identifying sub-

[2] www.bls.gov/respondents/ppi/

[3] www.ons.gov.uk/surveys/informationforbusinesses/businesssurveys/annualpurchasessurvey

[4] www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=2612

[5] www.iab.de/de/befragungen/becovid.aspx

[6] www.decisionmakerpanel.co.uk/

groups that are most affected by it, and adjusting for potential bias.

While there is much literature documenting response rates, nonresponse bias, and adjustment strategies in household surveys (e.g., Brick & Williams, 2013; De Heer & De Leeuw, 2002; Groves & Peytcheva, 2008; Kreuter et al., 2010; Peytcheva & Groves, 2009; Williams & Brick, 2018), such analyses are not widespread in voluntary establishment surveys. This article contributes to the rather small strand of literature by analyzing response rates and nonresponse bias over the last 10 years of the IAB-JVS. Using a comprehensive administrative database available for both respondents and non-respondents, we assess the magnitude of nonresponse bias and test several theory-driven hypotheses regarding survey participation. In addition, we evaluate the performance of using available administrative data and various modelling approaches, including machine learning methods, to adjust for nonresponse bias and improve on the traditional weighting strategy used in the IAB-JVS. Although some published studies have noted the potential advantages of machine learning methods for nonresponse bias adjustment, this is the first to evaluate a wide range of such methods for an establishment survey.

The remainder of this article is structured as follows. Section 2.3 briefly describes the theory of establishment survey participation and reviews the empirical evidence on response rates, nonresponse bias, and adjustment strategies. Section 2.4 presents the research objectives and survey participation hypotheses. Section 2.5 describes the data sources and analysis strategy. Section 2.6 presents the results and Section 2.7 concludes with a general discussion of the findings and their practical implications.

2.3 Theory and Background

2.3.1 Establishment Survey Participation

Survey participation in an organizational context differs substantially from the household context. The professional goals of the establishment can shape the participation decision in a positive or negative way. Establishments conduct a rational cost-benefit analysis in which they weigh the costs of participation against the possible benefits in the context of their professional goals (Snijkers et al., 2007; Willimack & Snijkers, 2013; Willimack et al., 2002). Costs of participation include the perceived burden of allocating resources to the response task, searching for the requested information, and completing the questionnaire, which may be particularly burdensome for certain types of establishments. On the benefits side, while survey participation may not directly contribute to establishments' professional goals (e.g., making a profit), they may find other value in participating or use the data provided by the survey for planning purposes. In addition, some establishments perceive survey response as part of their corporate social responsibility and their contribution to a working society that informs the current political discussion (Willimack & Snijkers, 2013; Willimack et al., 2002). In the following we discuss specific factors that influence the participation decision based on the framework of Willimack and Snijkers (2013), which forms the basis for the forthcoming hypotheses.

Based on previous theoretical work (e.g., Tomaskovic-Devey et al., 1994; Willimack et al., 2002), Willimack and Snijkers (2013) distinguishes between participation factors under the control of the researcher, such as the sample design, and factors outside their control, namely the establishment's environment, the establishment itself, and the actual respondent within the establishment. The environmental factor includes all surrounding influences, including economic conditions, survey-taking climate and legal requirements or general norms. The establishment itself is characterized by the profile and organization of the establishment including internal policies and resource availability. The last factor reflects the influences of the employee representative of the establishment who is assigned the response task, such as his or her experience level. These three factors are conceptualized hierarchically such that the environment shapes the establishment's decision, which in turn affects the responding employee (Willimack & Snijkers, 2013; Willimack et al., 2002). Within each hierarchical level, three further factors play a role: authority, capacity and motivation (Tomaskovic-Devey et al., 1994; Willimack & Snijkers, 2013). Authority reflects the formal and informal power to decide on the survey request. For example, organisational policies may shape the freedom of the representative to make the participation decision. Capacity is defined as the ability to comply with the survey request. This refers especially to the knowledge, time constraints and competence of the responding employee to gather the relevant information to complete the questionnaire. Lastly, motivation captures the establishment's or individual respondent's attitude towards the survey and the drive to participate. Examples of the interrelationship between these higher- and lower-level factors are illustrated in the following subsections.

2.3.1.1 Environmental Factors

Laws or regulations that make a survey mandatory are one example of an environmental factor that affects the survey decision. Here the laws shape the authority as the establishment is obligated to respond or face a fine. Also, from an empirical perspective, there is clear evidence that mandatory participation leads to a higher likelihood of response (Snijkers, 2008; Snijkers et al., 2007; Willimack & Nichols, 2010; Willimack & Snijkers, 2013). The economic situation also influences the decision. Both a boom and a recession reduce the capacity of establishments to respond: either they have no time, because they are dealing with growing markets and influx of customers, or they reduce staff to stay solvent, which also reduces resources for survey participation (Davis & Pihama, 2009; Fisher et al., 2003; Seiler, 2014).

2.3.1.2 Establishment Factors

Establishments differ in various aspects that likely affect their cost-benefit analysis for participation. In addition to previously mentioned aspects, such as internal policies and corporate social responsibility, establishment size also plays a role. While owners of small businesses can usually handle the survey request themselves, more coordination between hierarchies and departments is needed for larger establishments (Willimack & Snijkers, 2013). In terms of capacity, easily derivable data from record systems, established response processes and clear organizational responsibilities for survey requests reduce response burden and facilitate participation (Willimack & Snijkers, 2013).

2.3.1.3 Respondent Factors

It is important to keep in mind that multiple persons could be involved in the response decision. For example, an owner or unit head may have the authority to comply with the survey request, while other employees have the capacity. Several employees from different units may be needed to provide the requested information in multi-topic surveys. Usually the researcher has only a minor influence on who responds within the establishment and can only address the survey request to the establishment as a whole or a specific role within (Willimack et al., 2002). The characteristics of all individuals involved (e.g., motivation, level of experience) also factors into the response decision.

2.3.2 Response Rates in Establishment Surveys

Participation rates vary strongly between establishment surveys. For instance, mandatory (mostly governmental) surveys such as the Survey of Occupational Injuries and Illnesses (SOII) in the US (U.S. Bureau of Labor Statistics, 2023b) or the Survey on Investments in the Netherlands (Snijkers et al., 2018) reach response rates of almost 90 percent. On the other extreme, voluntary multi-topic surveys conducted by private research organizations can have response rates below 5 percent (G. D. White & Luo, 2005). Further, there are indications that response rates are declining over time for some voluntary surveys. In the 1990s Christianson and Tortora (1995) found that 30 percent of survey managers interviewed in 16 countries reported a declining response rate trend in their establishment surveys. In the early 2000s Petroni et al. (2004) found evidence of decreasing or stable response rates in both voluntary and mandatory surveys in the US. Anseel et al. (2010) concluded from a meta-analysis of 2,037 published studies that the increased use of response enhancement strategies prevented a strong decline in response rates. Most recently, a declining trend in response rates has been observed for voluntary surveys in the US and Germany (Janik & Kohaut, 2012; König et al., 2021; U.S. Bureau of Labor Statistics, 2023b). An international meta-analysis of family firm surveys also confirms this trend (Pielsticker & Hiebl, 2020).

2.3.3 Nonresponse Bias in Establishment Surveys

Given the low and sometimes declining response rates in many establishment surveys, it is important to assess their potential for nonresponse bias. Most often nonresponse bias analyses are performed by comparing respondents and nonrespondents based on the auxiliary information that is available for both groups, e.g., from the sampling frame (e.g., Earp et al., 2018; Lineback & Thompson, 2010). Alternatively, researchers compare early and late respondents, use previous census information (e.g., Earp et al., 2014) or conduct costly nonresponse surveys. With the rise of big data approaches, linking surveys with administrative data is gaining attention as a promising means to analyze nonresponse bias (Bavdaž et al., 2020). Administrative data offer potentially rich and up-to-date auxiliary information on responding and nonresponding establishments and are therefore uniquely suited for studying nonresponse. However, despite their high potential, administrative data are rarely used for nonresponse analysis (for exceptions, see (Janik & Kohaut, 2012; König et al., 2021)). The present study addresses this research gap by exploiting extensive administrative data to asses nonresponse bias in depth.

Nonresponse bias can have large effects on establishment statistics when influential establishments do not respond. This is especially true for very large establishments that employ a considerable share of the workforce. Such establishments can have a substantial impact on key survey estimates (Lineback & Thompson, 2010; Riviére, 2002; Thompson & Oliver, 2012). With regard to job vacancy statistics, large establishments are especially critical as they typically contribute disproportionately to estimates of total vacancies. Thus, if larger establishments have lower response propensities than smaller establishments, then severe nonresponse bias in vacancy statistics could result. There is indeed evidence that larger establishments are less likely to participate in surveys (e.g., Earp et al., 2018; Janik & Kohaut, 2012; König et al., 2021; Phipps & Toth, 2012). Other correlates of establishment survey participation are also documented in the literature. For example, industry (Phipps & Jones, 2007; Tomaskovic-Devey et al., 1995), multi-unit establishments (Phipps & Toth, 2012), establishment age (Phipps & Jones, 2007), wages (Phipps & Toth, 2012) and region of the establishment (Janik & Kohaut, 2012; Phipps & Jones, 2007). The present study contributes to the existing literature by analyzing additional hypothesized correlates of survey participation, including detailed workforce characteristics and diversity measures, employee demographic profile, and the development of the employment structure. To date, these workforce characteristics have not been explored in the establishment survey literature.

Additionally, most nonresponse bias studies present only measures of association (e.g., correlations, regression coefficients) between establishment characteristics and participation and do not evaluate the magnitude of nonresponse biases. Yet, magnitude is an important aspect of nonresponse bias as it allows researchers to compare the sizes of the biases over time and assess their impact on substantive analyses. We address this research gap by presenting individual and aggregate bias estimates for important substantive variables derived from administrative data.

2.3.4 Adjustment Strategies and Machine Learning Tools

To adjust for potential nonresponse bias in establishment surveys, sample-based weighting schemes, such as propensity score weighting, are often used (Valliant et al., 2013). Such weighting procedures rely on the availability and quality of auxiliary data. As illustrated by Little and Vartivarian (2005), weighting effects are optimized if the auxiliary data are correlated with both the response outcome and the target survey variables. In establishment surveys, auxiliary data are usually limited to available paradata or few sampling frame variables that may relate well to response propensity, but less so for the substantive survey variables. Administrative data offer a promising supplementary source, as they contain substantive attributes on the establishments (e.g., revenue) and their workforce (e.g., demographic composition) that likely have a stronger relationship with the key survey variables and the response propensity.

Propensity score weighting is traditionally performed by modeling the response outcome using a logistic (or probit) regression model conditional on the auxiliary variables and deriving response propensity scores to create weights for each sampled unit. However, within the last decade machine learning methods have become increasingly popular for modeling survey participation (e.g., Earp et al., 2014, 2018; Kern et al., 2019; Lohr et al., 2015; Phipps & Toth, 2012; Toth & Phipps, 2014; Zinn & Gnambs, 2022). A major advantage of these methods over traditional methods is that they can handle complex data structures with many variables and identify high-level interactions and other non-linear effects. As such, they offer the capability to identify intricate data-driven relationships between the auxiliary variables and the response outcome.

However, only a few studies have investigated the value of using machine learning algorithms for nonresponse weighting adjustments. In a simulation study, Buskirk and Kolenikov (2015) showed that logistic regression and Random Forests performed similarly well for inverse propensity weighting for a simple response pattern (only a few interactions), but logistic regression performed better for propensity score stratification. In a more complex response setting (with more interactions), Random Forest was superior for inverse propensity weighting and logistic regression was superior for propensity score stratification.

Lohr et al. (2015) conducted a similar simulation study comparing multiple tree-based methods, including Classification and Regression Trees (CART), Conditional Inference Trees (C-tree) and Random Forest, among others, to logistic regression. Response propensities were adequately estimated by logistic regression and C-Tree, if response was simulated linearly, with Random Forest and CART producing small deviations from the true response propensities. However, if interaction terms were used to simulate nonresponse, then logistic regression performed poorly compared to the tree-based methods, as expected. Using the estimated response propensities for weighting, the C-Tree algorithm performed rather well across different weighting schemes and response models, outperforming CART. In the direct response propensity weighting scheme, Random Forest reduced the most bias, closely followed by C-Tree and logistic regression.

Earp et al. (2018) demonstrated the application of regression trees (recursive partitioning) to estimate response propensities in the BLS Job Opening Labor Turnover Survey, which is also a vacancy survey, but they did not compare it to other methods. Kern et al. (2019) showed that Extreme Gradient Boosting (XG-Boost) and Random Forest performed best for panel nonresponse prediction in the German Socio-Economic Panel, closely followed by Model-based Recursive Partitioning (MOB) and Bayesian Additive Regression Trees (BART). Logistic Regression, as the reference group, could not compete with the prediction accuracy of the tree-based methods.

2.4 Research Objectives and Participation Hypotheses

2.4.1 Research Objectives

The present study has four research objectives derived from the aforementioned research gaps. The first research objective (RO1) investigates response rates in the 2010-2019 IAB-JVS to discern whether there is a noticeable trend over time. The second research objective (RO2) investigates the severity and trend (if any) of nonresponse bias in the IAB-JVS. Here, we utilize an extended set of administrative data containing detailed establishment and workforce characteristics to estimate nonresponse bias for each survey year. The third research objective (RO3) utilizes the extended administrative data to test nine hypotheses of survey participation (described in detail below), including new hypotheses not yet considered in the literature. The last research objective (RO4) builds on the second by evaluating what we gain in nonresponse bias reduction by including the extended set of administrative variables in the IAB-JVS nonresponse weighting procedure, as compared to the smaller set of auxiliary variables used in the current weighting procedure.

Further, we compare the performance of several machine learning algorithms for reducing nonresponse bias in the IAB-JVS relative to a logistic regression-based weighting procedure. The evaluation includes various data-driven algorithms, including some not yet applied in an establishment survey context (e.g., C-Tree, XG-Boost, general additive models). We expect that including the extended set of administrative variables in the IAB-JVS weighting procedure will reduce nonresponse bias relative to the currently used weighting variables. Moreover, we expect that the machine learning algorithms will reduce nonresponse bias even further by accounting for complex, non-linear relationships between the response outcome and the administrative variables. The effectiveness of the methods is evaluated on the basis of nonresponse bias in the administrative variables and via a proxy measure of the key survey variable – *vacancies*.

2.4.2 Hypotheses of Survey Participation

Pertinent to research objective 3, we use administrative data to test the following hypotheses: Relevance of the survey topic, establishment size, establishment age, average establishment wages, workforce diversity, interaction of establishment age and average employee age, response history, and development of the employment structure. Each hypothesis is motivated and described in the following subsections.

Relevance of the Survey Topic

One of the most frequently studied hypotheses is whether the topic of the survey influences the participation decision. Most of the literature, qualitative and quantitative, shows evidence that the topic of the survey matters (HMRC, 2010; Snijkers et al., 2013, 2018). That is, motivation to participate is higher if the survey topic is highly relevant to the establishment. Vacancy surveys and their statistics are especially relevant for establishments with many vacancies or those that employ many marginal employees, who are prone to change their jobs frequently. As the number of vacancies cannot be derived from administrative data, our analysis relies on new hires as a proxy measure for vacancies. This is reasonable given that vacancies are likely to be converted into new hires in the future. Thus, we hypothesize that establishments with a higher share of new hires and marginal employees (as proxies for survey topic relevance) are more likely to participate.
H1: The likelihood of participation increases with a higher share of new hires and a higher share of marginal employees.

Establishment Size

As previously stated, the size of establishments, measured by the number of employees, likely affects the participation outcome. However, empirical evidence on the direction of the effect is mixed. Two studies show that larger firms are more likely to participate than smaller ones (Davis & Pihama, 2009; Seiler, 2014). They argue that employees of large firms have specialised roles grouped into clear structures, leading to well-defined lines of authority and increased capacity to respond. However, both surveys have special procedures for handling large companies, which could have impacted the results. Other studies show that smaller establishments are more likely to respond, especially in voluntary surveys (Earp et al., 2018; Hecht et al., 2019; Janik & Kohaut, 2012; König et al., 2021). They argue that within smaller establishments less coordination is needed to organize the response task, it is easier to identify a capable employee to respond, and the same person can decide whether to participate and

also complete the interview. Since the IAB-JVS is a voluntary survey similar in design to the cited studies, we hypothesize a negative effect of establishment size on participation.
H2: The likelihood of participation decreases with establishment size.

Establishment Age

We posit an establishment age effect given that older, more entrenched firms are likely to have more experience and better infrastructure for handling information requests. In contrast, younger establishments face additional challenges that have higher priority than survey response. Accordingly, younger establishments are expected to have less motivation and capacity to respond. Although Hecht et al. (2019) and Foo et al. (2019) find no age effect, Phipps and Jones (2007) find a positive age effect. Hence, we hypothesize that older establishments are more likely to respond than younger ones.
H3: The likelihood of participation increases with establishment age.

Average Establishment Wages

According to rent-sharing theory, higher wages are associated with more profitable enterprises (Blanchflower et al., 1996), which in turn could be associated with more efficient organization of enterprises and better (data) management (Ogbadu, 2009). More efficient organization and data infrastructure should decrease response burden, as the required information can be gathered faster. On the other hand, the profitability of an establishment could lie in better prioritization of revenue-generating tasks. As survey participation does not directly affect a firm's revenue, profitable establishments might be less motivated to take part and give it a low priority. Phipps and Toth (2012) find support for this claim as they showed responding establishments have lower (average) wages than nonresponding establishments in the BLS Occupational Employment Statistics survey. Based on the empirical evidence, we hypothesize that establishments with higher wages are less likely to participate.
H4: The likelihood of participation decreases with average establishment wages.

Workforce Diversity

The public expects that businesses are part of, and contribute to, a functioning society, but businesses follow this norm with different intensities. Participating in surveys is one way of engaging with the general public and expressing social responsibility. Diversity management is seen as a related aspect to social corporate responsibility (Colgan, 2011; Hansen & Seierstad, 2017; Starostka-Patyk et al., 2015). We posit that an establishment's willingness to engage with society is related to their hiring preferences with regard to nationality, sex and education. We expect that establishments with little demographic diversity are less interested in social responsibility, which should translate into a lower likelihood of survey participation and the opposite for establishments with higher levels of diversity.

H5: The likelihood of participation increases with the diversity of the workforce.

Interaction of Establishment Age and Average Employee Age

We expect that younger establishments with a younger workforce (e.g., start-ups) differ from older establishments employing an older workforce with respect to survey participation. In particular, the first priority of the former group is to increase market share with less priority and capacity allocated to completing voluntary survey tasks. Thus, we hypothesize that younger establishments with a younger workforce are less likely to participate.
H6: The likelihood of participation decreases for younger establishments with a younger workforce, compared to older establishments with an older workforce.

Response History

Although the IAB-JVS is a yearly cross-sectional survey, there are several establishments which are sampled at a higher rate than others due to their size or industry type. We posit that receiving more participation requests for the same survey has a negative effect on response. Repeated requests could lead to suspicion regarding the random selection procedure or increase the perceived response burden, thus decreasing the response propensity.
H7: The likelihood of participation decreases if an establishment was sampled in the previous year, compared to an establishment that was not sampled.

Despite the expected negative effect of the previous-year's survey request, we anticipate that establishments whom already participated in the previous year are more likely to do so again. These establishments are familiar with the survey and its questionnaire and have already established a response process. Hence, the response task may be less burdensome compared to establishments who did not previously participate and must process the survey request from scratch (Earp et al., 2018; Janik & Kohaut, 2012; Smaill, 2012).
H8: The likelihood of participation increases if an establishment participated in the previous year, compared to an establishment that did not participate.

Development of Employment Structure

We expect that changes in the establishment that occurred prior to the survey request affect survey participation. For example, if the share of women in the establishment moves closer to 50 percent, compared to the previous year, this would reflect a development towards greater diversity. In line with the aforementioned diversity hypothesis (H5), we would therefore expect this development to translate into a higher likelihood of participation. Similarly, we expect that a strong wage growth is a sign of a more profitable establishment which is expected to have a negative effect on participation, as previously suggested by H4. Lastly, in line with the survey topic relevance hypothesis (H1), an increasing proportion of marginal employees or new hires (as a proxy for vacancies) could translate into the survey topic becoming more relevant to the establishment, due to an increasing number of job recruiting processes. We also consider changes that occurred after the survey request, as they likely reflect procedures being implemented at the time of the survey.

H9: The development of the employment structure affects the likelihood of participation.

H9 consists of the following sub-hypotheses. The subindicator refers to the relevant main hypothesis:

- *H9.1a: The likelihood of participation increases if the share of new hires and the share of marginal employees (as proxies for survey topic relevance) increased from the year before the survey* $(t-1)$ *to the survey year* (t)*, compared to no change or a decreasing share of new hires and marginal employees.*
- *H9.1b: The likelihood of participation increases if the share of new hires and the share of marginal employees (as proxies for survey topic relevance) increased from the survey year* (t) *to the year after the survey* $(t+1)$*, compared to no change or a decreasing share of new hires and marginal employees.*
- *H9.4a: The likelihood of participation decreases if the average establishment wage increased from the year before the survey* $(t-1)$ *to the survey year* (t)*, compared to no change of the average establishment wage or a decreasing average establishment wage.*
- *H9.4b: The likelihood of participation decreases if the average establishment wage increased from the survey year* (t) *to the year after the survey* $(t+1)$*, compared to no change of average establishment wage or a decreasing average establishment wage.*
- *H9.5a: The likelihood of participation increases if the diversity of the workforce increased from the year before the survey* $(t-1)$ *to the survey year* (t)*, compared to no change of diversity or a decreasing diversity.*
- *H9.5b: The likelihood of participation increases if the diversity of the workforce increased from the survey year* (t) *to the year after the survey* $(t+1)$*, compared to no change of diversity or a decreasing diversity.*

2.5 Data and Methods

2.5.1 Data

2.5.1.1 IAB Job Vacancy Survey

The IAB-JVS is a voluntary nationally-representative establishment survey that quantifies the size of the unfilled labor demand and other worker flows in Germany (Bossler et al., 2020). It is carried out annually as a repeated cross-sectional survey using a concurrent mixed-mode design, with establishments receiving paper questionnaires and the option of online completion. Random samples of about 110,000 establishments are drawn each year from the population of all establishments in Germany that have at least one regular employee liable for social security contributions. The sampling frame is the population on the 31st of December in the previous year. Using an expert allocation, samples are disproportionately stratified by region, industry and establishment size, resulting in unequal inclusion probabilities. The IAB-JVS is fielded every fourth quarter (October-December) with short reinterviews conducted via telephone in the subsequent three quarters to update the number of vacancies. Since our focus is on cross-sectional nonresponse we do not consider the reinterviews. We analyze survey years 2010-2019 only as it is not possible to link the IAB-JVS to administrative data for years prior to 2010.The data used in this study are available from the Research Data Centre (RDC) of the Federal Employment Agency in Germany. Restrictions apply to the availability of these data, which are not publicly available. For more information on data access, see https://fdz.iab.de/en.aspx.

2.5.1.2 Administrative Data

To analyze nonresponse bias in the IAB-JVS, each yearly sample is linked to administrative data of the Establishment History Panel (BHP) of the Federal Employment Agency (Ganzer et al., 2020). The BHP is a longitudinal administrative database compiled by aggregating individual records of all employees to the establishment level. The reference date for the aggregation is the 30th of June every year. This means there is one observation per year, which reflects the establishment profile in the quarter immediately prior to the survey. Since the IAB-JVS sampling frame and the BHP contain the same unique identifier it is straightforward to link them for almost every establishment. Exceptions are establishments that cease to exist between the reference dates of the sample selection and the BHP, which applies to 3.4 percent of all establishments.

In addition, we make use of the Administrative Wage and Labor Market Flow Panel (AWFP), which is an aggregation of employment biographies of individual employees and subsidy recipients to the establishment level (Seth & Stüber, 2017). It captures similar characteristics to the BHP and some additional aspects (e.g., mean employment tenure, standard deviation of wage) which we exploit to validate the results of the BHP through additional sensitivity analyses. However, the shares of some employee characteristics (e.g., males/females) are calculated differently by using only regular workers and excluding marginal employees. A key advantage of the AWFP over the BHP is that it is calculated quarterly and therefore the fourth quarter, which overlaps exactly with the quarter of data collection, can be used in the validation analysis. Hence, the validation analysis assesses nonresponse bias at the same time period of the survey. A major drawback of the AWFP is its availability only until 2014.

Table 2.1 provides an overview of the variables and data sources used for each research objective.

Table 2.1: Variable and Dataset Overview

Variable	Bias Measure	Bias Measure Validation	Hypothesis Testing	Current Response Propensity Estimation	Extended Response Propensity Estimation
Research Objective	RO2, RO4	RO2, RO4	RO3	RO4	RO4
Dataset	BHP	AWFP	BHP	BHP	BHP
Variables from the survey year					
East/West Germany °	Dum.	Dum.	Dum.	Dum.	Dum.
Number of Employees °	Cat.	Cat.	Cat.	Cat.	Con.
Establishment Age	-	-	Con.	-	Con.
Foundation Year °	Cat.	Cat.	-	-	-
Industry °	Cat.	Cat.	Cat.	Cat.	Cat.
Avg. Age of Employees *	Cat.	Cat.	Cat.	Cat.	Con.
Share of Female *	Cat.	Cat.	-	-	Con.
Sex Diversity	-	-	Cat.	-	-
Share of Fixed-Term *	Cat.	-	-	-	Con.
Share of Apprentices *	Cat.	Cat.	Cat.	-	Con.
Share of Full-Time *	Cat.	Cat.	Cat.	-	Con.
Share of Part-Time *	Cat.	Cat.	Cat.	-	Con.
Share of Germans *	Cat.	-	-	-	Con.
Nationality Diversity	-	-	Cat.	-	-
Share of Regular *	Cat.	Cat.	Cat.	-	Con.
Share of Marginal *	Cat.	Cat.	Cat.	Cat.	Con.
Share of High-Educated *	Cat.	Cat.	-	-	Con.
Share of Mid-Educated *	Cat.	Cat.	-	-	Con.
Share of Low-Educated *	Cat.	Cat.	-	-	Con.
Education Diversity	-	-	Cat.	-	-
Share of Unknown Educated *	Cat.	Cat.	Cat.	-	-
Quartile of Wage Distribution *	Cat.	Cat.	Cat.	-	Cat.
Mean Tenure *	-	Cat.	-	-	-
Std. Dev. of Wages *	-	Cat.	-	-	-
Sampled in t-1	-	-	Dum.	-	Dum.
Participated in t-1	-	-	Dum.	-	Dum.
Establishment Foundation in t-1 °	Dum.	Dum.	-	-	Dum.
Establishment Closure in t+1 °	Dum.	Dum.	-	-	Dum.
Development variables					
Change of Sex Diversity	-	-	Cat.	-	-
Change of Apprentices	-	-	Cat.	-	-
Change of Full-Time	-	-	Cat.	-	-
Change of Part-Time	-	-	Cat.	-	-
Change of Nationality Diversity	-	-	Cat.	-	-
Change of Regular	-	-	Cat.	-	-
Change of Marginal	-	-	Cat.	-	-
Change of Education Diversity	-	-	Cat.	-	-
Change of Unknown Educated	-	-	Cat.	-	-
Wage Growth	-	-	Cat.	-	-
Change of Avg. Age of Empl.	-	-	Cat.	-	-
Share of New Hirings	-	-	Cat.	-	-

Note: Cat. = Categorized Variable; Con. = Continuous Variable; Dum.= Dummy Variable; ° = Establishment Characteristic; * = Employee Characteristic

For the nonresponse bias analysis, we categorise all variables of interest into approximately equal-sized categories. Descriptive statistics are presented in the Appendix Section 2.A.

We note that all administrative variables used in the analysis are treated as proxy variables for the actual IAB-JVS survey variables. This is reasonable considering that the administrative variables are likely correlated with the multiple topics covered in the survey questionnaire, including the variety of questions on vacancies and recruiting processes. To give a few examples, establishment size and the number of new hires is likely correlated with the number of reported vacancies; the share of fixed-term employees should be correlated with the reported number of fixed-term employees in the survey; and the administrative wage information is correlated with survey variables on hiring wages and wage negotiation.

2.5.2 Methods

2.5.2.1 Response Rates

The first research objective investigates response rates in the IAB-JVS, which we define as the number of completed interviews divided by the sample size. This definition is equivalent to *Response Rate 1* as defined by the American Association for Public Opinion Research (2016). As the definition is based on the full sample, it is a conservative calculation and can be considered the minimum response rate. The stratified sampling design of the IAB-JVS has unequal inclusion probabilities between strata, which we take into account when calculating the response rates. Thus, we report the population response rate.

A distinction is made between the *drawn* sample and the *fielded* sample, which depends on the particular year of analysis. Some establishments from the drawn sample could not be fielded (e.g., invalid addresses) and had no chance to participate in the survey. These non-fielded establishments can be identified only for years 2016-2019 and are excluded from the analysis for these years. For years 2010-2015, only the drawn sample can be used as the basis since it is not possible to identify the non-fielded cases. Design weights are based on the drawn sample between 2010-2015 and on the fielded sample between 2016-2019. We believe this distinction does not substantially affect the interpretation of the results, as the share of non-fielded establishments is small (below five percent for each year) and sensitivity checks for RO2, RO3, and RO4 showed no systematic differences between these two sample definitions, and no large differences between the bridge years 2015 and 2016. In the remainder, we use the term *analytic* sample to refer to the compilation of the *drawn* sample for years 2010-2015 and the *fielded* sample for years 2016-2019.

2.5.2.2 Nonresponse Bias Calculation

The second research objective pertains to nonresponse bias. Nonresponse bias is computed as the difference between the estimate of interest based on the set of respondents and the corresponding estimate based on the full sample:

$$\widehat{\text{NR bias}}_i = \hat{Y}_{i,r} - \hat{Y}_{i,n} \tag{2.1}$$

where $\hat{Y}_{i,r}$ denotes the estimator for the i^{th} statistic of interest based on the respondents and $\hat{Y}_{i,n}$ is the estimator based on the full sample.

Nonresponse bias is estimated for each category of each administrative variable shown in Table 2.1 (columns 2 and 3). As all biases are based on proportions, they can be compared on the same scale. Additionally, we construct and compare measures of absolute bias and average absolute bias, where absolute nonresponse bias is defined as:

$$\text{Abs.} \widehat{\text{NR bias}}_i = \left| \widehat{\text{NR bias}}_i \right| \tag{2.2}$$

and average absolute nonresponse bias is defined as:

$$\text{Avg.} \widehat{\text{abs. NR}} \text{ bias} = \frac{\sum_{i=1}^{K} \text{Abs.} \widehat{\text{NR bias}}_i}{K} \tag{2.3}$$

where K is the total number of variable categories for which nonresponse bias is estimated.

Average absolute nonresponse bias is calculated across all variables and separately for two variable groups: establishment characteristics and employee characteristics (see Table 2.1). Separating these variable groups sheds light on which one is most impacted by nonresponse bias.

These three measures are used to assess nonresponse bias and corresponding nonresponse bias trends in the IAB-JVS (RO2) and examine the performance of the various nonresponse adjustment models (RO4). As some variables are not available in 2010 and 2019 (e.g., establishment closure in t+1, share of fixed-term employees), the nonresponse bias analysis is restricted to years 2011 to 2018. As a robustness check, we also estimate absolute relative nonresponse biases and report them in the Appendix Section (see 2.G). All nonresponse bias estimates are design weighted to account for unequal inclusion probabilities.

2.5.2.3 Modeling Survey Participation

RO3 tests hypotheses of survey participation using a series of logistic regressions modeling response (1=response, 0= nonresponse) for each survey year. Each model specification builds on the previous one by cumulatively adding more explanatory variables. Model 1 consists of the current set of IAB-JVS weighting variables. Model 2 adds static variables which are measured during the survey year (t). Model 3 adds the development variables which reflect changes in the establishment since the previous year (t-1). This is followed by Model 4, which includes development variables reflecting subsequent changes in the establishment from the survey year until the following year (t+1). Additional control variables about the establishment (e.g., industry, region, share of full-time employees) are included in all four models presented below.

Model 1: The current IAB-JVS logistic regression model for estimating response propensities:

$$logit(R_{k,t}) = \alpha + \beta_1 \mathbf{x}_{1,k,t}^{\top} + \gamma_1 \mathbf{z}_{1,k,t}^{\top} \tag{2.4}$$

where $R_{k,t}$ is the response indicator for the k^{th} establishment (R_k = 1 = response, R_k = 0 = non-response) in survey year t, $\mathbf{x_1}$ is a vector of current IAB-JVS weighting variables, and $\mathbf{z_1}$ is a set of additional control variables.

Model 2: Extended response model with static variables:

$$logit(R_{k,t}) = \alpha + \beta_1 \mathbf{x}_{1,k,t}^{\top} + \beta_2 \mathbf{x}_{2,k,t}^{\top} + \gamma_1 \mathbf{z}_{1,k,t}^{\top} \tag{2.5}$$

where $\mathbf{x_2}$ includes the extended set of administrative (static) variables.

Model 3: Extended response model with static variables and previous-year change variables:

$$logit(R_{k,t}) = \alpha + \beta_1 \mathbf{x}_{1,k,t}^{\top} + \beta_2 \mathbf{x}_{2,k,t}^{\top} + \beta_3 \mathbf{x}_{3,k,t-1}^{\top} + \gamma_1 \mathbf{z}_{1,k,t}^{\top} + \gamma_2 \mathbf{z}_{2,k,t-1}^{\top} \tag{2.6}$$

where $\mathbf{x_3}$ includes administrative change variables from t-1 and $\mathbf{z_2}$ is a set of control variables reflecting change from t-1

Model 4: Extended response model with static variables and previous- and subsequent-year change variables:

$$logit(R_{k,t}) = \alpha + \beta_1 \mathbf{x}_{1,k,t}^{\top} + \beta_2 \mathbf{x}_{2,k,t}^{\top} + \beta_3 \mathbf{x}_{3,k,t-1}^{\top} + \beta_4 \mathbf{x}_{4,k,t+1}^{\top} + \gamma_1 \mathbf{z}_{1,k,t}^{\top} + \gamma_2 \mathbf{z}_{2,k,t-1}^{\top} + \gamma_3 \mathbf{z}_{3,k,t+1}^{\top} \tag{2.7}$$

where $\mathbf{x_4}$ includes administrative change variables from t+1 and $\mathbf{z_3}$ is a set of control variables reflecting change from t+1

Design weights (i.e., inverse inclusion probabilities) and strata are accounted for in all model estimations. As the estimated model coefficients and test statistics were found to be stable over the years, we also report the pooled-data results. By using pooled data and controlling for year effects in the logistic regression, we assume stable effects of our variables of interest within the observation period. With more observation years available, one could consider fitting a multi-level model to account for year-specific effects. As a robustness check, we also estimated a random intercept model with respondents clustered within years. The results of the random intercept model supported the results of the logistic regression model using pooled data.

To facilitate comparisons between the different model specifications, the analytic sample is restricted to all establishments with observed variables for the survey year, the year before the survey, and the year after the survey. Thus, the number of observations is held constant for every model specification. Sensitivity checks incorporating establishments with missing variable information at t-1 and/or t+1 did not affect the study conclusions (results not shown).

2.5.2.4 Response Propensity Models and Adjustment Weights

The fourth research objective (RO4) investigates whether including the extended set of administrative variables in the response propensity estimation improves nonresponse bias reduction relative to the current set of IAB-JVS auxiliary variables. To do this, two separate logistic regression models are fitted: one using only the current IAB-JVS weighting variables and the other adding the extended administrative variables. The resulting weights derived from both models are then compared in terms of their bias-reducing performance.

More complex models are also evaluated, including several data-driven modelling methods, such as Lasso regression, generalized additive models and supervised machine learning (ML) algorithms. All of these methods are applied to estimate response propensities based on the full set of current and extended administrative auxiliary variables. In sum, the following modelling approaches are evaluated:

- Logistic regression (with and without extended administrative variables) (Cox, 1958)
- Lasso regression (with second order polynomials) (Lasso) (Tibshirani, 1996)
- Ridge regression (with second order polynomials) (Ridge) (Hoerl & Kennard, 1970)
- General additive model (GAM) (T. J. Hastie & Tibshirani, 1990)
- Generalized Additive Model Selection (GAMSEL) (Chouldechova & Hastie, 2015)
- Decision tree using the CART algorithm (CART) (Breiman et al., 1984)

- Decision tree using the C-Tree algorithm (C-Tree) (Hothorn et al., 2006)
- Model-based recursive partitioning (MOB) (Zeileis et al., 2008)
- Random Forest (Breiman, 2001)
- Extreme Gradient Boosting (XG-Boost) (T. Chen & Guestrin, 2016)
- Bayesian additive regression trees (BART) (Chipman et al., 2010)

As the goal is not to predict out-of-sample nonresponse, but to estimate response probabilities based on the explanatory variables, the data are not split into test and training sets. That is, the complete data are used both for training the models and estimating the response propensities. To optimize the CART, C-Tree, XG-Boost algorithms a hyper-parameter tuning is performed by conducting a grid search on various parameter settings with 5-fold cross validation. The BART algorithm is applied with the default setup and Random Forest with specific selected parameters to avoid overfitting. Table 2.E.1 in the Appendix provides an overview of the parameters used for the machine learning models. We follow Lohr et al. (2015) and estimate response propensities without using design weights, knowing that this implicitly assumes that our sampling design is non-informative for the response indicator (i.e., inclusion probabilities are unrelated to the response indicator (Pfeffermann, 2011)). Since we control for the variables used to create the sampling strata the effect of a possibly informative design is mitigated. The full analysis is implemented in Stata (StataCorp, 2019) and in R (R Core Team, 2019) using the packages *glmnet* (Friedman et al., 2010), *gam* (T. Hastie, 2019), *gamsel* (Chouldechova & Hastie, 2015), *rpart* (Therneau & Atkinson, 2019), *partykit* (Hothorn & Zeileis, 2015), *randomForest* (Liaw & Wiener, 2002), *xgboost* (T. Chen et al., 2019), *bartMachine* (Kapelner & Bleich, 2016) and *caret* (Kuhn, 2020).

To avoid overfitting, each target administrative variable for which nonresponse bias is assessed is left out of the corresponding set of explanatory variables for the response propensity estimation. This "leave-one-out" approach results in different sets of response propensities estimated for each establishment corresponding to each target variable of interest. As the proportion of unknown educated employees is colinear with the proportions of low-educated, middle-educated and high-educated employees, this variable is left out of the explanatory set for all response propensity estimations. The adjustment weight for this outcome variable is based on the full set of explanatory variables. The inverse of these propensities are the raw nonresponse weights. To reduce the variance of the raw weights, they are trimmed at the 99th percentile. The final adjustment weights are constructed by multiplying the nonresponse weight with the design weight. The adjustment weights are then used to compute weighted estimates of the corresponding target administrative variables. Nonresponse bias is assessed by comparing the nonresponse-adjusted weighted estimates under each modeling approach against the design-weighted benchmark values. This comparison provides information about which modelling approaches perform best in terms of reducing nonresponse bias.

The same set of explanatory variables are used in all modeling approaches. In contrast to the models used to test the survey participation hypotheses (RO3), the continuous variables are not categorized to allow the machine learning algorithms to make use of the full depth of information. The traditional response propensity estimation implemented in the IAB-JVS is based on categorized variables. In order to ensure a fair comparison with the machine learning methods, we use the continuous versions of these variables for all modelling approaches. For the Lasso and Ridge regressions second-order interactions and quadratic terms are included in the set of explanatory variables. To control for outliers, establishment size is top-coded at 20,000 employees.

2.6 Results

2.6.1 Response Rates in the IAB-JVS between 2010-2019

Figure 2.1 shows the design-weighted response rates of the IAB-JVS for years 2010-2019. The corresponding table can be found in the Appendix Section 2.B. One can see that the yearly response rates have always been below 21 percent since 2010. Over these years, the response rate has dropped from 18.87 percent (2010) to 14.65 percent (2019), representing an average design-weighted response rate of 16.40 percent and an average decline of 0.4 percentage points per year. A stabilizing trend is observed since 2016, which is the first year the fielded sample is analyzed (as opposed to the drawn sample). However, there are signs that this trend is not purely driven by the change in sample type, as the field reports also indicate a stabilizing trend with less decline in recent years (see Appendix Section 2.B). This decline is even more evident when looking at the response rates based on the field reports since 1989 (see Appendix Figure 2.B.1). The unweighted response rates declined from 40.1

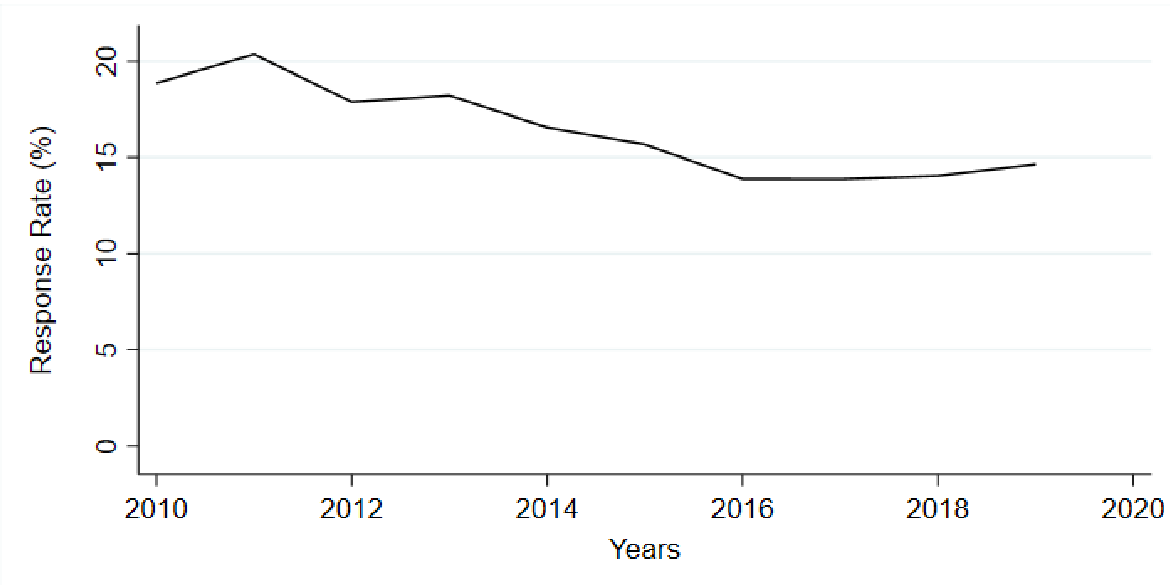


Figure 2.1: Design Weighted Response Rates, 2010-2019 IAB-JVS

percent in 1989 to 20.4 percent in 2009. In sum, the response rates of the IAB-JVS can be considered low compared to other establishment surveys worldwide. Moreover, the general decreasing trend in the IAB-JVS is consistent with indications of declining participation in other establishment surveys (see Section 2.3.2).

2.6.2 Nonresponse Bias

Figure 2.2 illustrates the average absolute nonresponse bias, estimated using only design weights, between 2011 and 2018 for all administrative variables, and separately for establishment and employee characteristics. Across all variables, the average absolute nonresponse bias lies between 1.37 percent (2012) and 1.74 percent (2015) across the eight years without any noticeable trend over time. These aggregate values are considered rather small. Given the low response rates reported earlier, it is reassuring that the aggregate bias is not particularly high. The subset of employee and establishment characteristics range between 1.18 (2011) and 1.63 (2017) percent and 1.76 (2012) and 2.08 (2015) percent, respectively. Thus, the establishment characteristics tend to be more impacted by nonresponse bias than the employee characteristics.

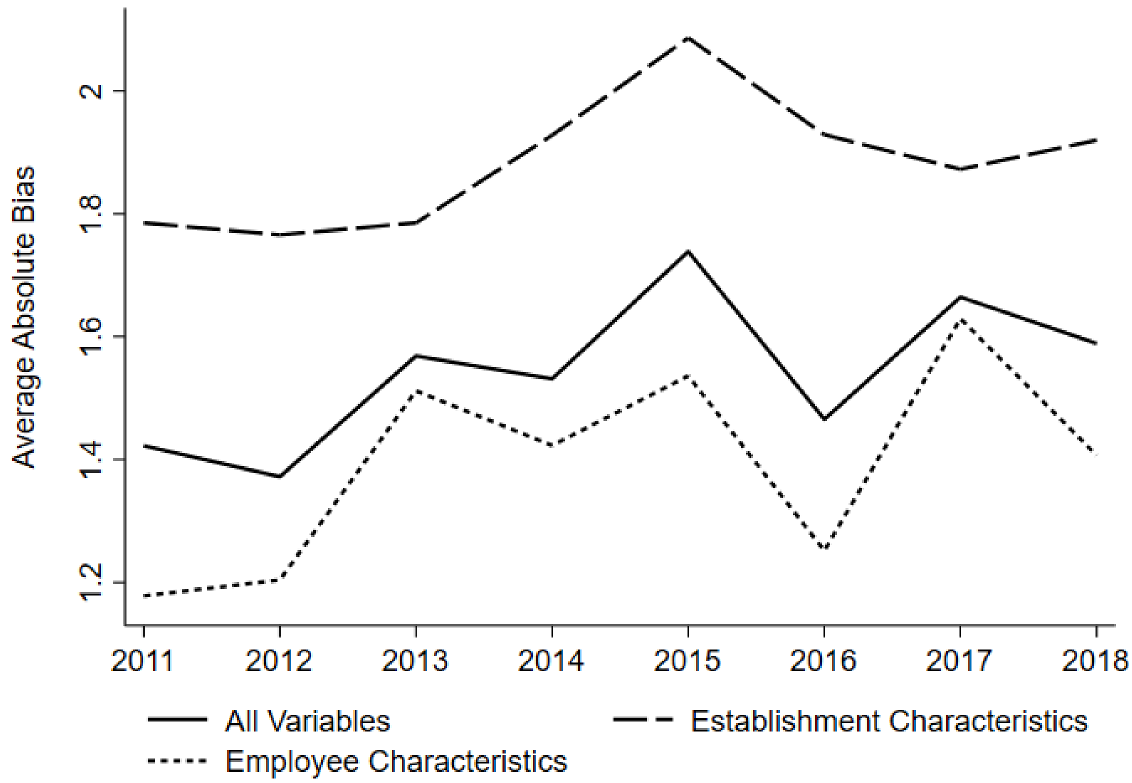


Figure 2.2: Design Weighted Average Absolute Bias by All Administrative Variables, Establishment Characteristics and Employee Characteristics, BHP 2011-2018

With respect to the 56 individual bias estimates (see 2.C.1 in the Appendix Section, the number of those that exceeded an arbitrary threshold of 2 percent ranged from 13 (2012) to 21 (2015) across the years, with more such bias estimates occurring in the later years than in the earlier years. There are particularly large biases for industry groups, establishment foundation year, and indicators of establishment closure in t+1, reaching up to 6.5 percent. Other large biases are observed for the mean age of employees, the share of high-educated employees, and the share of German employees with values up to 5.5 percent (see Appendix Section 2.E.4 for detailed information on individual bias estimates). Similar patterns of bias are also observed for the absolute relative nonresponse bias and additional validation data (see Appendix Section 2.C.2).

2.6.3 Hypotheses of Survey Participation

Table 2.2 presents the results of the four response models used to test the survey participation hypotheses. In addition to odds-ratios, average response propensities are shown to allow readers to assess the effect size of the predictor variables. As the results do not differ systematically between years, only the pooled results (i.e., across all years) are shown. The random intercept model (robustness check), the separate yearly regression results, and a yearly summary are displayed in the Appendix Section 2.D. Compared to the current IAB-JVS response model (Model 1), there are improvements in model fit when the extended set of (static) administrative variables are added to the model (Model 2). However, the additional effects of the developmental variables on model fit (Models 3 and 4) are negligible. The full model (Model 4) explains only little variation in the response outcome (Pseudo - R^2 of 0.025).

Next, we turn to the hypothesis testing results. Table 2.3 provides a short summary of the hypothesis testing results based on the pooled-data analysis and a significance level of 5%. An extended summary table, including operationalization, subhypotheses, and potential effect sizes are shown in the Appendix Table 2.D.2. We expected that establishments with a higher share of new hires (a proxy for job vacancies), an indication of greater topic relevance, would be positively associated with response (H1). The results do not confirm this relationship. Even more, we find that establishments with a higher share of hirings are less likely to respond. However, the second operationalization, which is based on the share of marginal employees, supports the posited hypothesis. Compared to establishments without any marginal employees, those with are more likely to participate. In line with the results of Janik and Kohaut (2012), Earp et al. (2018) and König et al. (2021) establishments with more employees are less likely to participate than those with fewer employees, which supports H2. Older establishments are more likely to respond than younger establishments, supporting hypothesis H3. Relatedly, the interaction effect of establishment age and the average age of employees is not statistically significant, yielding no support for H6.

Regarding the relationship between survey participation and wages, the results do not support hypothesis (H4). Establishments whose median wages belong to the third quartile of the wage distribution are significantly more likely to participate compared to the first quartile, but the fourth quartile is not significantly different from the first quarter. Thus, there is no support for H4.

The three diversity measures, which capture the corporate social responsibility of the establishment, indicate different relationships. While education and sex diversity support the hypothesis that the social responsibility of an establishment is positively associated with response (H5), establishments that are diverse with respect to the nationality of their workforce are less likely to respond. The effect size of these associations is rather small and partly insignificant for some years. Nonetheless, these findings are the first (partial) evidence of a positive effect of corporate social responsibility on establishment survey participation.

The response history variables clearly confirm the posited relationships. There is a strong negative effect of the sampling indicator (H7) on participation, suggesting that establishments who received a survey request in the previous year are less likely to participate in the current year, supporting H7. In addition, there is strong evidence that participation in the previous year is positively associated with response in the current year, lending support to H8.

Turning to the development of the employment structure, the majority of coefficients show no significant association with response, indicating that changes in the establishment within the preceding or subsequent year are unrelated to response (H9). Only the development of nationality diversity in t-1 shows a significant effect, suggesting that development towards lesser diversity is associated with a lower likelihood of response. Thus, there is support for subhypothesis H9.5a. Overall, there is only partial support for the global development hypothesis (H9).

Table 2.2: Logistic Regression Models of Survey Participation (Pooled Results)

	Model 1		Model 2		Model 3		Model 4		
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	RPr
DV: Response									
Num. of Employees (Ref.: 1-9)									18.14
10-19	0.914***	(0.022)	0.924**	(0.024)	0.968	(0.027)	0.964	(0.028)	17.47
20-49	0.854***	(0.018)	0.875***	(0.023)	0.917**	(0.026)	0.913**	(0.027)	16.95
50-249	0.733***	(0.016)	0.766***	(0.025)	0.787***	(0.028)	0.778***	(0.029)	15.14
250-499	0.563***	(0.018)	0.612***	(0.028)	0.600***	(0.029)	0.586***	(0.031)	11.57
500-999	0.487***	(0.019)	0.563***	(0.030)	0.542***	(0.031)	0.527***	(0.032)	10.39
≥1000	0.523***	(0.024)	0.624***	(0.038)	0.587***	(0.038)	0.572***	(0.039)	11.35
Avg. Employees Age (Ref.: 0-39)									13.73
39.00-43.49	1.184***	(0.029)	1.166***	(0.052)	1.153**	(0.052)	1.145**	(0.051)	16.19
43.50-47.99	1.211***	(0.030)	1.130**	(0.051)	1.101*	(0.051)	1.085	(0.050)	17.32
≥48.00	1.271***	(0.031)	1.285***	(0.056)	1.229***	(0.054)	1.207***	(0.054)	18.76
Share of Marginal Employees (Ref.: 0)									15.90
0.00-14.99	1.196***	(0.030)	1.226***	(0.041)	1.222***	(0.048)	1.189***	(0.051)	16.88
≥15	1.053*	(0.022)	1.210***	(0.049)	1.217***	(0.054)	1.192***	(0.056)	16.61
Wage Distribution (Ref.: First Quartile)									15.43
Second Quartile	1.066*	(0.030)	1.038	(0.030)	1.043	(0.030)	1.037	(0.030)	16.68
Third Quartile	1.156***	(0.035)	1.098**	(0.034)	1.099**	(0.034)	1.089**	(0.034)	17.72
Fourth Quartile	1.060	(0.033)	0.998	(0.032)	0.992	(0.032)	0.980	(0.032)	15.88
Missings	1.032	(0.031)	1.114**	(0.039)	1.019	(0.074)	1.142	(0.103)	17.24
Establishment Age			1.009***	(0.002)	1.009***	(0.002)	1.008***	(0.002)	16.34
Employees Age × Establishment Age									†
39.00-43.49 × Establishment Age (continuous)			0.999	(0.002)	0.999	(0.002)	0.999	(0.002)	†
43.50-47.99 × Establishment Age (continuous)			1.001	(0.002)	1.001	(0.002)	1.001	(0.002)	†
≥48.00 × Establishment Age (continuous)			0.996	(0.002)	0.996	(0.002)	0.996	(0.002)	†
Sex Diversity (Ref.: Nondiverse)									16.82
Slightly diverse Establishments			1.021	(0.021)	1.040	(0.024)	1.040	(0.025)	16.34
Diverse Establishment			1.068*	(0.030)	1.082**	(0.033)	1.086**	(0.034)	16.07
Nationality Diversity (Ref.: Nondiverse)									18.75
Diverse			0.868***	(0.020)	0.920**	(0.025)	0.936*	(0.028)	14.01
Education Diversity (Ref.: Low Level of Diversity)									17.56
Medium Level			1.017	(0.023)	1.052*	(0.026)	1.059*	(0.028)	16.82
High Level			1.052	(0.027)	1.086**	(0.031)	1.104***	(0.033)	15.25
Sampled in t-1 (Ref.: not sampled)									17.15
sampled			0.450***	(0.012)	0.450***	(0.012)	0.450***	(0.012)	14.63
Participated in t-1 (Ref.: not participated)									14.90
participated			10.454***	(0.412)	10.428***	(0.412)	10.418***	(0.414)	49.75
Share of New Hirings in t (Ref.: 0-6.25)									19.17
6.26 - 15.37					0.922**	(0.027)	0.919**	(0.027)	16.99
15.38 - 29.51					0.900***	(0.026)	0.908***	(0.026)	15.74
≥29.52					0.868***	(0.025)	0.882***	(0.025)	13.98
Δ_{t-1} *Sex Diversity (Ref.: No Change)*									17.71
Decrease					0.986	(0.026)	0.985	(0.027)	15.93
Increase					0.973	(0.027)	0.977	(0.028)	15.78
Δ_{t-1} *Nationality Diversity (Ref.: No Change)*									17.77
Decrease					0.919**	(0.029)	0.929*	(0.030)	13.84
Increase					0.940	(0.031)	0.955	(0.032)	13.52

	Model 1		Model 2		Model 3		Model 4		
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	RPr
Δ_{t-1} *Education Diversity (Ref.: No Change)*									17.91
Decrease					0.980	(0.028)	0.986	(0.029)	15.97
Increase					0.951	(0.026)	0.953	(0.026)	15.64
Δ_{t-1} *Share of Marginal Employees (Ref.: No Change)*									16.66
Decrease					1.037	(0.035)	1.030	(0.035)	16.24
Increase					1.013	(0.037)	1.012	(0.037)	16.40
Δ_{t-1} *Employees Age (Ref.: Stable Age)*									15.59
More than a half Year older					0.968	(0.025)	0.970	(0.025)	16.82
More than a half Year younger					1.027	(0.029)	1.026	(0.029)	16.62
Δ_{t-1} *Wage Growth (Ref.: No Change)*									17.13
Negative Wage Growth					0.957	(0.029)	0.960	(0.030)	15.85
Positive Wage Growth of up to 5 percent					0.998	(0.029)	0.997	(0.029)	16.69
Positive Wage Growth of more than 5 percent					0.978	(0.028)	0.983	(0.029)	16.11
Wage Missing Value					1.025	(0.071)	1.051	(0.073)	17.02
Share of New Hirings in t+1 (Ref.: 0-5.95)									18.64
5.96 - 14.99							1.035	(0.031)	17.54
15.00 - 27.99							0.962	(0.029)	15.65
≥28.00							0.920^{**}	(0.027)	14.00
Δ_{t+1} *Sex Diversity (Ref.: No Change)*									17.47
Decrease							0.995	(0.028)	15.90
Increase							1.027	(0.028)	16.04
Δ_{t+1} *Nationality Diversity (Ref.: No Change)*									17.75
Decrease							0.960	(0.034)	13.69
Increase							0.987	(0.029)	13.92
Δ_{t+1} *Education Diversity (Ref.: No Change)*									17.71
Decrease							0.971	(0.028)	15.83
Increase							1.022	(0.028)	15.93
Δ_{t+1} *Share of Marginal Employees (Ref.: No Change)*									16.52
Decrease							1.037	(0.036)	16.29
Increase							1.052	(0.035)	16.54
Δ_{t+1} *Employees Age (Ref.: Stable Age)*									15.52
More than a half Year older							1.008	(0.027)	16.94
More than a half Year younger							1.005	(0.029)	16.45
Δ_{t+1} *Wage Growth (Ref.: No Change)*									16.93
Negative Wage Growth							0.992	(0.031)	16.03
Positive Wage Growth of up to 5 percent							1.014	(0.030)	16.68
Positive Wage Growth of more than 5 percent							1.020	(0.030)	16.17
Wage Missing Value							0.839^{**}	(0.054)	16.75
Constant	0.363^{***}	(0.017)	0.249^{***}	(0.018)	0.293^{***}	(0.023)	0.316^{***}	(0.027)	
Observations	636105		636105		636105		636105		
Pseudo R^2	0.013		0.023		0.024		0.025		
AIC	12916940		12788558		12771784		12761739		
BIC	12917475		12789330		12772863		12763125		

Notes: OR = Odds-Ratio; SE=Standard Errror; RPr: Average Response Propensity by Category; †= Average Response Propensity for interaction terms does not provide useful insights.
Control variables: West/East Germany, industry, year, share of unknown educated, share of part-time, share of full-time, share of apprentices, share of regular, share of fixed-term, Δ_{t-1} share of unknown qualification, Δ_{t-1} share of part-time, Δ_{t-1} share of full-time , Δ_{t-1} share of apprentices, Δ_{t-1} share of regular, Δ_{t-1} share of fixed-term, Δ_{t+1} share of unknown educated, Δ_{t+1} share of part-time, Δ_{t+1} share of full-time , Δ_{t+1} share of apprentices, Δ_{t+1} share of regular, Δ_{t+1} share of fixed-term
Data: BHP & IAB-JVS 2011-2018 (pooled)

Table 2.3: Hypotheses and Findings

Hypothesis	**Pooled Result**
H1: The likelihood of participation increases with a higher share of new hires and a higher share of marginal employees.	*mix.*
H2: The likelihood of participation decreases with establishment size.	✓
H3: The likelihood of participation increases with establishment age.	✓
H4: The likelihood of participation decreases with establishment wages.	✗
H5: The likelihood of participation increases with the diversity of the workforce.	*mix.*
H6: The likelihood of participation decreases for younger establishments with a younger workforce, compared to older establishments with an older workforce.	✗
H7: The likelihood of participation decreases if an establishment was sampled in the previous year, compared to an establishment that was not sampled.	✓
H8: The likelihood of participation increases if an establishment participated in the previous year, compared to an establishment that did not participate.	✓
H9: The development of the employment structure affects the likelihood of participation.	(✓)

Notes: Significance Level(α) = 5%

✗= Rejected; ✓= Supported; (✓) = Partially supported; *mix.* = Mixed results;

Partially supported refers to the situation where only one of the hypothesized variables yields a statistically significant result.

Mixed results refers to the case where multiple hypothesized variables yield statistically significant results in both directions.

2.6.4 Evaluation of Nonresponse Bias Adjustments

Lastly, we evaluate the potential of using extensive administrative data and machine learning algorithms to adjust for nonresponse bias. Four bias measures are computed before and after the adjustments: average absolute bias, the number of individual significant biases, the mean squared error and the magnitude of bias in the mean number of new hires in t+1 (a key proxy measure for vacancies in the current survey year).

Figure 2.3 shows the average absolute bias for each year between 2011 and 2018 and for each modeling approach used to estimate propensity score weights. The unadjusted bias value, which is measured with design weights only, is also shown as a reference (Bar 1). The corresponding tables for average and individual biases are displayed in the Appendix Sections 2.E.3 and 2.E.4, respectively.

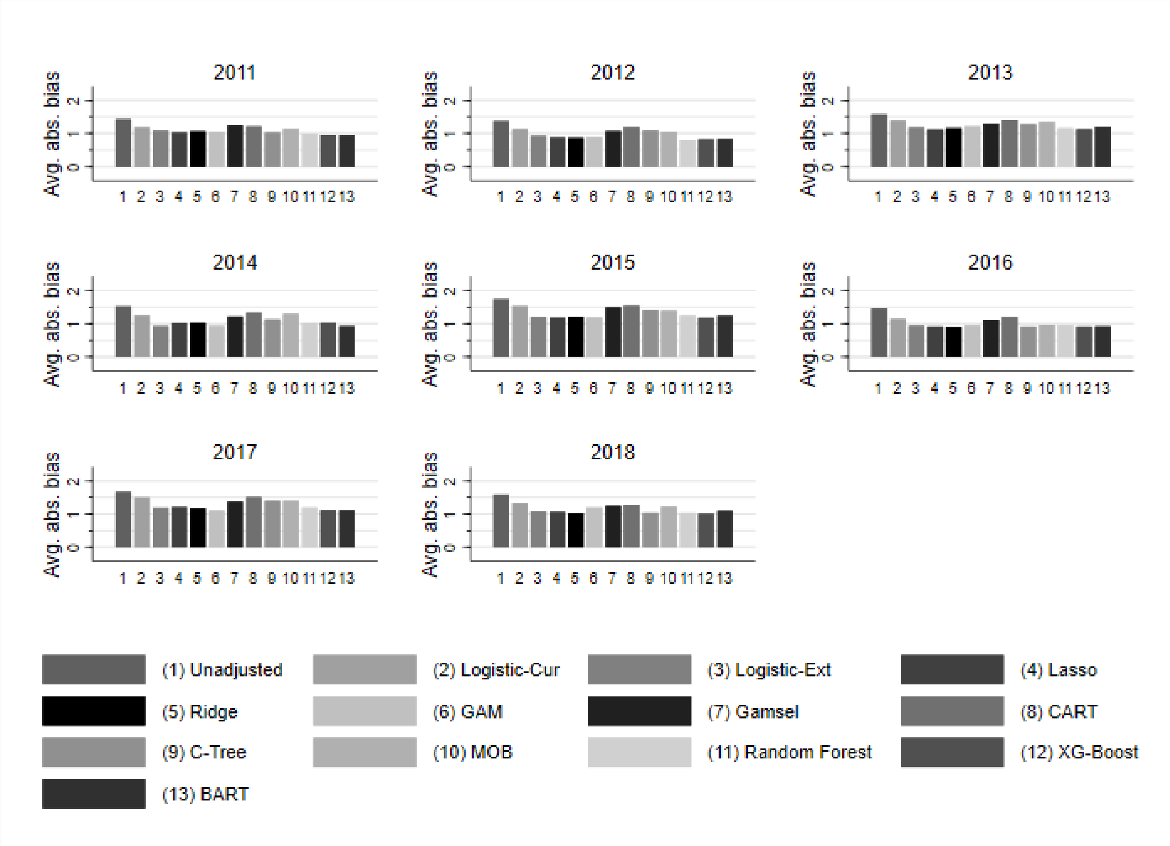


Figure 2.3: Average Absolute Bias by Modeling Approach and Set of Explanatory Variables, BHP 2011-2018

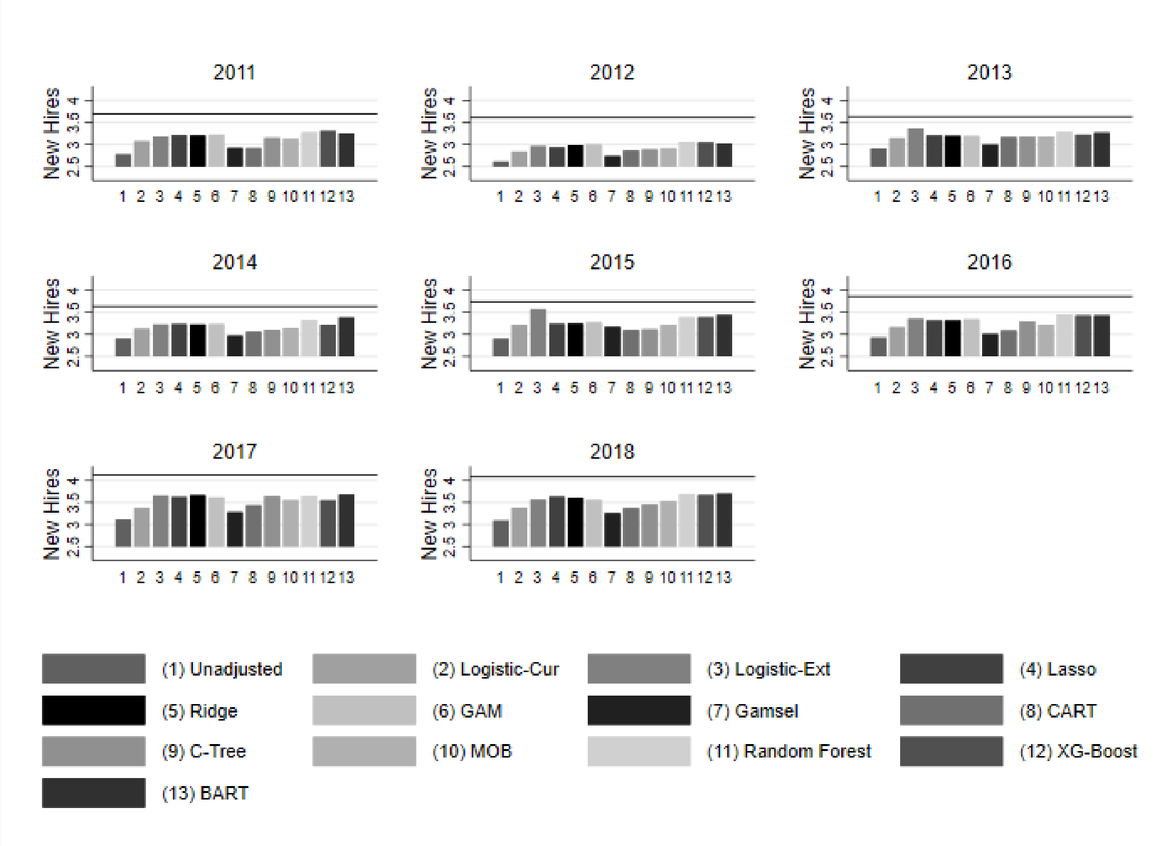
As expected, the inclusion of the extended set of administrative variables (Bar 3) in the traditional logistic regression model improves nonresponse bias reduction in each survey year relative to the current IAB-JVS auxiliary variables (Bar 2). In general, all modeling approaches reduce nonresponse bias for each year. With regard to the machine learning algorithms, random forest (Bar 11), XG-Boost (Bar 12) and the BART (Bar 13) algorithms compete well with traditional logistic regression (Bar 3), with no clear-cut winner among these tree ensemble methods. Lasso (Bar 4), Ridge (Bar 5) and GAM (Bar 6) all perform similar to logistic regression (Bar 3) in all years. Gamsel (Bar 7) performs less well than the other regression approaches. Out of the three single tree methods CART (Bar 8), C-Tree (Bar 9) and MOB (Bar 10), CART model performs worst in terms of bias reduction and C-Tree slightly outperforms MOB. These conclusions hold when comparing absolute relative nonresponse biases and analyzing the validation dataset (see Appendix Section 2.F).

The same patterns are present when analyzing average bias separately for the establishment and employee characteristics (see Appendix Section 2.E.3). That is, the extended set of administrative variables perform better than the current weighting variables in the traditional logistic regression model, and the regression and ensemble tree methods perform better than the single tree methods. These patterns are generally similar for the individual bias estimates (see Appendix Section 2.E.4). However, there are some methods that perform better than others for some variables and years. Such an example is the Random Forest algorithm, which reduces bias in estimates of the number of employees to a greater extent than all other methods (except in year 2017).

Next, the performance of the weighting strategies are compared in terms of their ability to reduce the number of individual statistically significant nonresponse biases. A nonresponse bias is statistically significant if the full sample estimate of the target variable lies outside the confidence interval of the weighted respondent estimate. Standard errors are derived using a linearization-based variance estimator and Wald confidence intervals are used. Stratification effects are accounted for in the variance estimation. Section 2.E.5 in the Appendix shows the number of significant bias estimates by year and by weighting strategy. In the unadjusted scenario, which again serves as the benchmark, between 16 (2012) and 31 (2015) out of 56 bias estimates are significant in each year, resulting in an average of 22.38 across the years. Including only the current set of IAB-JVS auxiliary variables in the standard logistic regression weighting procedure reduces the average number of statistically significant nonresponse biases to 16.38, a reduction of 6 estimates across the years. Including the extended set of administrative variables in the response propensity estimation further reduces this number to 9.38, a reduction of 7 estimates across the years compared to the model with current weighting variables. The XG-Boost algorithm performs best in terms of reducing the average number of significant nonresponse biases (5.88). Lasso (6.00), Ridge (6.63), Random Forest (7.38) and BART (7.75) are the runners-up, followed by standard logistic regression (9.38), C-Tree (9.50) and GAM (10.50). These methods perform better than the other single-tree methods – CART (17.50) and MOB (14.00) – and Gamsel (14.0), with CART being the least performing method.

For a combined assessment of the weighting schemes on nonresponse bias and variance, we also analyze the mean squared error (MSE). The MSE is estimated as the sum of the variance and the squared nonresponse bias estimated under each weighting approach. For a more detailed description and the corresponding tables and figures see Appendix Section 2.H. The results do not differ from the aforementioned metrics and are consistent with the conclusions previously drawn. The extended use of the administrative data leads to a lower MSE, and regression and ensemble-tree methods outperform single-tree methods in reducing MSE.

Lastly, we compare the methods in terms of reducing nonresponse bias in the mean number of establishment new hires in t+1, which is a key proxy for the number of job vacancies in the survey year (see also Appendix Section 2.E.2). As this target variable is not part of the response propensity estimation, the weights are based on all available explanatory variables, without any "leave-one-out" procedure. Figure 2.4 shows the (unadjusted) mean number of new hires in the full sample and the weighted mean new hires for all models used to create the response propensity weights. The tabular values are provided in the Appendix Section 2.E.6. The horizontal reference line represents the full sample estimate. Values below the reference line indicate an underestimation of mean new hires,



Notes: The horizontal line represents the number of new hires in the full sample.

Figure 2.4: Mean Number of New Hires in t+1 by Year and Modeling Approach, BHP 2011-2018

while values above the reference line indicate an overestimation of mean new hires.

All weighted values underestimate mean hirings in t+1. Although there is some variation in the performance of the weighting strategies from year to year, the pattern is fairly consistent and resembles the pattern observed for the previous three bias measures. In particular, the positive impact of including the additional administrative variables in the traditional logistic regression weighting procedure (Bar 3) persists when compared to the using only the current IAB-JVS weighting variables (Bar 2). Turning to the comparison of machine learning methods, logistic regression (Bar 3), Lasso (Bar 4), Ridge (Bar 5), GAM (Bar 6), Random Forest (Bar 11), XG-Boost (Bar 12) and BART (Bar 13) all perform very well in reducing the discrepancy between the weighted and full sample means. In 2015 logistic regression does a remarkably good job and reduces the nonresponse bias almost entirely. The next best performing group of algorithms consists of C-Tree (Bar 9) and MOB (Bar 10). The CART (Bar 8) and Gamsel (Bar 7) algorithms perform the worst, on average. However, all methods reduce the nonresponse bias at least somewhat.

To conclude, the ensemble tree methods (Random Forest, BART, XG-Boost) slightly outperform the traditional logistic regression and general additive regression weighting procedures in some years and for some bias measures. However, logistic regression and the other regression approaches

(Lasso, Ridge, GAM) perform remarkably well and even better than some machine learning algorithms (CART, C-Tree, MOB, GAMSEL).

2.7 Discussion

This article evaluated the use of extensive administrative data and machine learning techniques for analyzing and adjusting for the effects of nonresponse in a large-scale job vacancy survey, i.e., the IAB Job Vacancy Survey (IAB-JVS). The response rate of the IAB-JVS has been declining by about a half percentage point per year since 2010, which is indicative of similar declines in many establishment surveys worldwide. Despite the high level of nonresponse, the average nonresponse bias, calculated across 56 estimates from administrative data, was found to be reassuringly low. However, biases for individual estimates, such as industry or establishment closure in t+1, were more severe.

Exploiting the large administrative data source also permitted testing several hypotheses regarding survey participation and identified many establishment characteristics associated with the response outcome. As expected, smaller and older establishments were more likely to participate than their larger and younger counterparts. Consistent with the literature, the previous-year response history of the establishment explained a lot of the variation in current-year participation. The analysis found only limited support for the notion that year-to-year changes in the employment structure are associated with participation. However, the notion that higher levels of corporate social responsibility, expressed through greater workforce diversity, is positively associated with survey participation was supported, providing the first evidence of such a correlation. There was mixed evidence regarding the relevance of the survey topic for establishments that handle many recruiting processes. While having a greater share of marginal employees was positively associated with participation, having a higher share of new hires had a negative association. This negative effect could be due to HR departments being too occupied with filling vacancies that they cannot afford to allocate time or resources to completing the voluntary survey task, even if the topic is particularly relevant at the time.

To adjust for the aforementioned nonresponse biases in the IAB-JVS, the performance of several machine learning algorithms was compared for generating response propensity weights using the extended administrative data as auxiliary information. Even without using sophisticated data-driven approaches, utilizing the additional administrative data was an improvement over the current weighting variables used in the IAB-JVS standard logistic regression weighting procedure. Further reductions in nonresponse bias were observed in some years for some machine learning methods, namely, Random Forest, BART and XG-Boost. GAM, Lasso and Ridge performed similarly well to the standard logistic regression approach, while all other machine-learning methods (Gamsel, CART, MOB, C-Tree) were inferior to the standard modeling approach. The good performance of the traditional logistic regression approach relative to the majority of the machine learning algorithms might be explained by this particular case study, as there didn't appear to be high-level interactions or higher polynomial functions that explained participation in the IAB-JVS, which may not be the case for other establishment surveys. Additionally this analysis showed that the selection of auxiliary variables seems to be more important than the modeling approach used for creating response propensities, because several approaches produced comparable results. Similar conclusions were also drawn by Rizzo et al. (1996), Brick (2013) and Mercer et al. (2018).

If survey organizations or sponsors are able to access and link large auxiliary data (e.g., administrative data) to their surveys, the present study can serve as a blueprint for utilizing such data for the purposes of analyzing response patterns and estimating and adjusting for nonresponse bias. The information gleaned from these analyses could be used to develop adaptive designs and contact strategies that are tailored towards important subgroups most susceptible to nonresponse (e.g., large establishments) with the goal of reducing nonresponse bias at the design stage. Furthermore, incorporating additional auxiliary data into nonresponse adjustment procedures could improve the effectiveness of nonresponse weights, even without the use of data-driven, machine learning methods. However, in order to take advantage of the full potential of the auxiliary data, we recommend evaluating machine learning methods to optimize bias adjustment. Survey organizations would be best served by evaluating several algorithms and comparing their performance before deciding on a single approach. Further research could assist this decision by analyzing a wide range of methods and comparing their performance under multiple realistic settings, including the setting where only limited auxiliary data are available or when nonresponse bias is very large.

Although we made use of detailed administrative information on both establishment and employee characteristics to analyze nonresponse, these data do not provide information on the internal structure and the internal policies of the establishment. Theoretical and qualitative research suggests that internal factors, such as establishments' data sharing policies and the personal attitudes of the employees involved in the response decision predict survey participation much better than high-level establishment characteristics (e.g., Bavdaž, 2010b; Snijkers et al., 2013; Willimack et al., 2002). Therefore, future research would benefit from identifying ways in which data describing these internal factors could be generated and made available for nonresponse analyses.

In conclusion, this study demonstrated the important roles that large-scale administrative data and data-driven approaches can play in understanding the response behavior of establishments, identifying specific mechanisms of participation, and reducing nonresponse bias in establishment surveys. These tools are especially important at a time when response rates in voluntary surveys are very low and the risk of nonresponse bias is very high. Such tools may also prove useful in identifying subgroups most prone to nonresponse and informing tailored survey designs aimed at increasing their likelihood of participation.

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2.9 Appendix

2.A Data Description

2.A.1 Missing Data

Except for the median wage of employees per establishment, the administrative data have no missing values on the item level. The median wage is constructed by using the median wage of full-time employees per establishment. Since not every establishment has at least one full-time employee, a median cannot be computed for establishments with only part-time and marginal employees. This is the case for about 5-8 percent of establishments each year. In order not to lose these establishments in the analysis, we form an extra category for firms with missing wage information.

2.A.2 Description of Variables

This section describes the construction and categorization of each variable. For some variables we used different transformations and categorizations for the hypothesis testing and bias analysis. In general the variables used for the bias analysis are categorized into equally-sized categories. Table 2.A.1 provides an overview about the categorizations used and the corresponding descriptive statistics of all categorical variables and Table 2.A.2 summarizes the continuous variables used for the response propensity estimation.

Region

To control for regional differences, we use the same dichotomous variable as in the stratification procedure which differs between East and West Germany. This variable is based on the BHP variable *ao_bula*, which captures the federal states of Germany. The division of the federal states was aligned with the division of Germany before 1990.

Industrial Sectors

The categorization of the industrial sector is based on the BHP variable *w08_3*, which identifies the economic activity based on a 3-digit code. For hypothesis testing, we used the same aggregation of *w08_3* to 24 independent economic sectors as used for sampling stratification. For the comparison of nonresponse bias we aggregated them, resulting in the three categories "Agriculture/Production", "Service" and "Public Administration, Education, Health and Arts".

Establishment Size

We measure establishment size by the number of employees working in an establishment, independent of their working hours. The BHP variable *az_ges* reflects that information. As with the sample stratification, we use a categorical variable with seven values for RO3: less then 10, between 10 and 19, between 20 and 49, between 50 and 249, between 250-499, between 500-999 and at least 1000 employees. For the bias analysis we use a variable with four categories: less then 10 employees, between 10 and 19 employees, between 20 and 49 employees, and at least 50 employees.

Sampled

This indicator reflects, whether the establishment was sampled for the IAB-JVS in the previous year as well.

Participated

This indicator reflects, whether the establishment participated in the IAB-JVS in the previous year. Nonsampled establishments are grouped into the nonparticipated category.

Establishment Closure in t+1

The BHP enables us to detect if the establishments exist in the year after the survey. This is measured by the fact that it has at least one employee in the year after the survey.

Establishment Foundation in t-1

Analogous to establishment closures, it is possible to measure if the establishment is founded in the survey year. That's the case if the establishment has no employees subject to social security in the year prior to the survey year.

Establishment Age

To construct the age of the establishment we deduct the foundation year (BHP Variable: *grd_dat*) from the survey year. As the BHP does not contain any information before 1975, the establishment age is censored for older establishments. To address research objective 3, establishment age is implemented as a continuous variable.

Founding Decade of the Establishment

Nonresponse Bias is measured by comparing establishments that are founded in the 1970s/80s with establishments founded in the 1990s or 2000s. This categorization is based on the foundation year of the establishment. This categorized variable is also based on the BHP variable *grd_dat*.

New Hires

New hires can be viewed as a proxy for the number of vacancies. Therefore, it is very valuable that the BHP contains a variable (*ein_ges*) that counts the number of employees who were working in the establishment on the reference date in t+1 but were not working on the reference date in t. We construct the share of hiring, measured as the number of new hires compared to the number of employees in t. The share of new hires in t are constructed analogously. Both hiring measures are grouped into four equally-sized categories to test hypotheses with respect to survey participation (RO3).

Wage of Employees

The BHP offers different wage information. For this study the median wage per establishment (*te_imp_med*) is used, where censored wages above the limit for social security contributions are imputed. The median is less affected by outliers and the use of the imputation procedure provides a better picture for the establishment as a whole. Unfortunately the wage information is only available for establishments with at least one full-time employee. All establishments without any full-time employees are grouped into a missing category. To have comparable results between the years and be robust to inflation, we created indicators that assign each establishment each year to a quarter of the wage distribution of the population. This indicator is used for the bias analysis and the adjustment models. In order to take the wage growth into account for RO3 we constructed a variable with 5 categories. The categories are negative wage growth up to 1 percent, no substantial wage growth between -1 and 1 percent, positive wage growth up to 5 percent, positive wage growth more than 5 percent and the missing category for establishments without any full-time employees in at least one of both points.

Marginal Employment

Based on the BHP variable *az_gf*, the share of marginal employees in relation to the total number of employees is generated. The categorized variable classifies establishments into the following categories: Without marginal employees, below 15 percent of marginal employees and more than 15 percent of marginal employees.

Fixed-Term Employees

Since 2011 the BHP variable *az_bfr* captures the number of fixed-term employees and is used to generate the share of fixed-term employees in relation to the total number of employees. Similar to the share of marginal employees this variable is split into three categories: 0 percent, 1-15 percent, and more than 16 percent of employees with a fixed-term contract.

Education of Employees

The BHP distinguishes three education levels of employees: high-educated, middle-educated, and low-educated. The share of employees with the corresponding education level is calculated for each establishment, which are used for the bias analysis (RO2, RO4). The share of high-educated employees is grouped into establishments with 0 percent of high-educated employees, between 0.01 - 14.99 percent of high-educated employees and more than 15.00 percent of high-educated employees. The categorized variable of middle-educated employees consists out of the following groups: 0-55.25 percent of middle-educated employees, 55.26-74.99 percent of middle-educated employees, 75.00-88.88 percent of middle educated employees and more than 88.89 percent of middle-educated employees. Finally, establishments are grouped into the following categories with respect to low-educated employees: 0 percent of low-educated employees, between 0.01 - 11.99 percent of low-educated employees and more than 12.00 percent of low-educated employees.

Employees with an Unknown Education

Next to the three education levels, one can also compute the number of employees without information on their educational level. Analogous to the previously described variables, the share is calculated and divided into – in this case – two categories: 0 percent of employees with an unknown education level, and 0.01 percent or more with an unknown education level.

Education Diversity

For RO3, we construct a diversity measure for educational levels, which reflects a heterogeneous workforce consisting of employees from all educational levels. For this reason we computed a normalized entropy measure with the following formula:

$$Education.Div. = \frac{low.educ*log(low.educ)+mid.educ*log(mid.educ)+high.educ*log(high.educ)}{log(3)} \tag{2.8}$$

Accordingly, a highly diverse establishment with the same number of employees from each educational level receives a value of 1. In contrast, establishments with a homogeneous workforce reflecting only one educational level receive a value of zero. This variable is divided into three categories: Establishments with a high level of diversity (values above 0.7), medium level of diversity (between 0.7 and 0.4) and low level of diversity (below 0.4).

Nationality of Employees

The BHP variable *az_d* enables us to distinguish between German employees and non-German employees. As for the other employee characteristics, we use the share of German employees among all employees. For RO2 and RO4 we construct a bivariate variable reflecting establishments with 100.00 percent of German employees and establishment with less than 100.00 percent of German employees.

Nationality Diversity

To test our hypotheses about diversity and survey participation, we construct an additional nationality diversity measure. We define the highest diversity achieved if an establishment employs 50 percent Germans and 50 percent non-Germans. Any deviation from this optimal point represents lower diversity. The largest deviation is present in companies that employ only Germans or only non-Germans. Since the underlying variable is highly skewed, we define only 2 categories: Establishments with a homogeneous workforce (100 percent German employees or 100 percent non-German employees) and with a more heterogeneous workforce.

Sex of Employees

The share of female employees, constructed from the BHP variable *az_f*, is split into 4 equally-sized categories to measure nonresponse bias: 0-18.75 percent of female employees, 18.76 - 44.43 percent of female employees, 44.44 - 71.41 percent of female employees and more than 71.42 percent of female employees.

Sex Diversity

With respect to RO3 an additional diversity measure is constructed. All establishments with a share of 40%-50% men or women are labeled as diverse establishments, establishments with a share of men or women ranging between 40%-15% men or women are grouped into the slightly diverse category and establishments with less than 15% men or women form the nondiverse category.

Age of the Employees

The mean age of employees (BHP variable :*alter_mw*) are categorized into four equal sized groups: 0-38.99 years; 39.00-34.49 years; 43.50-47.99 years; ≥48.00 years.

Change variables

The change variables for the employment characteristics share of regular employees, share of fixed-term employees, share of apprentices, share of full-time employees, share of part-time employees, share of unknown qualified, share of marginal employees are split into three categories: Stable (change less than 2 percent), Increase (change more than 2 percent), Decrease (change more than 2 percent). Change of the average age of employees is grouped into the following three categories: Stable age (less than a half year older or younger), older (more than a half year older), younger (more than a half year younger). The three diversity measures are also grouped into three categories: Stable means a change of less than 2 percent, an increase is more than 2 percent to the optimal diversity spot, and a decrease is more than 2 percent away from the optimal diversity spot.

Table 2.A.1: Descriptive Statistics - Categorized Variables, BHP

Variable	**Bias Analysis (RO2, RO4)**				**Hypotheses Testing (RO3)**			
	Categories	Obs	Proportion	Std. Error	Categories	Obs	Proportion	Std. Error
Region	East Germany	289,299	42.85	0.06	East Germany	289,299	42.85	0.06
	West Germany	385,839	57.15	0.06	West Germany	385,839	57.15	0.06
Establishment Size	1-9	181,737	26.92	0.05	1-9	181,737	26.92	0.05
	10-19	148,342	21.97	0.05	10-19	175,207	22.44	0.05
	20-49	160,462	23.77	0.05	20-49	184,791	23.67	0.05
	≥50	184,597	27.34	0.05	50-249	120,756	17.89	0.05
					250-499	35,040	5.19	0.03
					500-999	18,790	2.78	0.02
					≥1000	10,011	1.48	0.01
Industry	Agriculture / Production	229,288	33.96	0.06	Agriculture / Forestry	18,002	2.67	0.02
	Services	229,962	34.06	0.06	Mining / Ores / Earths	11,144	1.65	0.02
	Public/Education/Health/Arts	215,883	31.98	0.06	Nutrition / Textiles / Clothing / Furniture etc.	29,197	4.32	0.02
					Wood / Paper / Printing	25,150	3.73	0.02
					Chemistry / Plastics / Glass / Construction Materials	27,460	4.07	0.02
					Metals / Metal Production	26,549	3.93	0.02
					Machines / Electronics / Vehicles	28,951	4.29	0.02
					Energy Utilities	20,702	3.07	0.02
					Water / Waste Management	18,826	2.79	0.02
					Construction	23,307	3.45	0.02
					Trade / Retail / Repairs	40,830	6.05	0.03
					Transport/ Warehouses	29,004	4.30	0.02
					Hospitality	37,054	5.49	0.03
					Information and Communication	37,471	5.55	0.03
					Financial Services / Insurance	34,730	5.14	0.03
					Real Estate	21,994	3.26	0.02
					Liberal Professions / Scientific / Technical Services	28,879	4.28	0.02
					Other Commercial Services/ without Temporary Employment	28,022	4.15	0.02
					Temporary Employment Agencies	22,613	3.35	0.02
					Public Administration	33,102	4.90	0.03
					Education / Child care	34,976	5.18	0.03
					Health / Social Services	38,130	5.65	0.03
					Art / Entertainment / Recreation	29,129	4.31	0.02
					Other services	29,911	4.43	0.03
Founding Decade of the Establishment	70s/80s	165,191	24.47	0.05				
	90s	215,918	31.98	0.06				
	00s/10s	294,029	43.55	0.06				
Share of New Hirings in t					0.00% - 5.95%	160,629	24.80	0.05
					5.96% - 14.99%	161,648	24.95	0.05
					15.00% - 27.99%	162,998	25.16	0.05
					≥28.00%	162,536	25.09	0.05
Share of Apprentices	0.00%	434,131	64.30	0.06	0.00%	434,131	64.30	0.06
	≥0.01%	241,007	35.70	0.06	≥0.01%	241,007	35.70	0.06
Average Age of Employees	0.00 - 38.99	173,979	25.77	0.05	0.00 - 38.99	173,979	25.77	0.05
	39.00 - 43.49	169,800	25.15	0.05	39.00 - 43.49	169,800	25.15	0.05
	43.50 - 47.99	177,343	26.27	0.05	43.50 - 47.99	177,343	26.27	0.05
	≥48.00	154,016	22.81	0.05	≥48.00	154,016	22.81	0.05
Share of Fixed-Term Employees	0%	267,555	39.63	0.06	0%	267,555	39.63	0.06
	1-15%	208,422	30.87	0.06	1-15%	208,422	30.87	0.06
	≥16%	199,161	29.50	0.06	≥16%	199,161	29.50	0.06

Variable	**Bias Analysis (RO2, RO4)**				**Hypotheses Testing (RO3)**			
	Categories	Obs	Proportion	Std. Error	Categories	Obs	Proportion	Std. Error
Share of German Employees	100%	351,687	52.09	0.06				
	0-99%	323,451	47.91	0.06				
Nationality Diversity					Diverse	317,313	47.00	0.06
					Completely not Diverse	357,825	53.00	0.06
Share of Female Employees	0.00% - 18.75%	170,070	25.19	0.05				
	18.76% - 44.34%	165,411	24.50	0.05				
	44.44% - 71.41%	169,366	25.09	0.05				
	≥71.42%	170,291	25.22	0.05				
Sex Diversity					Nondiverse Establishment	232,819	34.48	0.06
					Slightly Diverse Establishment	324,254	48.03	0.06
					Diverse Establishment	118,065	17.49	0.05
Share of High-Educated Employees	0.00%	204,793	30.33	0.06				
	0.01% - 14.99%	234,294	34.70	0.06				
	≥15.0	236,051	34.96	0.06				
Share of Mid-Educated Employees	0.00% - 55.25%	166,952	24.73	0.05				
	55.26% - 74.99%	155,098	22.97	0.05				
	75.00% - 88.88%	179,308	26.56	0.05				
	≥88.89	173,780	25.74	0.05				
Share of Low-Educated Employees	0.00%	248,481	36.80	0.06				
	0.01% - 11.99%	228,972	33.91	0.06				
	≥12.00	197,685	29.28	0.06				
Share of Unknown-Educated Employees	0.00%	453,682	67.20	0.06	0.00%	453,682	67.20	0.06
	> 0.00%	221,456	32.80	0.06	> 0.00%	221,456	32.80	0.06
Education Diversity					High Level	239,558	35.48	0.06
					Medium Level	242,185	35.87	0.06
					Low Level	193,395	28.65	0.06
Share of Regular Employees	0.00% - 71.24%	166,017	24.59	0.05	0.00% - 71.24%	166,017	24.59	0.05
	71.25% - 87.49%	165,131	24.46	0.05	71.25% - 87.49%	165,131	24.46	0.05
	87.50% - 96.90%	173,299	25.67	0.05	87.50% - 96.90%	173,299	25.67	0.05
	≥96.61	170,691	25.28	0.05	≥96.61	170,691	25.28	0.05
Share of Full-Time Employees	0.00% - 37.14%	169,507	25.11	0.05	0.00% - 37.14%	169,507	25.11	0.05
	37.15% - 66.66%	158,540	23.48	0.05	37.15% - 66.66%	158,540	23.48	0.05
	66.67% - 86.04%	178,494	26.44	0.05	66.67% - 86.04%	178,494	26.44	0.05
	≥86.05	168,597	24.97	0.05	≥86.05	168,597	24.97	0.05
Share of Part-Time Employees	0.00%	155,581	23.04	0.05	0.00%	155,581	23.04	0.05
	0.01% - 19.99%	257,453	38.13	0.06	0.01% - 19.99%	257,453	38.13	0.06
	≥20.00	262,104	38.82	0.06	≥20.00	262,104	38.82	0.06
Share of Marginal Employees	0.00%	242,546	35.93	0.06	0.00%	242,546	35.93	0.06
	0.01% - 14.99%	221,748	32.84	0.06	0.01% - 14.99%	221,748	32.84	0.06
	≥15.00	210,844	31.23	0.06	≥15.00	210,844	31.23	0.06
Quartiles of Wage Distribution	First Quartile	102,253	15.15	0.04	First Quartile	102,253	15.15	0.04
	Second Quartile	134,772	19.96	0.05	Second Quartile	134,772	19.96	0.05
	Third Quartile	138,767	20.55	0.05	Third Quartile	138,767	20.55	0.05
	Fourth Quartile	246,268	36.48	0.06	Fourth Quartile	246,268	36.48	0.06
	Missings	53,078	7.86	0.03	Missings	53,078	7.86	0.03
Sampled in the Previous Year					Not Sampled	493,656	73.12	0.05
					Sampled	181,482	26.88	0.05
Participated in the Previous Year					Not Participated	646,066	95.69	0.02
					Participated	29,072	4.31	0.02
Establishment Closed in Following Year	No Closure	647,811	95.95	0.02	No Closure	647,811	95.95	0.02
	Closure	27,327	4.05	0.02	Closure	27,327	4.05	0.02
Establishment Founded in Previous Year	Not Founded	663,823	98.32	0.02	Not Founded	663,823	98.32	0.02
	Founded	11,315	1.68	0.02	Founded	11,315	1.68	0.02

Variable	Bias Analysis (RO2, RO4)				Hypotheses Testing (RO3)			
	Categories	Obs	Proportion	Std. Error	Categories	Obs	Proportion	Std. Error
Share of New Hirings in t-1					0.00% - 6.25%	168,637	25.40	0.05
					6.26% - 15.38%	160,253	24.14	0.05
					15.39% - 29.51%	169,438	25.52	0.05
					≥29.52	165,495	24.93	0.05
Δ_{t-1} Share of Apprentices					No Change	399,593	62.58	0.06
					Decrease	123,920	19.41	0.05
					Increase	114,982	18.01	0.05
Δ_{t-1} Share of Full-Time Employees					No Change	236,495	37.04	0.06
					Decrease	209,458	32.80	0.06
					Increase	192,542	30.16	0.06
Δ_{t-1} Share of Part-Time Employees					No Change	210,003	32.89	0.06
					Decrease	182,650	28.61	0.06
					Increase	245,842	38.50	0.06
Δ_{t-1} Share of Regular Employees					No Change	297,585	46.61	0.06
					Decrease	155,267	24.32	0.05
					Increase	185,643	29.08	0.06
Δ_{t-1} Share of Fixed-Term Employees					No Change	216,142	38.02	0.06
					Decrease	136,653	24.03	0.06
					Increase	215,775	37.95	0.06
Δ_{t-1} Share of Unknown Educated Employees					No Change	425,748	66.68	0.06
					Decrease	92,172	14.44	0.04
					Increase	120,575	18.88	0.05
Δ_{t-1} Share of Marginal Employees					No Change	251,870	39.45	0.06
					Decrease	205,685	32.21	0.06
					Increase	180,940	28.34	0.06
Δ_{t-1} Nationality Diversity					No Change	434,913	68.12	0.06
					Decrease	83,919	13.14	0.05
					Increase	119,663	18.74	0.05
Δ_{t-1} Sex Diversity					No Change	206,481	32.34	0.06
					Decrease	212,398	33.27	0.06
					Increase	219,616	34.40	0.06
Δ_{t-1} Education Diversity					No Change	194,715	30.59	0.06
					Decrease	226,936	35.65	0.06
					Increase	214,894	33.76	0.06
Δ_{t-1} Wage Growth					Negative Wage Growth	128,859	20.18	0.05
					No Wage Growth	92,699	14.52	0.04
					Positive Wage Growth of up to 5 percent	189,475	29.68	0.05
					Positive Wage Growth of more than 5 percent	176,843	27.70	0.06
					Wage Missing Value	50,619	7.93	0.03
Δ_{t-1} Employees Age					Stable Age	164,119	25.70	0.05
					A half Year older	316,195	49.52	0.06
					A half Year younger	158,181	24.77	0.05
Δ_{t+1} Share of Apprentices					No Change	400,976	62.80	0.06
					Decrease	122,489	19.18	0.05
					Increase	115,030	18.02	0.05
Δ_{t+1} Share of Full-Time Employees					No Change	241,272	37.79	0.06
					Decrease	204,997	32.11	0.06
					Increase	192,226	30.11	0.06
Δ_{t+1} Share of Part-Time Employees					No Change	209,634	32.83	0.06
					Decrease	189,779	29.72	0.06
					Increase	239,082	37.44	0.06

Variable	Bias Analysis (RO2, RO4)				Hypotheses Testing (RO3)			
	Categories	Obs	Proportion	Std. Error	Categories	Obs	Proportion	Std. Error
Δ_{t+1} Share of Regular Employees					No Change	301,321	47.19	0.06
					Decrease	157,624	24.69	0.05
					Increase	179,550	28.12	0.06
Δ_{t+1} Share of Fixed-Term Employees					No Change	242,867	38.04	0.06
					Decrease	161,009	25.22	0.05
					Increase	234,619	36.75	0.06
Δ_{t+1} Share of Unknown Educated Employees					No Change	415,937	65.14	0.06
					Decrease	93,979	14.72	0.04
					Increase	128,579	20.14	0.05
Δ_{t+1} Share of Marginal Employees					No Change	253,771	39.75	0.06
					Decrease	201,171	31.51	0.06
					Increase	183,553	28.75	0.06
Δ_{t+1} Nationality Diversity					No Change	427,735	66.99	0.06
					Decrease	87,310	13.67	0.04
					Increase	123,450	19.33	0.05
Δ_{t+1} Sex Diversity					No Change	205,741	32.22	0.06
					Decrease	213,513	33.44	0.06
					Increase	219,241	34.34	0.06
Δ_{t+1} Education Diversity					No Change	197,638	31.05	0.06
					Decrease	214,896	33.76	0.06
					Increase	223,966	35.19	0.06
Δ_{t+1} Wage Growth					Negative Wage Growth	125,705	19.69	0.05
					No Wage Growth	91,229	14.29	0.04
					Positive Wage Growth of up to 5 percent	192,387	30.13	0.06
					Positive Wage Growth of more than 5 percent	176,664	27.67	0.06
					Wage Missing Value	52,510	8.22	0.03
Δ_{t+1} Employees Age					Stable Age	164,050	25.69	0.05
					A half Year older	316,959	49.64	0.06
					A half Year younger	157,486	24.67	0.05

Note: Years, 2011-2018 of the BHP; Change variables are reported only for establishments with administrative data in the subsequent and the previous year.

Table 2.A.2: Descriptive Statistics - Continuous Variables, BHP

	Full Sample			
	mean	sd	min	max
Number of Employees	98.86	407.44	1.00	65,308.00
Establishment Age	18.98	12.44	0.00	43.00
Average Age of Employees	43.13	7.09	15.00	90.00
Share of German Employees	0.92	0.17	0.00	1.00
Share of Regular Employees	0.81	0.22	0.00	1.00
Share of Part-Time Employees	0.22	0.26	0.00	1.00
Share of Full-Time Employees	0.60	0.31	0.00	1.00
Share of Employees on Fixed-Term Contracts	0.14	0.20	0.00	1.00
Share of High-Educated Employees	0.17	0.23	0.00	1.00
Share of Mid-Educated Employees	0.70	0.26	0.00	1.00
Share of Low-Educated Employees	0.10	0.14	0.00	1.00
Share of Employees with an Unknown Education	0.04	0.11	0.00	1.00
Share of Marginal Employees	0.14	0.20	0.00	1.00
Share of Female Employees	0.46	0.31	0.00	1.00
Share of Apprentices	0.03	0.08	0.00	1.00
N	800,671			

2.B Response Rate

Table 2.B.1: Design Weighted and Unweighted Response Rates by Year, IAB-JVS 2010-2019

Response Rate	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Design Weighted Response Rate	18.87	20.37	17.88	18.22	16.56	15.67	13.88	13.87	14.04	14.65
Unweighted Response Rate	19.69	19.69	17.64	18.14	16.58	15.01	13.61	13.28	13.20	12.64
Field Report - Response Rate	20.20	20.30	18.40	18.60	17.00	15.40	13.60	13.30	13.20	12.60

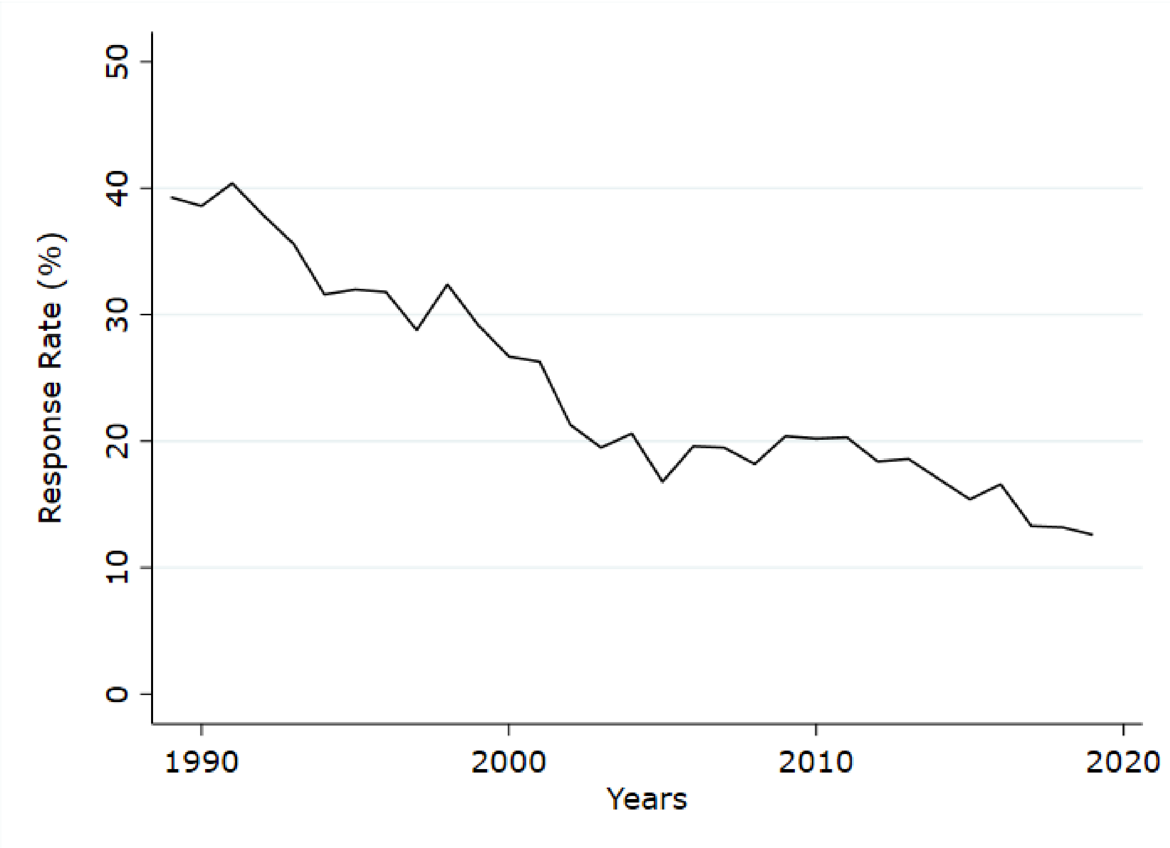

Figure 2.B.1: Unweighted Reponse Rate, Field Reports 1989-2019

2.C Nonresponse Bias

2.C.1 BHP

Table 2.C.1: Number of Individual Nonresponse Bias Estimates Exceeding 2 Percent by Year, BHP 2011-2018

	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
≥ 2 percent	14	13	17	17	21	15	17	17
< 2 percent	42	43	39	39	35	41	39	39
Total	56	56	56	56	56	56	56	56

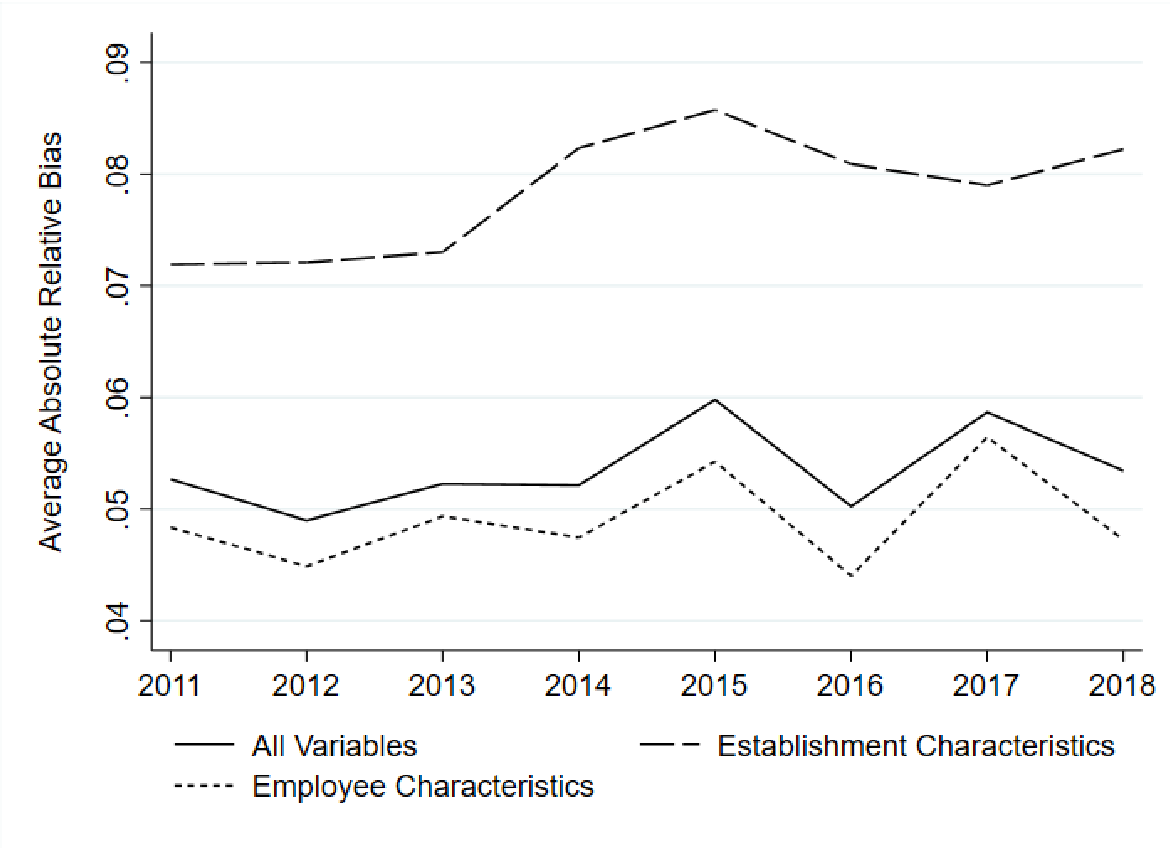

Figure 2.C.1: Average Absolute Relative Bias Across All Administrative Variables, Establishment Characteristics and Employee Characteristics, BHP 2011-2018

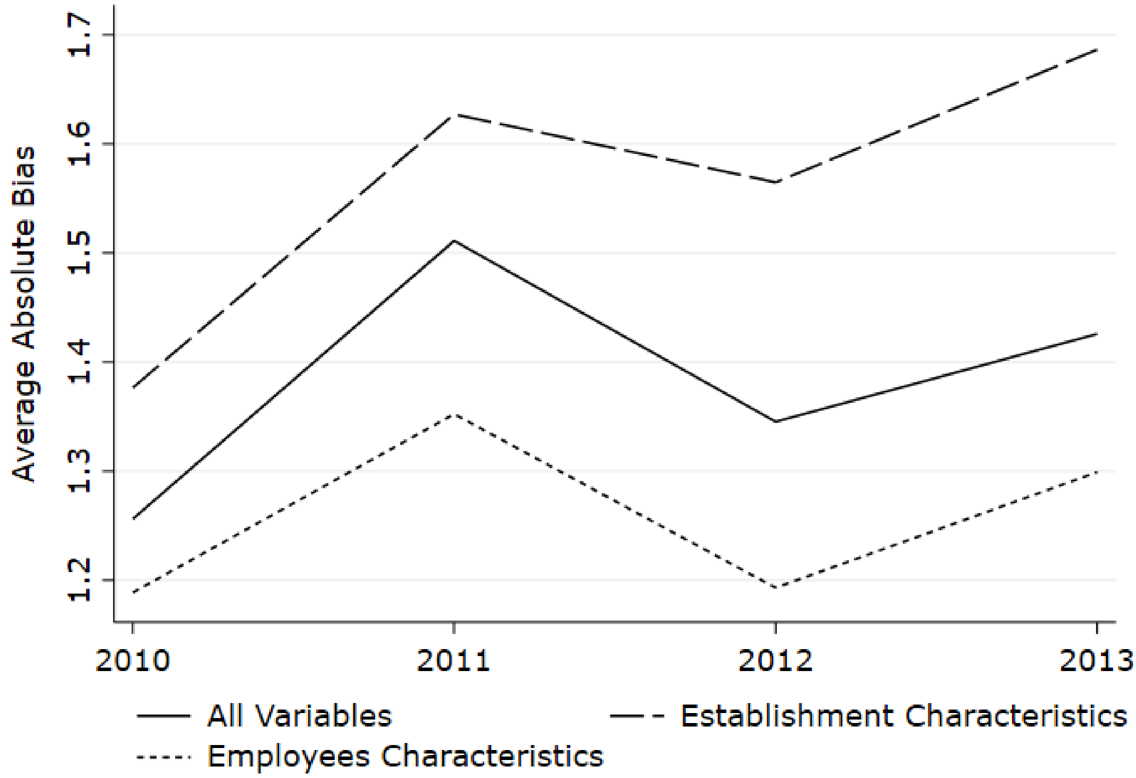

Figure 2.C.2: Average Absolute Bias Across All Administrative Variables, Establishment Characteristics and Employee Characteristics, AWFP 2010-2013

2.C.2 AWFP (Validation Data Set)

Table 2.C.2: Number of Individual Nonresponse Bias Estimates Exceeding 2 Percent by Year, AWFP 2010-2013

	2010	**2011**	**2012**	**2013**
≥ 2 percent	10	16	13	14
< 2 percent	50	44	47	46
Total	60	60	60	60

2.D Hypotheses Testing

2.D.1 Formulas

Model 1: The current IAB-JVS logistic-regression model for estimating response propensities:

$$logit(R_{k,t}) = \alpha + \beta_1 \mathbf{x}_{1,k,t}^{\top} + \gamma_1 \mathbf{z}_{1,k,t}^{\top} \tag{2.9}$$

where $R_{k,t}$ is the response indicator for the k-th establishment ($R_k = 1$ = response, $R_k = 0$ = nonresponse) in year t,

$\mathbf{x}_1$ includes the following variables: Establishment Size, Employees Age, share of Marginal Employees, Employees Wage

and $\mathbf{z}_1$ includes the following variables: Industry, Region, Share of Part-Time Employees, Share of Full-Time Employees, Share of Apprentices, Share of Regular Employees, Share of Employees with an Unknown Education, Year.

Model 2: Extended response model with static variables:

$$logit(R_{k,t}) = \alpha + \beta_1 \mathbf{x}_{1,k,t}^{\top} + \beta_2 \mathbf{x}_{2,k,t}^{\top} + \gamma_1 \mathbf{z}_{1,k,t}^{\top} \tag{2.10}$$

where $\mathbf{x}_2$ includes the following variables: Establishment Age, Education Diversity, Sex Diversity, Nationality Diversity, Interaction term between Employee Age and Establishment Age, Sampled Indicator, Participated Indicator.

Model 3: Extended response model with static variables and previous-year change variables

$$logit(R_{k,t}) = \alpha + \beta_1 \mathbf{x}_{1,k,t}^{\top} + \beta_2 \mathbf{x}_{2,k,t}^{\top} + \beta_3 \mathbf{x}_{3,k,t-1}^{\top} + \gamma_1 \mathbf{z}_{1,k,t}^{\top} + \gamma_2 \mathbf{z}_{2,k,t-1}^{\top} \tag{2.11}$$

where $\mathbf{x}_3$ includes the following variables: Δ_{t-1} Share of Marginal Employees, Δ_{t-1} Education Diversity, Δ_{t-1} Sex Diversity, Δ_{t-1} Nationality Diversity, Δ_{t-1} Wage Growth, Δ_{t-1} Average Employees' Age, New Hires between t-1 and t

and $\mathbf{z}_2$ includes the following variables: Δ_{t-1} Share of Part-Time Employees, Δ_{t-1} Share of

Full-Time Employees, Δ_{t-1} Share of Apprentices, Δ_{t-1} Share of Regular Employees, Δ_{t-1} Share of Employees with Unknown Education.

Model 4: Extended response model analysis with static variables and previous- and subsequent-year change variables

$$logit(R_{k,t}) = \alpha + \beta_1 \mathbf{x}_{1,k,t}^{\top} + \beta_2 \mathbf{x}_{2,k,t}^{\top} + \beta_3 \mathbf{x}_{3,k,t-1}^{\top} + \beta_4 \mathbf{x}_{4,k,t+1}^{\top} + \gamma_1 \mathbf{z}_{1,k,t}^{\top} + \gamma_2 \mathbf{z}_{2,k,t-1}^{\top} + \gamma_3 \mathbf{z}_{3,k,t+1}^{\top} \quad (2.12)$$

where $\mathbf{x}_4$ includes the following variables: Δ_{t+1} Share of Marginal Employees, Δ_{t+1} Education Diversity, Δ_{t+1} Sex Diversity, Δ_{t+1} Nationality Diversity, Δ_{t+1} Wage Growth, Δ_{t+1} Average Employees' Age, New Hires between t and t+1.

and $\mathbf{z}_3$ includes the following variables: Δ_{t+1} Share of Part-Time Employees, Δ_{t+1} Share of Full-Time Employees, Δ_{t+1} Share of Apprentices, Δ_{t+1} Share of Regular Employees, Δ_{t+1} Share of Employees with Unknown Education.

Table 2.D.1: Hypotheses and Findings

Hypothesis	**Pooled**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
H1	*mix.*	✗	✗	✗	✗	*mix.*	(✓)	✗	*mix.*
H2	✓	✓	✓	✓	✓	✓	✓	✓	✓
H3	✓	✗	✗	✓	✗	✓	✗	✓	✓
H4	✗	✓	✗	✗	✗	✗	✗	✗	✗
H5	*mix.*	✗	✗	✗	(✓)	✗	✗	✗	✗
H6	✗	✗	✗	✗	✗	✓	✗	✗	✗
H7	✓	✓	✓	✓	✓	✓	✓	✓	✓
H8	✓	✓	✓	✓	✓	✓	✓	✓	✓
H9	(✓)	(✓)	✗	✗	(✓)	✗	(✓)	(✓)	(✓)

Notes: ✗ =Rejected; ✓ = Supported; (✓) = Partially supported; *mix.* = Mixed results

Partially supported refers to the situation where only one of the hypothesized variables yields a statistically significant result.

Mixed results refers to the case where multiple hypothesized variables yield statistically significant results in both directions.

Table 2.D.2: Hypotheses and Findings

Hypothesis	**Effect Range (Min-Max)**	**Significance**
H1: The likelihood of participation increases with a higher share of new hires and a higher share of marginal employees.	*mixed*	
- Hirings	0.882 - 0.919	✓
- Share of Marginal Employees	1.189 - 1.192	✓
H2: The likelihood of participation decreases with establishment size.	0.527 - 0.964	✓
H3: The likelihood of participation increases with establishment age.	1.008	✓
H4: The likelihood of participation decreases with establishment wages.	0.980 - 1.089	✓
H5: The likelihood of participation increases with the diversity of the workforce.	*mixed*	
- Sex Diversity	1.040 - 1.086	✓
- Nationality Diversity	0.936	✓
- Education Diversity	1.059 - 1.104	✓
H6: The likelihood of participation decreases for younger establishments with a younger workforce, compared to older establishments with an older workforce.	0.999 - 1.001	✗
H7: The likelihood of participation decreases if an establishment was sampled in the previous year compared to an establishment that was not sampled.	0.450	✓
H8: The likelihood of participation increases if an establishment participated in the previous year compared to an establishment that did not participate.	10.418	✓
H9: The development of the employment structure affects the likelihood of participation.		(✓)
• H9.1a: The likelihood of participation increases if the share of new hires and the share of marginal employees increased from the year before the survey to the survey year, compared to no change or a decreasing share of new hires and marginal employees.		✗
- Hirings	–	–
- Share of Marginal Employees	1.012 - 1.030	✗
• H9.1b: The likelihood of participation increases if the share of new hires and the share of marginal employees increased from the survey year to the year after the survey, compared to no change or a decreasing share of new hires and marginal employees.		(✓)
- Hirings	0.920 - 1.035	✓
- Share of Marginal Employees	1.037 - 1.052	✗
• H9.4a: The likelihood of participation decreases if the average establishment wage increased from the year before the survey to the survey year, compared to no change of the average establishment wage or a decreasing average establishment wage.	0.960 - 0.997	✗
• H9.4b: The likelihood of participation decreases if the average establishment wage increased from the survey year to the year after the survey, compared to no change of average establishment wage or a decreasing average establishment wage.	0.992 - 1.020	✗
• H9.5a: The likelihood of participation increases if the diversity of the workforce increased from the year before the survey to the survey year, compared to no change of diversity or a decreasing diversity.		(✓)
- Sex Diversity	0.977 - 0.985	✗
- Nationality Diversity	0.929 - 0.955	✓
- Education Diversity	0.953 - 0.986	✗
• H9.5b: The likelihood of participation increases if the diversity of the workforce increased from the survey year to the year after the survey, compared to no change of diversity or a decreasing diversity.		✗
- Sex Diversity	0.995 - 1.027	✗
- Nationality Diversity	0.960 - 0.987	✗
- Education Diversity	0.971 - 1.022	✗

Notes: *Effect Range* shows maximum and minimum odds ratio per variable based on Model 4
Significance (α= 0.05): ✗ = Rejected; ✓= Supported; (✓) = Partially supported; *mix.* = Mixed results;
Partially supported refers to the situation where only one of the hypothesized variables yields a statistically significant result.
Mixed results refers to the case where multiple hypothesized variables yield statistically significant results in both directions.

Table 2.D.3: Logistic Regression Models of Survey Participation - 2011-2018 (Pooled)

	Model 1		Model 2		Model 3		Model 4		
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	RPr
DV: Response									
Region (Ref.: East Germany)									17.29
West Germany	0.938***	(0.016)	0.937***	(0.017)	0.940***	(0.017)	0.943**	(0.017)	15.83
Industry (Ref.: Agriculture / Forestry)									23.23
Mining / Ores / Earths	0.692***	(0.033)	0.710***	(0.037)	0.712***	(0.037)	0.712***	(0.037)	18.28
Nutrition / Textiles / Clothing / Furniture etc.	0.654***	(0.030)	0.644***	(0.031)	0.645***	(0.031)	0.645***	(0.031)	15.85
Wood / Paper / Printing	0.677***	(0.032)	0.665***	(0.033)	0.664***	(0.033)	0.662***	(0.033)	16.67
Chemistry / Plastics / Glass / Construction Materials	0.704***	(0.031)	0.702***	(0.032)	0.700***	(0.032)	0.696***	(0.032)	17.12
Metals / Metal Production	0.684***	(0.031)	0.689***	(0.032)	0.689***	(0.033)	0.687***	(0.033)	17.15
Machines / Electronics / Vehicles	0.735***	(0.033)	0.735***	(0.034)	0.733***	(0.034)	0.729***	(0.034)	17.37
Energy Utilities	0.677***	(0.033)	0.741***	(0.039)	0.733***	(0.038)	0.727***	(0.038)	16.68
Water / Waste Management	0.931	(0.042)	0.944	(0.045)	0.944	(0.045)	0.944	(0.045)	22.86
Construction	0.744***	(0.036)	0.754***	(0.038)	0.760***	(0.038)	0.761***	(0.038)	18.68
Trade / Retail / Repairs	0.538***	(0.025)	0.561***	(0.027)	0.564***	(0.028)	0.564***	(0.028)	13.22
Transport/ Warehouses	0.654***	(0.030)	0.698***	(0.033)	0.715***	(0.034)	0.723***	(0.035)	15.87
Hospitality	0.517***	(0.026)	0.587***	(0.030)	0.604***	(0.031)	0.615***	(0.032)	12.10
Information and Communication	0.534***	(0.026)	0.580***	(0.029)	0.582***	(0.029)	0.581***	(0.029)	12.36
Financial Services / Insurance	0.505***	(0.026)	0.516***	(0.027)	0.517***	(0.027)	0.516***	(0.027)	12.22
Real Estate	0.661***	(0.034)	0.696***	(0.037)	0.693***	(0.037)	0.691***	(0.037)	17.99
Liberal Professions / Scientific / Technical Services	0.804***	(0.039)	0.827***	(0.042)	0.830***	(0.042)	0.826***	(0.042)	17.95
Other Commercial Services/ Without Temporary Employment Agencies	0.626***	(0.037)	0.681***	(0.042)	0.698***	(0.043)	0.704***	(0.043)	12.69
Temporary Employment Agencies	0.739***	(0.038)	0.815***	(0.043)	0.827***	(0.044)	0.833***	(0.044)	15.88
Public Administration	0.945	(0.042)	0.912*	(0.043)	0.918	(0.043)	0.914	(0.044)	21.97
Education / Child Care	0.699***	(0.031)	0.732***	(0.035)	0.750***	(0.036)	0.757***	(0.036)	17.21
Health / Social Services	0.758***	(0.034)	0.798***	(0.038)	0.799***	(0.038)	0.799***	(0.038)	17.63
Art / Entertainment / Recreation	0.553***	(0.027)	0.599***	(0.030)	0.611***	(0.031)	0.615***	(0.031)	12.88
Other Services	0.817***	(0.039)	0.835***	(0.041)	0.839***	(0.041)	0.839***	(0.041)	19.87
Num. of Employees (Ref.: 1-9)									18.14
10-19	0.914***	(0.022)	0.924**	(0.024)	0.968	(0.027)	0.964	(0.028)	17.47
20-49	0.854***	(0.018)	0.875***	(0.023)	0.917**	(0.026)	0.913**	(0.027)	16.95
50-249	0.733***	(0.016)	0.766***	(0.025)	0.787***	(0.028)	0.778***	(0.029)	15.14
250-499	0.563***	(0.018)	0.612***	(0.028)	0.600***	(0.029)	0.586***	(0.031)	11.57
500-999	0.487***	(0.019)	0.563***	(0.030)	0.542***	(0.031)	0.527***	(0.032)	10.39
≥1000	0.523***	(0.024)	0.624***	(0.038)	0.587***	(0.038)	0.572***	(0.039)	11.35
Avg. Employees Age (Ref.: 0-39)									13.73
39.00-43.49	1.184***	(0.029)	1.166***	(0.052)	1.153**	(0.052)	1.145**	(0.051)	16.19
43.50-47.99	1.211***	(0.030)	1.130**	(0.051)	1.101*	(0.051)	1.085	(0.050)	17.32
≥48.00	1.271***	(0.031)	1.285***	(0.056)	1.229***	(0.054)	1.207***	(0.054)	18.76
Share of Marginal Employees (Ref.: 0)									15.89
0.00-14.99	1.196***	(0.030)	1.226***	(0.041)	1.222***	(0.048)	1.189***	(0.051)	16.88
≥15	1.053*	(0.022)	1.210***	(0.049)	1.217***	(0.054)	1.192***	(0.056)	16.61
Wage Distribution (Ref.: First Quartile)									15.43
Second Quartile	1.066*	(0.030)	1.038	(0.030)	1.043	(0.030)	1.037	(0.030)	16.68
Third Quartile	1.156***	(0.035)	1.098**	(0.034)	1.099**	(0.034)	1.089**	(0.034)	17.72
Fourth Quartile	1.060	(0.033)	0.998	(0.032)	0.992	(0.032)	0.980	(0.032)	15.88
Missings	1.032	(0.031)	1.114**	(0.039)	1.019	(0.074)	1.142	(0.103)	17.24
Year (Ref.: 2011)									21.61
2012	0.844***	(0.029)	0.847***	(0.029)	0.842***	(0.029)	0.839***	(0.029)	19.06
2013	0.839***	(0.029)	0.843***	(0.029)	0.838***	(0.029)	0.836***	(0.029)	18.96
2014	0.756***	(0.025)	0.758***	(0.026)	0.753***	(0.026)	0.751***	(0.026)	17.16
2015	0.704***	(0.024)	0.708***	(0.024)	0.705***	(0.024)	0.703***	(0.024)	15.96
2016	0.602***	(0.021)	0.607***	(0.021)	0.604***	(0.021)	0.602***	(0.021)	13.93
2017	0.612***	(0.020)	0.621***	(0.020)	0.619***	(0.020)	0.619***	(0.020)	13.84
2018	0.609***	(0.020)	0.621***	(0.021)	0.620***	(0.021)	0.619***	(0.021)	13.59

	Model 1		Model 2		Model 3		Model 4		
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	RPr
Establishment Age			1.009***	(0.002)	1.009***	(0.002)	1.008***	(0.002)	16.34
Employees Age × Establishment Age									†
39.00-43.49 × Establishment Age (continuous)			0.999	(0.002)	0.999	(0.002)	0.999	(0.002)	†
43.50-47.99 × Establishment Age (continuous)			1.001	(0.002)	1.001	(0.002)	1.001	(0.002)	†
≥48.00 × Establishment Age (continuous)			0.996	(0.002)	0.996	(0.002)	0.996	(0.002)	†
Sex Diversity (Ref.: Nondiverse)									16.82
Slightly diverse Establishments			1.021	(0.021)	1.040	(0.024)	1.040	(0.025)	16.34
Diverse Establishment			1.068*	(0.030)	1.082**	(0.033)	1.086**	(0.034)	16.07
Nationality Diversity (Ref.: Nondiverse)									18.70
Diverse			0.868***	(0.020)	0.920**	(0.025)	0.936*	(0.028)	14.01
Education Diversity (Ref.: Low Level of Diversity)									17.56
Medium Level			1.017	(0.023)	1.052*	(0.026)	1.059*	(0.028)	16.82
High Level			1.052	(0.027)	1.086**	(0.031)	1.104***	(0.033)	15.25
Share of Unknown Education (Ref.: 0)									18.16
0.01-100.00			0.853***	(0.020)	0.891**	(0.035)	0.919	(0.041)	13.00
Share of Part-Time (Ref.: 0)									17.79
0.01 - 19.99			1.062*	(0.030)	1.110**	(0.036)	1.109**	(0.039)	16.19
≥20			1.034	(0.032)	1.070	(0.038)	1.068	(0.040)	15.96
Share of Full-Time (Ref.: 0 - 37.14)									15.45
37.15 - 66.66			1.120***	(0.031)	1.114***	(0.031)	1.102***	(0.031)	16.88
66.67 - 86.04			1.149***	(0.042)	1.146***	(0.042)	1.132***	(0.042)	17.22
>86.05			1.173***	(0.053)	1.156**	(0.054)	1.125*	(0.053)	16.18
Share of Apprentices (Ref.: 0)									16.69
0.01-100			1.093***	(0.029)	1.072	(0.044)	1.031	(0.051)	16.04
Share of Regular Employees (Ref.: 0 - 71.24)									15.92
71.25 - 87.49			1.077*	(0.032)	1.080**	(0.032)	1.076*	(0.032)	17.72
87.50 - 96.90			1.048	(0.042)	1.046	(0.042)	1.039	(0.042)	16.02
>96.91			1.129**	(0.052)	1.097	(0.053)	1.083	(0.054)	16.14
Sampled in t-1 (Ref.: not sampled)									17.15
sampled			0.450***	(0.012)	0.450***	(0.012)	0.450***	(0.012)	14.63
Participated in t-1 (Ref.: not participated)									14.89
participated			10.454***	(0.412)	10.428***	(0.412)	10.418***	(0.414)	49.75
Share of New Hirings in t (Ref.: 0-6.25)									19.17
6.26 - 15.37					0.922**	(0.027)	0.919**	(0.027)	16.99
15.38 - 29.51					0.900***	(0.026)	0.908***	(0.026)	15.74
≥29.52					0.868***	(0.025)	0.882***	(0.025)	13.98
Δ_{t-1} *Sex Diversity (Ref.: No Change)*									17.71
Decrease					0.986	(0.026)	0.985	(0.027)	15.93
Increase					0.973	(0.027)	0.977	(0.028)	15.78
Δ_{t-1} *Nationality Diversity (Ref.: No Change)*									17.77
Decrease					0.919**	(0.029)	0.929*	(0.030)	13.84
Increase					0.940	(0.031)	0.955	(0.032)	13.52
Δ_{t-1} *Education Diversity (Ref.: No Change)*									17.94
Decrease					0.980	(0.028)	0.986	(0.029)	15.97
Increase					0.951	(0.026)	0.953	(0.026)	15.64
Δ_{t-1} *Share of Marginal Employees (Ref.: No Change)*									16.66
Decrease					1.037	(0.035)	1.030	(0.035)	16.24
Increase					1.013	(0.037)	1.012	(0.037)	16.41
Δ_{t-1} *Employees Age (Ref.: Stable Age)*									15.59
More than a half Year older					0.968	(0.025)	0.970	(0.025)	16.82
More than a half Year younger					1.027	(0.029)	1.026	(0.029)	16.62
Δ_{t-1} *Wage Growth (Ref.: No Change)*									17.17
Negative Wage Growth					0.957	(0.029)	0.960	(0.030)	15.85
Positive Wage Growth of up to 5 percent					0.998	(0.029)	0.997	(0.029)	16.68
Positive Wage Growth of more than 5 percent					0.978	(0.028)	0.983	(0.029)	16.11
Wage Missing Value					1.025	(0.071)	1.051	(0.073)	17.02

	Model 1		Model 2		Model 3		Model 4		
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	RPr
Δ_{t-1} *Share of Unknown Education (Ref.: No Change)*									18.14
Decrease					0.931	(0.037)	0.946	(0.037)	13.27
Increase					0.971	(0.045)	0.981	(0.046)	12.92
Δ_{t-1} *Share of Part-Time (Ref.: No Change)*									17.92
Decrease					0.941^{*}	(0.028)	0.944	(0.029)	15.36
Increase					0.956	(0.029)	0.961	(0.030)	16.01
Δ_{t-1} *Share of Full-Time (Ref.: No Change)*									17.08
Decrease					0.973	(0.029)	0.977	(0.030)	16.33
Increase					0.923^{*}	(0.029)	0.932^{*}	(0.029)	15.51
Δ_{t-1} *Share of Apprentices (Ref.: No Change)*									16.77
Decrease					1.003	(0.039)	0.989	(0.039)	15.59
Increase					1.026	(0.047)	1.014	(0.046)	16.29
Δ_{t-1} *Share of Regular Employees (Ref.: No Change)*									16.68
Decrease					0.972	(0.034)	0.973	(0.034)	16.22
Increase					0.985	(0.032)	0.989	(0.032)	16.28
Share of New Hirings in t+1 (Ref.: 0-5.95)									18.64
5.96 - 14.99							1.035	(0.031)	17.54
15.00 - 27.99							0.962	(0.029)	15.65
≥28.00							0.920^{**}	(0.027)	14.00
Δ_{t+1} *Sex Diversity (Ref.: No Change)*									17.47
Decrease							0.995	(0.028)	15.90
Increase							1.027	(0.028)	16.04
Δ_{t+1} *Nationality Diversity (Ref.: No Change)*									17.75
Decrease							0.960	(0.034)	13.69
Increase							0.987	(0.029)	13.92
Δ_{t+1} *Education Diversity (Ref.: No Change)*									17.71
Decrease							0.971	(0.028)	15.83
Increase							1.022	(0.028)	15.94
Δ_{t+1} *Share of Marginal Employees (Ref.: No Change)*									16.52
Decrease							1.037	(0.036)	16.29
Increase							1.052	(0.035)	16.54
Δ_{t+1} *Employees Age (Ref.: Stable Age)*									15.52
More than a half Year older							1.008	(0.027)	16.94
More than a half Year younger							1.005	(0.029)	16.45
Δ_{t+1} *Wage Growth (Ref.: No Change)*									16.93
Negative Wage Growth							0.992	(0.031)	16.03
Positive Wage Growth of up to 5 percent							1.014	(0.030)	16.68
Positive Wage Growth of more than 5 percent							1.020	(0.030)	16.17
Wage Missing Value							0.839^{**}	(0.054)	16.75
Δ_{t+1} *Share of Unknown Education (Ref.: No Change)*									18.25
Decrease							0.969	(0.043)	13.60
Increase							0.895^{**}	(0.031)	12.72
Δ_{t+1} *Share of Part-Time (Ref.: No Change)*									17.78
Decrease							1.008	(0.032)	16.03
Increase							0.969	(0.029)	15.63
Δ_{t+1} *Share of Full-Time (Ref.: No Change)*									17.10
Decrease							0.954	(0.030)	15.84
Increase							0.944	(0.029)	16.30
Δ_{t+1} *Share of Apprentices (Ref.: No Change)*									16.69
Decrease							1.064	(0.049)	16.07
Increase							1.059	(0.043)	16.04
Δ_{t+1} *Share of Regular Employees (Ref.: No Change)*									16.57
Decrease							0.971	(0.031)	16.21
Increase							0.998	(0.033)	16.47
Constant	0.363^{***}	(0.017)	0.249^{***}	(0.018)	0.293^{***}	(0.023)	0.316^{***}	(0.027)	
Observations	636105		636105		636105		636105		
Pseudo R^2	0.013		0.023		0.024		0.025		
AIC	12916940		12788558		12771784		12761739		
BIC	12917475		12789330		12772863		12763125		

Table 2.D.4: Logistic Regression Models of Survey Participation - 2011

	Model 1		Model 2		Model 3		Model 4		
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	RPr
DV: Response									
Region (Ref.: East Germany)									21.03
West Germany	1.011	(0.046)	1.020	(0.051)	1.029	(0.052)	1.038	(0.053)	19.95
Industry (Ref.: Agriculture / Forestry)									29.59
Mining / Ores / Earths	0.779	(0.101)	0.765	(0.106)	0.784	(0.110)	0.787	(0.111)	24.18
Nutrition / Textiles / Clothing / Furniture etc.	0.613***	(0.078)	0.597***	(0.078)	0.592***	(0.078)	0.590***	(0.078)	19.36
Wood / Paper / Printing	0.714*	(0.095)	0.672**	(0.091)	0.681**	(0.093)	0.677**	(0.093)	21.94
Chemistry / Plastics / Glass / Construction Materials	0.726**	(0.090)	0.690**	(0.088)	0.692**	(0.089)	0.688**	(0.089)	21.72
Metals / Metal Production	0.814	(0.102)	0.797	(0.102)	0.808	(0.104)	0.801	(0.104)	24.34
Machines / Electronics / Vehicles	0.776*	(0.096)	0.754*	(0.097)	0.760*	(0.098)	0.749*	(0.097)	22.69
Energy Utilities	0.576***	(0.093)	0.591**	(0.101)	0.602**	(0.099)	0.601**	(0.097)	17.64
Water / Waste Management	0.840	(0.109)	0.835	(0.112)	0.849	(0.114)	0.861	(0.116)	25.76
Construction	0.839	(0.113)	0.833	(0.115)	0.847	(0.118)	0.849	(0.118)	24.95
Trade / Retail / Repairs	0.555***	(0.072)	0.581***	(0.077)	0.593***	(0.079)	0.591***	(0.079)	16.96
Transport/ Warehouses	0.656***	(0.084)	0.671**	(0.088)	0.705**	(0.093)	0.720*	(0.096)	19.72
Hospitality	0.569***	(0.076)	0.627***	(0.087)	0.665**	(0.092)	0.678**	(0.095)	16.82
Information and Communication	0.519***	(0.068)	0.547***	(0.075)	0.556***	(0.076)	0.556***	(0.077)	14.42
Financial Services / Insurance	0.460***	(0.063)	0.469***	(0.066)	0.473***	(0.067)	0.470***	(0.067)	13.62
Real Estate	0.621***	(0.083)	0.650**	(0.090)	0.653**	(0.091)	0.655**	(0.091)	20.55
Liberal Professions / Scientific / Technical Services	0.757*	(0.104)	0.768	(0.108)	0.773	(0.109)	0.764	(0.108)	20.97
Other Commercial Services/ Without Temporary Employment Agencies	0.533***	(0.090)	0.556***	(0.096)	0.581**	(0.101)	0.601**	(0.105)	15.79
Temporary Employment Agencies	0.717*	(0.102)	0.770	(0.112)	0.791	(0.117)	0.802	(0.119)	20.51
Public Administration	0.971	(0.114)	0.968	(0.119)	1.000	(0.124)	0.995	(0.124)	25.09
Education / Child Care	0.748*	(0.089)	0.788	(0.098)	0.837	(0.106)	0.844	(0.108)	20.70
Health / Social Services	0.787*	(0.092)	0.843	(0.105)	0.850	(0.106)	0.853	(0.107)	22.11
Art / Entertainment / Recreation	0.557***	(0.074)	0.588***	(0.081)	0.613***	(0.085)	0.618***	(0.086)	16.81
Other Services	0.763*	(0.094)	0.786	(0.100)	0.808	(0.103)	0.803	(0.103)	22.49
Num. of Employees (Ref.: 1-9)									23.10
10-19	0.870*	(0.057)	0.864*	(0.061)	0.903	(0.067)	0.882	(0.069)	21.76
20-49	0.773***	(0.045)	0.776***	(0.056)	0.811**	(0.062)	0.811**	(0.066)	20.43
50-249	0.651***	(0.038)	0.654***	(0.057)	0.665***	(0.061)	0.662***	(0.065)	17.78
250-499	0.575***	(0.049)	0.585***	(0.071)	0.570***	(0.074)	0.561***	(0.078)	15.80
500-999	0.456***	(0.048)	0.481***	(0.069)	0.463***	(0.071)	0.462***	(0.076)	13.21
≥1000	0.600***	(0.081)	0.632**	(0.111)	0.605**	(0.113)	0.605*	(0.120)	16.60
Avg. Employees Age (Ref.: 0-39)									17.38
39.00-43.49	1.222**	(0.080)	1.081	(0.129)	1.066	(0.129)	1.058	(0.128)	20.80
43.50-47.99	1.162*	(0.079)	1.039	(0.129)	1.004	(0.126)	0.977	(0.123)	20.72
≥48.00	1.323***	(0.089)	1.362*	(0.166)	1.304*	(0.162)	1.256	(0.158)	23.85
Share of Marginal Employees (Ref.: 0)									19.08
0.00-14.99	1.339***	(0.091)	1.333**	(0.117)	1.310**	(0.133)	1.192	(0.131)	21.57
≥15	1.080	(0.062)	1.277*	(0.139)	1.262*	(0.147)	1.163	(0.143)	20.82
Wage Distribution (Ref.: First Quartile)									21.17
Second Quartile	1.019	(0.078)	0.990	(0.076)	0.996	(0.077)	0.983	(0.077)	22.27
Third Quartile	0.956	(0.079)	0.919	(0.077)	0.916	(0.077)	0.895	(0.077)	21.19
Fourth Quartile	0.862	(0.074)	0.812*	(0.072)	0.799*	(0.072)	0.776**	(0.071)	18.63
Missings	0.942	(0.079)	1.077	(0.107)	1.318	(0.245)	1.646*	(0.358)	22.53
Establishment Age			1.007	(0.004)	1.006	(0.004)	1.006	(0.004)	20.52
Employees Age × Establishment Age									†
39.00-43.49 × Establishment Age (continuous)			1.005	(0.006)	1.005	(0.006)	1.005	(0.006)	†
43.50-47.99 × Establishment Age (continuous)			1.003	(0.006)	1.004	(0.006)	1.004	(0.006)	†
≥48.00 × Establishment Age (continuous)			0.995	(0.006)	0.995	(0.006)	0.995	(0.006)	†

	Model 1		Model 2		Model 3		Model 4		
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	RPr
Sex Diversity (Ref.: Nondiverse)									20.68
Slightly diverse Establishments			1.079	(0.061)	1.099	(0.067)	1.108	(0.071)	20.59
Diverse Establishment			1.083	(0.083)	1.114	(0.090)	1.142	(0.095)	19.64
Nationality Diversity (Ref.: Nondiverse)									22.20
Diverse			0.887	(0.057)	0.959	(0.074)	1.007	(0.087)	17.82
Education Diversity (Ref.: Low Level of Diversity)									21.98
Medium Level			0.981	(0.060)	1.026	(0.070)	1.024	(0.073)	20.48
High Level			1.047	(0.073)	1.084	(0.082)	1.097	(0.089)	19.18
Share of Unknown Education (Ref.: 0)									21.71
0.01-100.00			0.863^{*}	(0.060)	1.032	(0.117)	0.858	(0.119)	16.44
Share of Part-Time (Ref.: 0)									21.99
0.01 - 19.99			1.058	(0.079)	1.028	(0.096)	1.040	(0.103)	20.06
≥20			0.954	(0.080)	0.906	(0.091)	0.922	(0.097)	19.65
Share of Full-Time (Ref.: 0 - 37.14)									19.35
37.15 - 66.66			1.123	(0.084)	1.104	(0.084)	1.069	(0.081)	20.27
66.67 - 86.04			1.177	(0.116)	1.162	(0.115)	1.128	(0.112)	21.46
>86.05			1.220	(0.150)	1.208	(0.152)	1.137	(0.146)	20.53
Share of Apprentices (Ref.: 0)									21.05
0.01-100			1.029	(0.073)	0.938	(0.099)	0.968	(0.127)	19.46
Share of Regular Employees (Ref.: 0 - 71.24)									19.78
71.25 - 87.49			1.124	(0.091)	1.115	(0.091)	1.096	(0.090)	21.32
87.50 - 96.90			1.184	(0.126)	1.145	(0.124)	1.110	(0.121)	20.62
>96.91			1.159	(0.147)	1.067	(0.138)	1.022	(0.135)	19.99
Sampled in t-1 (Ref.: not sampled)									21.05
sampled			0.520^{***}	(0.046)	0.516^{***}	(0.045)	0.513^{***}	(0.045)	18.75
Participated in t-1 (Ref.: not participated)									18.79
participated			7.508^{***}	(0.837)	7.501^{***}	(0.842)	7.581^{***}	(0.859)	49.44
Share of New Hirings in t (Ref.: 0-6.25)									23.18
6.26 - 15.37					0.929	(0.076)	0.905	(0.074)	20.56
15.38 - 29.51					0.928	(0.073)	0.928	(0.073)	19.85
≥29.52					0.880	(0.068)	0.890	(0.069)	18.02
Δ_t-1 *Sex Diversity (Ref.: No Change)*									21.98
Decrease					1.036	(0.076)	1.033	(0.077)	20.25
Increase					0.946	(0.070)	0.958	(0.072)	19.14
Δ_t-1 *Nationality Diversity (Ref.: No Change)*									21.47
Decrease					0.928	(0.080)	0.958	(0.083)	17.93
Increase					0.907	(0.088)	0.932	(0.090)	17.23
Δ_t-1 *Education Diversity (Ref.: No Change)*									22.68
Decrease					0.993	(0.078)	0.986	(0.078)	20.14
Increase					0.904	(0.067)	0.893	(0.067)	18.91
Δ_t-1 *Share of Marginal Employees (Ref.: No Change)*									20.33
Decrease					1.026	(0.088)	1.010	(0.087)	20.01
Increase					1.044	(0.100)	1.028	(0.098)	21.09
Δ_t-1 *Employees Age (Ref.: Stable Age)*									19.20
More than a half Year older					0.987	(0.070)	0.995	(0.069)	20.96
More than a half Year younger					1.032	(0.080)	1.046	(0.081)	20.66
Δ_t-1 *Wage Growth (Ref.: No Change)*									21.84
Negative Wage Growth					0.936	(0.075)	0.947	(0.077)	19.59
Positive Wage Growth of up to 5 percent					0.910	(0.071)	0.911	(0.072)	19.72
Positive Wage Growth of more than 5 percent					0.981	(0.076)	0.990	(0.078)	20.71
Wage Missing Value					0.762	(0.135)	0.799	(0.141)	21.61
Δ_t-1 *Share of Unknown Education (Ref.: No Change)*									22.04
Decrease					0.692^{***}	(0.074)	0.697^{***}	(0.076)	14.82
Increase					0.837	(0.117)	0.807	(0.111)	16.76
Δ_t-1 *Share of Part-Time (Ref.: No Change)*									21.73
Decrease					1.002	(0.090)	1.012	(0.091)	18.65
Increase					1.053	(0.092)	1.062	(0.093)	20.39

	Model 1		Model 2		Model 3		Model 4		
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	RPr
Δ_$t-1$ *Share of Full-Time (Ref.: No Change)*									21.13
Decrease					1.114	(0.089)	1.118	(0.090)	21.26
Increase					0.971	(0.085)	0.969	(0.085)	18.66
Δ_$t-1$ *Share of Apprentices (Ref.: No Change)*									20.98
Decrease					1.121	(0.114)	1.133	(0.116)	19.42
Increase					1.136	(0.139)	1.129	(0.137)	19.85
Δ_$t-1$ *Share of Regular Employees (Ref.: No Change)*									21.57
Decrease					0.815*	(0.077)	0.820*	(0.077)	20.02
Increase					0.890	(0.078)	0.896	(0.078)	19.18
Share of New Hirings in t+1 (Ref.: 0-5.95)									22.15
5.96 - 14.99							1.203*	(0.098)	22.71
15.00 - 27.99							0.930	(0.075)	18.71
≥28.00							0.910	(0.070)	17.93
Δ_$t+1$ *Sex Diversity (Ref.: No Change)*									21.89
Decrease							0.935	(0.072)	19.10
Increase							1.034	(0.077)	20.35
Δ_$t+1$ *Nationality Diversity (Ref.: No Change)*									21.55
Decrease							0.905	(0.092)	17.55
Increase							0.882	(0.077)	16.91
Δ_$t+1$ *Education Diversity (Ref.: No Change)*									22.07
Decrease							1.002	(0.077)	19.75
Increase							1.033	(0.078)	19.70
Δ_$t+1$ *Share of Marginal Employees (Ref.: No Change)*									19.84
Decrease							1.184	(0.112)	20.97
Increase							1.093	(0.096)	20.76
Δ_$t+1$ *Employees Age (Ref.: Stable Age)*									18.85
More than a half Year older							1.033	(0.076)	20.87
More than a half Year younger							1.120	(0.091)	21.26
Δ_$t+1$ *Wage Growth (Ref.: No Change)*									21.35
Negative Wage Growth							0.958	(0.076)	19.20
Positive Wage Growth of up to 5 percent							0.995	(0.077)	20.57
Positive Wage Growth of more than 5 percent							1.018	(0.080)	20.61
Wage Missing Value							0.687*	(0.111)	21.12
Δ_$t+1$ *Share of Unknown Education (Ref.: No Change)*									21.85
Decrease							1.503**	(0.200)	19.25
Increase							0.896	(0.092)	14.64
Δ_$t+1$ *Share of Part-Time (Ref.: No Change)*									22.23
Decrease							0.928	(0.081)	19.53
Increase							0.979	(0.077)	19.46
Δ_$t+1$ *Share of Full-Time (Ref.: No Change)*									21.74
Decrease							0.905	(0.078)	19.64
Increase							0.934	(0.080)	19.80
Δ_$t+1$ *Share of Apprentices (Ref.: No Change)*									21.17
Decrease							0.977	(0.121)	19.57
Increase							0.899	(0.097)	18.99
Δ_$t+1$ *Share of Regular Employees (Ref.: No Change)*									20.88
Decrease							1.071	(0.095)	20.52
Increase							0.910	(0.084)	19.74
Constant	0.372***	(0.043)	0.257***	(0.046)	0.316***	(0.064)	0.359***	(0.078)	
Observations	69752		69752		69752		69752		
Pseudo R^2	0.0104		0.019		0.023		0.027		
AIC	1810654		1794912		1788129		1781016		
BIC	1811020		1795470		1788934		1782069		

Table 2.D.5: Logistic Regression Models of Survey Participation - 2012

	Model 1		Model 2		Model 3		Model 4		
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	RPr
DV: Response									
Region (Ref.: East Germany)									20.32
West Germany	0.875**	(0.041)	0.898*	(0.047)	0.899*	(0.047)	0.913	(0.048)	17.89
Industry (Ref.: Agriculture / Forestry)									28.26
Mining / Ores / Earths	0.625**	(0.090)	0.597***	(0.093)	0.595***	(0.093)	0.604**	(0.095)	20.25
Nutrition / Textiles / Clothing / Furniture etc.	0.610***	(0.084)	0.595***	(0.084)	0.589***	(0.084)	0.608***	(0.086)	18.46
Wood / Paper / Printing	0.604***	(0.086)	0.584***	(0.085)	0.575***	(0.084)	0.591***	(0.086)	18.72
Chemistry / Plastics / Glass / Construction Materials	0.648***	(0.085)	0.650**	(0.088)	0.644**	(0.088)	0.656**	(0.089)	19.82
Metals / Metal Production	0.686**	(0.094)	0.696*	(0.098)	0.691**	(0.098)	0.714*	(0.101)	21.29
Machines / Electronics / Vehicles	0.689**	(0.093)	0.693**	(0.097)	0.691**	(0.097)	0.706*	(0.099)	20.63
Energy Utilities	0.578***	(0.080)	0.614***	(0.089)	0.606***	(0.088)	0.609***	(0.089)	17.91
Water / Waste Management	0.936	(0.127)	0.962	(0.135)	0.955	(0.135)	0.973	(0.138)	27.43
Construction	0.707*	(0.102)	0.718*	(0.106)	0.711*	(0.105)	0.734*	(0.109)	21.77
Trade / Retail / Repairs	0.481***	(0.068)	0.495***	(0.072)	0.499***	(0.073)	0.514***	(0.075)	15.65
Transport/ Warehouses	0.648**	(0.088)	0.693**	(0.097)	0.703*	(0.099)	0.738*	(0.104)	19.51
Hospitality	0.455***	(0.069)	0.515***	(0.080)	0.532***	(0.084)	0.559***	(0.088)	14.15
Information and Communication	0.453***	(0.064)	0.485***	(0.071)	0.486***	(0.071)	0.502***	(0.074)	16.64
Financial Services / Insurance	0.404***	(0.061)	0.411***	(0.064)	0.414***	(0.064)	0.424***	(0.066)	12.79
Real Estate	0.526***	(0.082)	0.551***	(0.088)	0.548***	(0.088)	0.563***	(0.091)	18.67
Liberal Professions / Scientific / Technical Services	0.650**	(0.095)	0.664**	(0.099)	0.662**	(0.099)	0.678**	(0.101)	19.13
Other Commercial Services/ Without Temporary Employment Agencies	0.526***	(0.091)	0.574**	(0.101)	0.591**	(0.105)	0.620**	(0.111)	14.52
Temporary Employment Agencies	0.614**	(0.093)	0.676*	(0.105)	0.675*	(0.106)	0.705*	(0.110)	17.59
Public Administration	0.824	(0.106)	0.771	(0.103)	0.773	(0.104)	0.786	(0.106)	23.67
Education / Child Care	0.694**	(0.090)	0.722*	(0.098)	0.741*	(0.102)	0.773	(0.106)	20.70
Health / Social Services	0.663**	(0.084)	0.709*	(0.095)	0.712*	(0.096)	0.734*	(0.099)	19.68
Art / Entertainment / Recreation	0.469***	(0.069)	0.500***	(0.075)	0.508***	(0.077)	0.526***	(0.080)	14.45
Other Services	0.728*	(0.096)	0.749*	(0.102)	0.753*	(0.104)	0.766	(0.105)	21.82
Num. of Employees (Ref.: 1-9)									20.75
10-19	0.929	(0.065)	0.966	(0.074)	1.004	(0.080)	1.024	(0.085)	20.51
20-49	0.857**	(0.049)	0.929	(0.069)	0.949	(0.076)	0.949	(0.081)	19.45
50-249	0.743***	(0.046)	0.845	(0.080)	0.833	(0.084)	0.793*	(0.087)	17.25
250-499	0.551***	(0.051)	0.672**	(0.089)	0.620***	(0.089)	0.546***	(0.086)	13.22
500-999	0.522***	(0.060)	0.676*	(0.106)	0.604**	(0.102)	0.510***	(0.094)	12.49
≥1000	0.481***	(0.063)	0.613**	(0.105)	0.533***	(0.099)	0.442***	(0.089)	11.74
Avg. Employees Age (Ref.: 0-39)									16.77
39.00-43.49	1.078	(0.077)	0.940	(0.119)	0.931	(0.118)	0.903	(0.115)	18.59
43.50-47.99	1.035	(0.073)	1.038	(0.132)	1.007	(0.130)	0.948	(0.122)	19.06
≥48.00	1.167*	(0.083)	0.995	(0.125)	0.957	(0.124)	0.895	(0.117)	22.31
Share of Marginal Employees (Ref.: 0)									18.45
0.00-14.99	1.144	(0.081)	1.123	(0.110)	1.048	(0.128)	0.971	(0.129)	19.11
≥15	1.118	(0.068)	1.161	(0.144)	1.114	(0.159)	1.044	(0.157)	19.61
Wage Distribution (Ref.: First Quartile)									18.42
Second Quartile	1.040	(0.082)	1.005	(0.080)	1.013	(0.080)	1.007	(0.080)	19.44
Third Quartile	1.174	(0.102)	1.110	(0.098)	1.122	(0.099)	1.110	(0.099)	20.48
Fourth Quartile	1.113	(0.099)	1.038	(0.095)	1.047	(0.096)	1.021	(0.095)	18.02
Missings	1.080	(0.093)	1.156	(0.117)	0.901	(0.185)	0.777	(0.193)	20.57
Establishment Age			1.002	(0.005)	1.001	(0.005)	1.000	(0.005)	19.09
Employees Age × Establishment Age									†
39.00-43.49 × Establishment Age (continuous)			1.008	(0.006)	1.007	(0.006)	1.007	(0.006)	†
43.50-47.99 × Establishment Age (continuous)			0.999	(0.006)	0.999	(0.006)	1.000	(0.006)	†
≥48.00 × Establishment Age (continuous)			1.007	(0.006)	1.007	(0.006)	1.007	(0.006)	†

	Model 1		Model 2		Model 3		Model 4		
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	RPr
Sex Diversity (Ref.: Nondiverse)									18.72
Slightly diverse Establishments			1.126	(0.070)	1.137	(0.080)	1.127	(0.083)	19.22
Diverse Establishment			1.201^{*}	(0.103)	1.203^{*}	(0.109)	1.201	(0.112)	19.09
Nationality Diversity (Ref.: Nondiverse)									21.29
Diverse			0.800^{***}	(0.054)	0.878	(0.075)	0.918	(0.085)	15.80
Education Diversity (Ref.: Low Level of Diversity)									19.89
Medium Level			1.034	(0.069)	1.051	(0.076)	1.074	(0.082)	19.71
High Level			1.034	(0.079)	1.037	(0.087)	1.067	(0.093)	17.54
Share of Unknown Education (Ref.: 0)									20.35
0.01-100.00			0.855^{*}	(0.062)	0.819	(0.109)	0.797	(0.111)	15.22
Share of Part-Time (Ref.: 0)									20.76
0.01 - 19.99			0.928	(0.072)	0.981	(0.089)	0.972	(0.096)	17.94
≥20			1.002	(0.087)	1.037	(0.103)	1.023	(0.106)	18.98
Share of Full-Time (Ref.: 0 - 37.14)									18.68
37.15 - 66.66			1.044	(0.084)	1.058	(0.085)	1.041	(0.084)	19.15
66.67 - 86.04			1.091	(0.112)	1.114	(0.115)	1.095	(0.113)	19.77
>86.05			1.148	(0.154)	1.163	(0.159)	1.085	(0.150)	18.41
Share of Apprentices (Ref.: 0)									19.32
0.01-100			1.101	(0.087)	1.067	(0.126)	0.917	(0.133)	18.53
Share of Regular Employees (Ref.: 0 - 71.24)									18.55
71.25 - 87.49			1.146	(0.098)	1.135	(0.097)	1.132	(0.096)	21.11
87.50 - 96.90			1.008	(0.120)	0.996	(0.120)	0.969	(0.116)	18.04
>96.91			1.025	(0.148)	0.960	(0.148)	0.897	(0.141)	18.24
Sampled in t-1 (Ref.: not sampled)									19.61
sampled			0.465^{***}	(0.033)	0.460^{***}	(0.033)	0.456^{***}	(0.033)	17.32
Participated in t-1 (Ref.: not participated)									17.43
participated			8.866^{***}	(1.096)	8.874^{***}	(1.126)	8.970^{***}	(1.160)	50.14
Share of New Hirings in t (Ref.: 0-6.25)									22.23
6.26 - 15.37					0.840^{*}	(0.070)	0.834^{*}	(0.070)	19.02
15.38 - 29.51					0.837^{*}	(0.069)	0.849^{*}	(0.070)	18.43
≥29.52					0.777^{**}	(0.065)	0.790^{**}	(0.067)	16.21
Δ_t-1 *Sex Diversity (Ref.: No Change)*									19.81
Decrease					0.998	(0.081)	1.007	(0.082)	18.35
Increase					1.018	(0.086)	1.025	(0.088)	18.91
Δ_t-1 *Nationality Diversity (Ref.: No Change)*									20.28
Decrease					0.866	(0.087)	0.886	(0.091)	15.36
Increase					0.884	(0.091)	0.919	(0.095)	15.31
Δ_t-1 *Education Diversity (Ref.: No Change)*									20.12
Decrease					1.054	(0.093)	1.072	(0.095)	18.92
Increase					0.994	(0.078)	1.006	(0.080)	18.23
Δ_t-1 *Share of Marginal Employees (Ref.: No Change)*									18.77
Decrease					1.180	(0.121)	1.169	(0.120)	19.58
Increase					1.095	(0.117)	1.113	(0.121)	18.77
Δ_t-1 *Employees Age (Ref.: Stable Age)*									18.71
More than a half Year older					0.888	(0.066)	0.890	(0.066)	19.09
More than a half Year younger					0.958	(0.079)	0.970	(0.080)	19.24
Δ_t-1 *Wage Growth (Ref.: No Change)*									20.26
Negative Wage Growth					0.871	(0.072)	0.886	(0.074)	17.26
Positive Wage Growth of up to 5 percent					0.992	(0.081)	0.983	(0.080)	19.74
Positive Wage Growth of more than 5 percent					0.931	(0.074)	0.950	(0.076)	18.50
Wage Missing Value					1.205	(0.234)	1.238	(0.247)	20.61
Δ_t-1 *Share of Unknown Education (Ref.: No Change)*									20.37
Decrease					0.959	(0.124)	0.975	(0.127)	15.08
Increase					1.137	(0.175)	1.132	(0.178)	15.90
Δ_t-1 *Share of Part-Time (Ref.: No Change)*									20.84
Decrease					0.901	(0.078)	0.887	(0.078)	17.28
Increase					0.932	(0.083)	0.923	(0.083)	18.58

	Model 1		Model 2		Model 3		Model 4		
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	RPr
Δ_$t-1$ *Share of Full-Time (Ref.: No Change)*									19.54
Decrease					1.028	(0.093)	1.060	(0.097)	18.95
Increase					0.891	(0.083)	0.933	(0.088)	18.50
Δ_$t-1$ *Share of Apprentices (Ref.: No Change)*									19.38
Decrease					1.021	(0.114)	1.007	(0.114)	18.28
Increase					1.023	(0.134)	0.994	(0.132)	18.63
Δ_$t-1$ *Share of Regular Employees (Ref.: No Change)*									18.98
Decrease					0.916	(0.094)	0.918	(0.095)	18.50
Increase					1.017	(0.098)	1.022	(0.097)	19.50
Share of New Hirings in t+1 (Ref.: 0-5.95)									21.20
5.96 - 14.99							1.023	(0.087)	19.85
15.00 - 27.99							0.963	(0.085)	18.41
≥28.00							0.872	(0.076)	16.13
Δ_$t+1$ *Sex Diversity (Ref.: No Change)*									20.01
Decrease							1.016	(0.086)	18.64
Increase							1.023	(0.084)	18.40
Δ_$t+1$ *Nationality Diversity (Ref.: No Change)*									20.29
Decrease							0.884	(0.094)	14.89
Increase							0.931	(0.085)	15.75
Δ_$t+1$ *Education Diversity (Ref.: No Change)*									20.64
Decrease							0.934	(0.078)	18.28
Increase							0.979	(0.081)	18.17
Δ_$t+1$ *Share of Marginal Employees (Ref.: No Change)*									19.18
Decrease							1.053	(0.110)	18.51
Increase							1.183	(0.114)	19.33
Δ_$t+1$ *Employees Age (Ref.: Stable Age)*									18.20
More than a half Year older							0.927	(0.070)	19.07
More than a half Year younger							1.071	(0.090)	19.87
Δ_$t+1$ *Wage Growth (Ref.: No Change)*									19.39
Negative Wage Growth							0.918	(0.080)	17.60
Positive Wage Growth of up to 5 percent							1.095	(0.090)	20.40
Positive Wage Growth of more than 5 percent							0.979	(0.081)	17.98
Wage Missing Value							1.008	(0.185)	20.12
Δ_$t+1$ *Share of Unknown Education (Ref.: No Change)*									20.41
Decrease							1.122	(0.150)	16.31
Increase							0.932	(0.093)	14.61
Δ_$t+1$ *Share of Part-Time (Ref.: No Change)*									20.64
Decrease							1.005	(0.094)	18.27
Increase							1.083	(0.094)	18.05
Δ_$t+1$ *Share of Full-Time (Ref.: No Change)*									20.92
Decrease							0.728***	(0.066)	17.03
Increase							0.848	(0.076)	18.70
Δ_$t+1$ *Share of Apprentices (Ref.: No Change)*									19.29
Decrease							1.290	(0.177)	19.61
Increase							1.108	(0.133)	17.50
Δ_$t+1$ *Share of Regular Employees (Ref.: No Change)*									19.80
Decrease							0.889	(0.087)	17.93
Increase							0.860	(0.088)	18.66
Constant	0.374***	(0.047)	0.308***	(0.059)	0.411***	(0.088)	0.545*	(0.129)	
Observations	70929		70929		70929		70929		
Pseudo R^2	0.0091		0.0190		0.0221		0.0262		
AIC	1700879		1683599		1678261		1671435		
BIC	1700512		1684158		1679068		16172489		

Table 2.D.6: Logistic Regression Models of Survey Participation - 2013

	Model 1		Model 2		Model 3		Model 4		
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	RPr
DV: Response									
Region (Ref.: East Germany)									19.52
West Germany	0.951	(0.044)	0.938	(0.047)	0.941	(0.048)	0.940	(0.048)	18.45
Industry (Ref.: Agriculture / Forestry)									23.53
Mining / Ores / Earths	0.797	(0.118)	0.822	(0.128)	0.822	(0.128)	0.833	(0.131)	20.92
Nutrition / Textiles / Clothing / Furniture etc.	0.734*	(0.105)	0.729*	(0.107)	0.737*	(0.109)	0.735*	(0.109)	19.95
Wood / Paper / Printing	0.711*	(0.105)	0.710*	(0.108)	0.711*	(0.109)	0.707*	(0.109)	17.71
Chemistry / Plastics / Glass / Construction Materials	0.854	(0.116)	0.857	(0.120)	0.858	(0.121)	0.852	(0.121)	20.94
Metals / Metal Production	0.754	(0.109)	0.774	(0.114)	0.784	(0.116)	0.786	(0.117)	19.45
Machines / Electronics / Vehicles	0.856	(0.119)	0.872	(0.125)	0.874	(0.126)	0.873	(0.127)	20.67
Energy Utilities	0.754*	(0.109)	0.860	(0.131)	0.852	(0.131)	0.841	(0.130)	18.37
Water / Waste Management	1.007	(0.144)	1.057	(0.157)	1.057	(0.158)	1.057	(0.159)	24.65
Construction	0.716*	(0.111)	0.736	(0.116)	0.737	(0.117)	0.737	(0.117)	18.87
Trade / Retail / Repairs	0.673**	(0.097)	0.725*	(0.108)	0.725*	(0.108)	0.725*	(0.108)	16.39
Transport/ Warehouses	0.685**	(0.099)	0.762	(0.113)	0.760	(0.114)	0.762	(0.115)	17.14
Hospitality	0.587***	(0.090)	0.697*	(0.110)	0.707*	(0.113)	0.717*	(0.115)	13.77
Information and Communication	0.598***	(0.088)	0.682*	(0.104)	0.689*	(0.106)	0.680*	(0.105)	13.95
Financial Services / Insurance	0.570***	(0.088)	0.610**	(0.097)	0.612**	(0.097)	0.605**	(0.097)	13.70
Real Estate	0.697*	(0.112)	0.761	(0.125)	0.763	(0.126)	0.750	(0.124)	19.25
Liberal Professions / Scientific / Technical Services	1.021	(0.152)	1.092	(0.168)	1.101	(0.170)	1.093	(0.169)	22.50
Other Commercial Services/ Without Temporary Employment Agencies	0.816	(0.140)	0.927	(0.164)	0.938	(0.166)	0.930	(0.166)	17.35
Temporary Employment Agencies	0.916	(0.141)	1.058	(0.168)	1.063	(0.169)	1.065	(0.170)	20.10
Public Administration	1.063	(0.140)	1.055	(0.144)	1.070	(0.147)	1.068	(0.149)	24.03
Education / Child Care	0.843	(0.113)	0.914	(0.128)	0.928	(0.131)	0.932	(0.133)	19.47
Health / Social Services	0.843	(0.115)	0.907	(0.130)	0.912	(0.132)	0.909	(0.132)	19.09
Art / Entertainment / Recreation	0.659**	(0.101)	0.742	(0.117)	0.753	(0.119)	0.755	(0.120)	15.50
Other Services	0.908	(0.127)	0.938	(0.134)	0.943	(0.136)	0.943	(0.136)	21.24
Num. of Employees (Ref.: 1-9)									20.35
10-19	0.951	(0.069)	0.960	(0.079)	0.998	(0.085)	0.981	(0.086)	20.40
20-49	0.864*	(0.059)	0.873	(0.077)	0.916	(0.085)	0.900	(0.087)	19.28
50-249	0.748***	(0.050)	0.776*	(0.079)	0.815	(0.088)	0.809	(0.091)	17.48
250-499	0.611***	(0.058)	0.660**	(0.092)	0.688*	(0.102)	0.692*	(0.107)	14.43
500-999	0.554***	(0.061)	0.613**	(0.097)	0.638**	(0.108)	0.655*	(0.117)	13.11
≥1000	0.561***	(0.074)	0.663*	(0.117)	0.677*	(0.129)	0.701	(0.140)	13.72
Avg. Employees Age (Ref.: 0-39)									15.21
39.00-43.49	1.252**	(0.091)	1.284	(0.165)	1.277	(0.164)	1.282	(0.165)	18.78
43.50-47.99	1.228**	(0.091)	1.122	(0.149)	1.108	(0.148)	1.110	(0.150)	19.49
≥48.00	1.450***	(0.104)	1.401**	(0.183)	1.391*	(0.186)	1.393*	(0.187)	22.53
Share of Marginal Employees (Ref.: 0)									18.02
0.00-14.99	1.251**	(0.099)	1.252*	(0.128)	1.304*	(0.153)	1.279	(0.167)	19.57
≥15	1.098	(0.065)	1.259	(0.151)	1.316*	(0.169)	1.292	(0.177)	19.36
Wage Distribution (Ref.: First Quartile)									18.42
Second Quartile	0.996	(0.084)	0.981	(0.083)	0.988	(0.085)	0.992	(0.086)	18.58
Third Quartile	1.150	(0.103)	1.098	(0.100)	1.100	(0.101)	1.111	(0.103)	20.87
Fourth Quartile	1.009	(0.092)	0.959	(0.090)	0.965	(0.091)	0.982	(0.095)	18.34
Missings	0.923	(0.081)	1.014	(0.106)	0.883	(0.186)	1.166	(0.327)	19.03
Establishment Age			1.011*	(0.005)	1.010*	(0.005)	1.010*	(0.005)	18.57
Employees Age × Establishment Age									†
39.00-43.49 × Establishment Age (continuous)			0.998	(0.006)	0.998	(0.006)	0.998	(0.006)	†
43.50-47.99 × Establishment Age (continuous)			1.003	(0.006)	1.004	(0.006)	1.004	(0.006)	†
≥48.00 × Establishment Age (continuous)			1.000	(0.006)	0.999	(0.006)	1.000	(0.006)	†

	Model 1		Model 2		Model 3		Model 4		
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	RPr
Sex Diversity (Ref.: Nondiverse)									19.41
Slightly diverse Establishments			0.968	(0.060)	0.988	(0.066)	1.011	(0.072)	18.76
Diverse Establishment			1.001	(0.086)	1.027	(0.094)	1.076	(0.103)	18.62
Nationality Diversity (Ref.: Nondiverse)									20.97
Diverse			0.830**	(0.058)	0.794**	(0.065)	0.770**	(0.066)	16.20
Education Diversity (Ref.: Low Level of Diversity)									19.84
Medium Level			0.996	(0.067)	1.028	(0.074)	1.049	(0.081)	18.95
High Level			1.091	(0.084)	1.123	(0.095)	1.152	(0.101)	18.24
Share of Unknown Education (Ref.: 0)									20.37
0.01-100.00			0.855*	(0.065)	0.864	(0.116)	0.908	(0.142)	15.32
Share of Part-Time (Ref.: 0)									20.12
0.01 - 19.99			1.046	(0.090)	1.095	(0.110)	1.049	(0.113)	18.75
≥20			0.945	(0.088)	0.980	(0.105)	0.943	(0.107)	18.49
Share of Full-Time (Ref.: 0 - 37.14)									18.22
37.15 - 66.66			1.109	(0.091)	1.101	(0.091)	1.088	(0.090)	19.42
66.67 - 86.04			1.085	(0.114)	1.098	(0.117)	1.088	(0.117)	19.44
>86.05			1.110	(0.146)	1.099	(0.149)	1.093	(0.152)	18.70
Share of Apprentices (Ref.: 0)									19.19
0.01-100			1.156	(0.094)	1.225	(0.146)	1.101	(0.154)	18.55
Share of Regular Employees (Ref.: 0 - 71.24)									18.58
71.25 - 87.49			1.078	(0.098)	1.076	(0.099)	1.073	(0.098)	19.79
87.50 - 96.90			1.117	(0.143)	1.139	(0.147)	1.138	(0.147)	19.06
>96.91			1.136	(0.163)	1.172	(0.171)	1.148	(0.172)	18.28
Sampled in t-1 (Ref.: not sampled)									19.59
sampled			0.455***	(0.041)	0.455***	(0.041)	0.452***	(0.041)	17.09
Participated in t-1 (Ref.: not participated)									17.40
participated			9.495***	(1.085)	9.556***	(1.101)	9.655***	(1.142)	51.98
Share of New Hirings in t (Ref.: 0-6.25)									20.60
6.26 - 15.37					1.016	(0.093)	1.013	(0.091)	19.54
15.38 - 29.51					1.055	(0.091)	1.063	(0.092)	18.98
≥29.52					0.960	(0.079)	0.970	(0.081)	16.35
Δ_t-1 *Sex Diversity (Ref.: No Change)*									20.34
Decrease					0.976	(0.073)	0.981	(0.074)	18.52
Increase					0.943	(0.076)	0.960	(0.078)	18.00
Δ_t-1 *Nationality Diversity (Ref.: No Change)*									19.83
Decrease					0.921	(0.092)	0.918	(0.092)	15.18
Increase					1.172	(0.116)	1.161	(0.121)	17.37
Δ_t-1 *Education Diversity (Ref.: No Change)*									20.60
Decrease					0.958	(0.081)	0.972	(0.083)	18.62
Increase					0.913	(0.073)	0.915	(0.073)	17.66
Δ_t-1 *Share of Marginal Employees (Ref.: No Change)*									19.15
Decrease					0.976	(0.096)	0.980	(0.096)	19.02
Increase					0.909	(0.101)	0.897	(0.100)	18.61
Δ_t-1 *Employees Age (Ref.: Stable Age)*									18.42
More than a half Year older					0.942	(0.073)	0.943	(0.073)	18.87
More than a half Year younger					1.034	(0.087)	1.031	(0.087)	19.77
Δ_t-1 *Wage Growth (Ref.: No Change)*									19.98
Negative Wage Growth					0.943	(0.084)	0.943	(0.086)	18.63
Positive Wage Growth of up to 5 percent					0.955	(0.082)	0.963	(0.084)	19.29
Positive Wage Growth of more than 5 percent					0.922	(0.079)	0.935	(0.081)	18.27
Wage Missing Value					1.043	(0.210)	1.094	(0.220)	18.91
Δ_t-1 *Share of Unknown Education (Ref.: No Change)*									20.35
Decrease					0.936	(0.122)	0.957	(0.123)	15.06
Increase					1.017	(0.160)	1.053	(0.164)	15.62
Δ_t-1 *Share of Part-Time (Ref.: No Change)*									20.53
Decrease					0.902	(0.081)	0.897	(0.081)	17.64
Increase					0.954	(0.088)	0.958	(0.089)	18.49

	Model 1		Model 2		Model 3		Model 4		
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	RPr
Δ_t-1 *Share of Full-Time (Ref.: No Change)*									19.87
Decrease					0.948	(0.088)	0.934	(0.087)	18.70
Increase					0.873	(0.080)	0.873	(0.080)	18.09
Δ_t-1 *Share of Apprentices (Ref.: No Change)*									19.42
Decrease					0.945	(0.103)	0.932	(0.103)	17.95
Increase					0.903	(0.118)	0.889	(0.115)	18.34
Δ_t-1 *Share of Regular Employees (Ref.: No Change)*									18.93
Decrease					1.108	(0.126)	1.114	(0.125)	19.00
Increase					1.085	(0.104)	1.087	(0.104)	18.95
Share of New Hirings in t+1 (Ref.: 0-5.95)									21.04
5.96 - 14.99							1.039	(0.087)	19.98
15.00 - 27.99							0.960	(0.083)	18.04
≥28.00							0.926	(0.076)	16.24
Δ_t+1 *Sex Diversity (Ref.: No Change)*									20.09
Decrease							0.884	(0.074)	17.53
Increase							1.022	(0.084)	19.24
Δ_t+1 *Nationality Diversity (Ref.: No Change)*									19.70
Decrease							1.104	(0.124)	16.96
Increase							1.074	(0.096)	16.88
Δ_t+1 *Education Diversity (Ref.: No Change)*									20.30
Decrease							0.918	(0.077)	18.21
Increase							0.997	(0.080)	18.38
Δ_t+1 *Share of Marginal Employees (Ref.: No Change)*									18.90
Decrease							1.076	(0.113)	19.43
Increase							0.997	(0.098)	18.52
Δ_t+1 *Employees Age (Ref.: Stable Age)*									17.50
More than a half Year older							1.104	(0.084)	19.72
More than a half Year younger							1.034	(0.087)	18.91
Δ_t+1 *Wage Growth (Ref.: No Change)*									19.88
Negative Wage Growth							0.928	(0.084)	17.97
Positive Wage Growth of up to 5 percent							0.907	(0.076)	18.31
Positive Wage Growth of more than 5 percent							1.059	(0.090)	20.10
Wage Missing Value							0.727	(0.142)	18.43
Δ_t+1 *Share of Unknown Education (Ref.: No Change)*									20.45
Decrease							0.875	(0.127)	14.92
Increase							0.919	(0.101)	15.77
Δ_t+1 *Share of Part-Time (Ref.: No Change)*									19.60
Decrease							1.065	(0.099)	18.48
Increase							1.104	(0.097)	18.73
Δ_t+1 *Share of Full-Time (Ref.: No Change)*									18.94
Decrease							1.034	(0.095)	18.07
Increase							1.123	(0.104)	19.88
Δ_t+1 *Share of Apprentices (Ref.: No Change)*									19.16
Decrease							1.230	(0.161)	19.63
Increase							1.082	(0.125)	17.57
Δ_t+1 *Share of Regular Employees (Ref.: No Change)*									19.10
Decrease							0.936	(0.091)	17.88
Increase							0.916	(0.093)	19.62
Constant	0.253^{***}	(0.033)	0.178^{***}	(0.036)	0.198^{***}	(0.045)	0.192^{***}	(0.048)	
Observations	71084		71084		71084		71084		
Pseudo R^2	0.010		0.021		0.023		0.025		
AIC	1711934		1693413		1689858		1685342		
BIC	1712301		1693972		1690665		1686397		

Table 2.D.7: Logistic Regression Models of Survey Participation - 2014

	Model 1		Model 2		Model 3		Model 4		
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	RPr
DV: Response									
Region (Ref.: East Germany)									18.98
West Germany	0.838***	(0.039)	0.824***	(0.042)	0.820***	(0.042)	0.823***	(0.043)	16.79
Industry (Ref.: Agriculture / Forestry)									21.11
Mining / Ores / Earths	0.570***	(0.075)	0.612***	(0.086)	0.623***	(0.089)	0.618***	(0.088)	18.88
Nutrition / Textiles / Clothing / Furniture etc.	0.586***	(0.074)	0.594***	(0.077)	0.617***	(0.082)	0.609***	(0.081)	17.86
Wood / Paper / Printing	0.605***	(0.079)	0.618***	(0.083)	0.633***	(0.086)	0.629***	(0.085)	18.46
Chemistry / Plastics / Glass / Construction Materials	0.625***	(0.076)	0.641***	(0.081)	0.644***	(0.082)	0.635***	(0.082)	19.58
Metals / Metal Production	0.534***	(0.067)	0.545***	(0.070)	0.546***	(0.071)	0.540***	(0.071)	17.43
Machines / Electronics / Vehicles	0.633***	(0.078)	0.653***	(0.084)	0.659**	(0.085)	0.652**	(0.085)	19.85
Energy Utilities	0.576***	(0.074)	0.651**	(0.089)	0.661**	(0.091)	0.654**	(0.091)	18.10
Water / Waste Management	0.800	(0.098)	0.842	(0.108)	0.861	(0.112)	0.855	(0.111)	24.95
Construction	0.629***	(0.081)	0.656**	(0.088)	0.676**	(0.091)	0.671**	(0.091)	20.06
Trade / Retail / Repairs	0.420***	(0.055)	0.434***	(0.059)	0.448***	(0.062)	0.443***	(0.062)	13.31
Transport/ Warehouses	0.553***	(0.070)	0.593***	(0.078)	0.627***	(0.084)	0.623***	(0.084)	17.15
Hospitality	0.451***	(0.062)	0.510***	(0.073)	0.534***	(0.077)	0.531***	(0.077)	13.61
Information and Communication	0.411***	(0.055)	0.449***	(0.062)	0.458***	(0.064)	0.452***	(0.064)	12.78
Financial Services / Insurance	0.428***	(0.061)	0.431***	(0.063)	0.445***	(0.065)	0.439***	(0.065)	13.32
Real Estate	0.621***	(0.088)	0.643**	(0.095)	0.657**	(0.098)	0.649**	(0.097)	20.59
Liberal Professions / Scientific / Technical Services	0.757*	(0.101)	0.766	(0.105)	0.776	(0.108)	0.764	(0.106)	21.47
Other Commercial Services/ Without Temporary Employment Agencies	0.510***	(0.085)	0.547***	(0.094)	0.559***	(0.097)	0.554***	(0.097)	14.47
Temporary Employment Agencies	0.643**	(0.091)	0.702*	(0.102)	0.719*	(0.106)	0.716*	(0.106)	18.01
Public Administration	0.701**	(0.088)	0.688**	(0.092)	0.722*	(0.098)	0.714*	(0.097)	20.94
Education / Child Care	0.490***	(0.063)	0.488***	(0.066)	0.513***	(0.071)	0.508***	(0.071)	15.47
Health / Social Services	0.647***	(0.083)	0.659**	(0.089)	0.671**	(0.092)	0.656**	(0.090)	18.80
Art / Entertainment / Recreation	0.530***	(0.070)	0.565***	(0.078)	0.587***	(0.082)	0.582***	(0.082)	15.23
Other Services	0.739*	(0.101)	0.743*	(0.105)	0.763	(0.109)	0.753*	(0.107)	21.86
Num. of Employees (Ref.: 1-9)									18.92
10-19	0.945	(0.065)	0.966	(0.073)	1.042	(0.082)	1.085	(0.089)	19.16
20-49	0.870*	(0.050)	0.915	(0.067)	1.005	(0.079)	1.053	(0.088)	18.61
50-249	0.722***	(0.046)	0.785**	(0.074)	0.844	(0.085)	0.874	(0.093)	16.06
250-499	0.619***	(0.060)	0.708**	(0.094)	0.725*	(0.103)	0.732*	(0.110)	13.70
500-999	0.525***	(0.060)	0.645**	(0.099)	0.646**	(0.106)	0.658*	(0.115)	11.92
≥1000	0.575***	(0.070)	0.800	(0.133)	0.765	(0.138)	0.785	(0.151)	12.95
Avg. Employees Age (Ref.: 0-39)									15.22
39.00-43.49	1.096	(0.078)	1.076	(0.136)	1.067	(0.136)	1.071	(0.136)	16.88
43.50-47.99	1.243**	(0.087)	1.143	(0.144)	1.121	(0.142)	1.121	(0.143)	19.62
≥48.00	1.188*	(0.082)	1.252	(0.154)	1.198	(0.148)	1.201	(0.149)	19.56
Share of Marginal Employees (Ref.: 0)									17.50
0.00-14.99	1.156*	(0.080)	1.161	(0.104)	1.067	(0.118)	1.080	(0.133)	18.60
≥15	0.984	(0.057)	1.066	(0.122)	1.004	(0.129)	1.026	(0.142)	17.28
Wage Distribution (Ref.: First Quartile)									17.26
Second Quartile	1.067	(0.086)	1.043	(0.085)	1.030	(0.084)	1.039	(0.086)	18.28
Third Quartile	1.196*	(0.103)	1.146	(0.101)	1.136	(0.102)	1.143	(0.104)	19.07
Fourth Quartile	1.149	(0.102)	1.090	(0.100)	1.053	(0.099)	1.062	(0.102)	17.14
Missings	0.987	(0.085)	0.992	(0.102)	0.799	(0.169)	0.770	(0.198)	17.31
Establishment Age			1.009*	(0.005)	1.009*	(0.005)	1.009	(0.005)	17.90
Employees Age × Establishment Age									†
39.00-43.49 × Establishment Age (continuous)			0.999	(0.006)	0.998	(0.006)	0.998	(0.006)	†
43.50-47.99 × Establishment Age (continuous)			1.002	(0.006)	1.001	(0.006)	1.001	(0.006)	†
≥48.00 × Establishment Age (continuous)			0.994	(0.006)	0.993	(0.006)	0.993	(0.006)	†

	Model 1		Model 2		Model 3		Model 4		
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	RPr
Sex Diversity (Ref.: Nondiverse)									18.32
Slightly diverse Establishments			0.928	(0.056)	0.976	(0.064)	0.954	(0.065)	17.19
Diverse Establishment			1.113	(0.092)	1.154	(0.101)	1.095	(0.101)	18.53
Nationality Diversity (Ref.: Nondiverse)									19.64
Diverse			0.889	(0.059)	0.959	(0.078)	1.007	(0.092)	15.55
Education Diversity (Ref.: Low Level of Diversity)									18.52
Medium Level			1.038	(0.067)	1.064	(0.077)	1.126	(0.086)	17.91
High Level			1.123	(0.085)	1.160	(0.095)	1.243*	(0.106)	17.11
Share of Unknown Education (Ref.: 0)									19.47
0.01-100.00			0.796***	(0.054)	0.858	(0.095)	0.927	(0.114)	14.07
Share of Part-Time (Ref.: 0)									18.68
0.01 - 19.99			1.086	(0.086)	1.193	(0.110)	1.183	(0.119)	17.71
≥20			1.102	(0.101)	1.185	(0.121)	1.163	(0.126)	17.35
Share of Full-Time (Ref.: 0 - 37.14)									16.36
37.15 - 66.66			1.074	(0.087)	1.074	(0.088)	1.074	(0.088)	18.12
66.67 - 86.04			1.067	(0.113)	1.081	(0.116)	1.074	(0.115)	18.57
>86.05			1.096	(0.145)	1.105	(0.150)	1.066	(0.147)	17.98
Share of Apprentices (Ref.: 0)									18.01
0.01-100			1.045	(0.080)	1.057	(0.118)	1.031	(0.143)	17.46
Share of Regular Employees (Ref.: 0 - 71.24)									16.60
71.25 - 87.49			1.067	(0.089)	1.075	(0.090)	1.082	(0.091)	19.14
87.50 - 96.90			0.969	(0.108)	0.959	(0.109)	0.971	(0.112)	17.60
>96.91			1.052	(0.138)	0.958	(0.132)	0.968	(0.138)	17.82
Sampled in t-1 (Ref.: not sampled)									18.40
sampled			0.379***	(0.026)	0.380***	(0.027)	0.379***	(0.027)	16.13
Participated in t-1 (Ref.: not participated)									16.04
participated			11.974***	(1.331)	12.082***	(1.339)	12.111***	(1.361)	52.63
Share of New Hirings in t (Ref.: 0-6.25)									20.84
6.26 - 15.37					0.860	(0.071)	0.872	(0.073)	17.96
15.38 - 29.51					0.816*	(0.068)	0.824*	(0.069)	16.24
≥29.52					0.883	(0.074)	0.894	(0.075)	15.82
$\Delta\_t - 1$ *Sex Diversity (Ref.: No Change)*									19.50
Decrease					0.893	(0.067)	0.898	(0.068)	16.86
Increase					0.898	(0.070)	0.884	(0.069)	17.06
$\Delta\_t - 1$ *Nationality Diversity (Ref.: No Change)*									18.75
Decrease					1.033	(0.097)	1.054	(0.101)	16.95
Increase					0.860	(0.084)	0.888	(0.088)	14.28
$\Delta\_t - 1$ *Education Diversity (Ref.: No Change)*									19.01
Decrease					0.992	(0.080)	1.014	(0.082)	16.98
Increase					1.058	(0.083)	1.068	(0.083)	17.49
$\Delta\_t - 1$ *Share of Marginal Employees (Ref.: No Change)*									17.80
Decrease					1.180	(0.118)	1.183	(0.118)	17.46
Increase					1.246*	(0.136)	1.274*	(0.140)	18.18
$\Delta\_t - 1$ *Employees Age (Ref.: Stable Age)*									15.98
More than a half Year older					1.118	(0.080)	1.128	(0.081)	18.67
More than a half Year younger					1.132	(0.089)	1.130	(0.089)	17.90
$\Delta\_t - 1$ *Wage Growth (Ref.: No Change)*									17.01
Negative Wage Growth					1.072	(0.093)	1.084	(0.094)	17.01
Positive Wage Growth of up to 5 percent					1.117	(0.093)	1.120	(0.094)	18.11
Positive Wage Growth of more than 5 percent					1.177*	(0.098)	1.184*	(0.099)	18.64
Wage Missing Value					1.249	(0.250)	1.271	(0.254)	17.29
$\Delta\_t - 1$ *Share of Unknown Education (Ref.: No Change)*									19.44
Decrease					0.929	(0.102)	0.937	(0.104)	13.78
Increase					0.920	(0.121)	0.936	(0.127)	19.44
$\Delta\_t - 1$ *Share of Part-Time (Ref.: No Change)*									19.43
Decrease					0.876	(0.074)	0.869	(0.075)	16.51
Increase					0.904	(0.079)	0.895	(0.079)	17.25

	Model 1		Model 2		Model 3		Model 4		
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	RPr
Δ_$t-1$ *Share of Full-Time (Ref.: No Change)*									18.86
Decrease					0.965	(0.087)	0.980	(0.089)	17.50
Increase					0.896	(0.080)	0.909	(0.081)	16.73
Δ_$t-1$ *Share of Apprentices (Ref.: No Change)*									18.18
Decrease					0.914	(0.101)	0.914	(0.104)	16.52
Increase					1.034	(0.132)	1.021	(0.131)	17.81
Δ_$t-1$ *Share of Regular Employees (Ref.: No Change)*									18.54
Decrease					0.846	(0.087)	0.837	(0.087)	17.14
Increase					0.922	(0.092)	0.919	(0.092)	17.13
Share of New Hirings in t+1 (Ref.: 0-5.95)									19.52
5.96 - 14.99							1.007	(0.086)	18.01
15.00 - 27.99							1.071	(0.090)	17.39
≥28.00							1.065	(0.086)	16.03
Δ_$t+1$ *Sex Diversity (Ref.: No Change)*									18.65
Decrease							1.136	(0.091)	18.57
Increase							0.973	(0.074)	16.22
Δ_$t+1$ *Nationality Diversity (Ref.: No Change)*									18.88
Decrease							0.873	(0.092)	14.60
Increase							0.927	(0.082)	15.74
Δ_$t+1$ *Education Diversity (Ref.: No Change)*									19.37
Decrease							0.835^{*}	(0.070)	16.77
Increase							0.937	(0.073)	17.34
Δ_$t+1$ *Share of Marginal Employees (Ref.: No Change)*									18.04
Decrease							0.925	(0.094)	16.92
Increase							1.031	(0.104)	18.52
Δ_$t+1$ *Employees Age (Ref.: Stable Age)*									16.56
More than a half Year older							1.102	(0.079)	18.43
More than a half Year younger							1.023	(0.082)	17.82
Δ_$t+1$ *Wage Growth (Ref.: No Change)*									18.69
Negative Wage Growth							0.963	(0.086)	17.81
Positive Wage Growth of up to 5 percent							0.960	(0.082)	17.80
Positive Wage Growth of more than 5 percent							0.998	(0.082)	17.54
Wage Missing Value							0.966	(0.165)	17.28
Δ_$t+1$ *Share of Unknown Education (Ref.: No Change)*									19.46
Decrease							0.856	(0.113)	13.75
Increase							0.902	(0.093)	14.69
Δ_$t+1$ *Share of Part-Time (Ref.: No Change)*									18.85
Decrease							1.074	(0.098)	18.14
Increase							1.001	(0.085)	16.65
Δ_$t+1$ *Share of Full-Time (Ref.: No Change)*									18.66
Decrease							0.903	(0.081)	17.03
Increase							0.902	(0.081)	17.51
Δ_$t+1$ *Share of Apprentices (Ref.: No Change)*									18.07
Decrease							1.078	(0.139)	17.73
Increase							1.016	(0.122)	16.93
Δ_$t+1$ *Share of Regular Employees (Ref.: No Change)*									18.11
Decrease							0.971	(0.093)	17.76
Increase							1.053	(0.101)	17.37
Constant	0.369^{***}	(0.043)	0.286^{***}	(0.055)	0.274^{***}	(0.061)	0.264^{***}	(0.065)	
Observations	70227		70227		70227		70227		
Pseudo R^2	0.0122		0.0236		0.027		0.029		
AIC	1630073		1611418		1605495		1602357		
BIC	1630439		1611976		1606301		1603411		

Table 2.D.8: Logistic Regression Models of Survey Participation - 2015

	Model 1		Model 2		Model 3		Model 4		
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	RPr
DV: Response									
Region (Ref.: East Germany)									15.76
West Germany	0.974	(0.044)	0.964	(0.048)	0.957	(0.048)	0.962	(0.049)	15.36
Industry (Ref.: Agriculture / Forestry)									24.53
Mining / Ores / Earths	0.621***	(0.082)	0.667**	(0.094)	0.661**	(0.094)	0.660**	(0.094)	17.59
Nutrition / Textiles / Clothing / Furniture etc.	0.536***	(0.068)	0.525***	(0.069)	0.522***	(0.068)	0.518***	(0.068)	14.06
Wood / Paper / Printing	0.696**	(0.092)	0.691**	(0.094)	0.683**	(0.093)	0.670**	(0.092)	17.46
Chemistry / Plastics / Glass / Construction Materials	0.685**	(0.083)	0.701**	(0.089)	0.690**	(0.088)	0.684**	(0.087)	17.65
Metals / Metal Production	0.572***	(0.071)	0.577***	(0.074)	0.564***	(0.073)	0.556***	(0.072)	15.49
Machines / Electronics / Vehicles	0.569***	(0.070)	0.577***	(0.074)	0.565***	(0.073)	0.557***	(0.072)	14.86
Energy Utilities	0.548***	(0.071)	0.600***	(0.083)	0.586***	(0.081)	0.575***	(0.079)	14.30
Water / Waste Management	0.893	(0.110)	0.923	(0.119)	0.911	(0.119)	0.903	(0.118)	22.75
Construction	0.688**	(0.092)	0.687**	(0.094)	0.683**	(0.094)	0.676**	(0.093)	18.21
Trade / Retail / Repairs	0.482***	(0.061)	0.503***	(0.066)	0.502***	(0.066)	0.496***	(0.065)	12.58
Transport/ Warehouses	0.628***	(0.079)	0.683**	(0.090)	0.699**	(0.092)	0.700**	(0.092)	15.93
Hospitality	0.461***	(0.065)	0.541***	(0.079)	0.558***	(0.082)	0.566***	(0.083)	11.50
Information and Communication	0.477***	(0.063)	0.528***	(0.073)	0.524***	(0.072)	0.520***	(0.072)	11.28
Financial Services / Insurance	0.526***	(0.073)	0.530***	(0.076)	0.524***	(0.075)	0.517***	(0.074)	13.15
Real Estate	0.625***	(0.089)	0.667**	(0.098)	0.657**	(0.097)	0.645**	(0.095)	17.70
Liberal Professions / Scientific / Technical Services	0.733*	(0.098)	0.746*	(0.103)	0.737*	(0.102)	0.729*	(0.101)	17.19
Other Commercial Services/ Without Temporary Employment Agencies	0.596**	(0.095)	0.660*	(0.109)	0.665*	(0.110)	0.665*	(0.110)	12.91
Temporary Employment Agencies	0.655**	(0.091)	0.730*	(0.104)	0.737*	(0.106)	0.735*	(0.106)	15.30
Public Administration	0.823	(0.103)	0.772	(0.102)	0.767*	(0.102)	0.753*	(0.101)	19.87
Education / Child Care	0.610***	(0.078)	0.639***	(0.086)	0.646**	(0.087)	0.646**	(0.088)	15.47
Health / Social Services	0.718**	(0.091)	0.740*	(0.098)	0.729*	(0.097)	0.718*	(0.096)	17.29
Art / Entertainment / Recreation	0.460***	(0.064)	0.513***	(0.074)	0.520***	(0.075)	0.516***	(0.075)	11.65
Other Services	0.735*	(0.102)	0.742*	(0.106)	0.746*	(0.107)	0.737*	(0.106)	18.02
Num. of Employees (Ref.: 1-9)									17.40
10-19	0.852*	(0.054)	0.876	(0.062)	0.903	(0.067)	0.899	(0.068)	16.22
20-49	0.812***	(0.045)	0.853*	(0.062)	0.873	(0.068)	0.868	(0.070)	15.95
50-249	0.707***	(0.043)	0.763**	(0.070)	0.757**	(0.075)	0.748**	(0.076)	14.04
250-499	0.562***	(0.054)	0.630***	(0.084)	0.596***	(0.085)	0.583***	(0.087)	11.43
500-999	0.494***	(0.054)	0.585***	(0.087)	0.540***	(0.087)	0.529***	(0.089)	10.22
≥1000	0.496***	(0.062)	0.616**	(0.105)	0.561**	(0.104)	0.555**	(0.108)	10.49
Avg. Employees Age (Ref.: 0-39)									12.39
39.00-43.49	1.240**	(0.087)	1.295*	(0.162)	1.273	(0.161)	1.269	(0.160)	15.29
43.50-47.99	1.305***	(0.090)	1.356*	(0.174)	1.289*	(0.165)	1.281	(0.165)	16.85
≥48.00	1.296***	(0.088)	1.422**	(0.173)	1.325*	(0.164)	1.313*	(0.162)	17.76
Share of Marginal Employees (Ref.: 0)									14.69
0.00-14.99	1.168*	(0.080)	1.175	(0.109)	1.159	(0.121)	1.156	(0.128)	15.58
≥15	1.146*	(0.065)	1.274*	(0.138)	1.286*	(0.151)	1.297*	(0.159)	16.49
Wage Distribution (Ref.: First Quartile)									14.31
Second Quartile	1.127	(0.088)	1.098	(0.086)	1.096	(0.087)	1.083	(0.086)	16.03
Third Quartile	1.210*	(0.100)	1.143	(0.097)	1.134	(0.096)	1.121	(0.096)	16.99
Fourth Quartile	1.098	(0.094)	1.049	(0.092)	1.037	(0.092)	1.020	(0.091)	14.92
Missings	0.984	(0.081)	1.048	(0.101)	1.165	(0.231)	1.403	(0.349)	15.85
Establishment Age			1.013**	(0.004)	1.012**	(0.004)	1.012**	(0.004)	15.12
Employees Age × Establishment Age									†
39.00-43.49 × Establishment Age (continuous)			0.995	(0.006)	0.994	(0.006)	0.995	(0.006)	†
43.50-47.99 × Establishment Age (continuous)			0.995	(0.006)	0.995	(0.006)	0.995	(0.006)	†
≥48.00 × Establishment Age (continuous)			0.991	(0.006)	0.991	(0.006)	0.991	(0.006)	†

	Model 1		Model 2		Model 3		Model 4		
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	RPr
Sex Diversity (Ref.: Nondiverse)									15.94
Slightly diverse Establishments			0.941	(0.054)	0.946	(0.059)	0.933	(0.061)	15.13
Diverse Establishment			1.057	(0.083)	1.047	(0.088)	1.033	(0.090)	15.81
Nationality Diversity (Ref.: Nondiverse)									17.48
Diverse			0.873*	(0.056)	0.882	(0.069)	0.922	(0.076)	13.43
Education Diversity (Ref.: Low Level of Diversity)									16.38
Medium Level			1.050	(0.067)	1.062	(0.075)	1.089	(0.081)	16.41
High Level			0.993	(0.071)	0.998	(0.078)	1.031	(0.085)	13.98
Share of Unknown Education (Ref.: 0)									17.05
0.01-100.00			0.823**	(0.055)	0.849	(0.095)	0.955	(0.123)	12.42
Share of Part-Time (Ref.: 0)									16.37
0.01 - 19.99			1.048	(0.081)	1.105	(0.100)	1.081	(0.106)	15.29
≥20			1.077	(0.093)	1.142	(0.110)	1.116	(0.115)	15.31
Share of Full-Time (Ref.: 0 - 37.14)									14.31
37.15 - 66.66			1.207*	(0.092)	1.187*	(0.092)	1.171*	(0.090)	16.62
66.67 - 86.04			1.315**	(0.133)	1.284*	(0.132)	1.257*	(0.128)	16.99
>86.05			1.103	(0.139)	1.074	(0.139)	1.032	(0.136)	14.12
Share of Apprentices (Ref.: 0)									15.55
0.01-100			1.143	(0.086)	1.129	(0.133)	1.098	(0.160)	15.52
Share of Regular Employees (Ref.: 0 - 71.24)									15.88
71.25 - 87.49			0.944	(0.076)	0.950	(0.077)	0.956	(0.078)	16.60
87.50 - 96.90			0.989	(0.108)	0.977	(0.109)	0.989	(0.111)	14.96
>96.91			1.073	(0.134)	1.021	(0.131)	1.043	(0.136)	14.81
Sampled in t-1 (Ref.: not sampled)									16.16
sampled			0.435***	(0.031)	0.433***	(0.031)	0.434***	(0.031)	13.80
Participated in t-1 (Ref.: not participated)									14.12
participated			10.463***	(1.225)	10.445***	(1.207)	10.398***	(1.203)	47.00
Share of New Hirings in t (Ref.: 0-6.25)									17.85
6.26 - 15.37					0.995	(0.080)	0.991	(0.081)	16.94
15.38 - 29.51					0.842*	(0.068)	0.852	(0.070)	14.37
≥29.52					0.839*	(0.066)	0.851*	(0.069)	12.95
Δ_t-1 *Sex Diversity (Ref.: No Change)*									16.48
Decrease					1.008	(0.075)	0.991	(0.076)	14.82
Increase					1.051	(0.081)	1.039	(0.082)	15.36
Δ_t-1 *Nationality Diversity (Ref.: No Change)*									16.61
Decrease					0.896	(0.082)	0.905	(0.084)	12.49
Increase					1.055	(0.098)	1.077	(0.103)	13.76
Δ_t-1 *Education Diversity (Ref.: No Change)*									16.74
Decrease					1.036	(0.082)	1.048	(0.085)	15.54
Increase					0.951	(0.072)	0.964	(0.074)	14.41
Δ_t-1 *Share of Marginal Employees (Ref.: No Change)*									15.59
Decrease					1.081	(0.099)	1.074	(0.100)	15.20
Increase					1.047	(0.105)	1.061	(0.108)	15.88
Δ_t-1 *Employees Age (Ref.: Stable Age)*									14.74
More than a half Year older					0.979	(0.074)	0.986	(0.074)	15.79
More than a half Year younger					1.024	(0.084)	1.017	(0.083)	15.86
Δ_t-1 *Wage Growth (Ref.: No Change)*									17.06
Negative Wage Growth					0.933	(0.081)	0.936	(0.081)	15.33
Positive Wage Growth of up to 5 percent					0.977	(0.081)	0.974	(0.081)	16.15
Positive Wage Growth of more than 5 percent					0.893	(0.071)	0.895	(0.071)	14.40
Wage Missing Value					0.803	(0.154)	0.828	(0.161)	15.53
Δ_t-1 *Share of Unknown Education (Ref.: No Change)*									17.00
Decrease					0.984	(0.108)	1.019	(0.113)	12.84
Increase					0.977	(0.128)	1.016	(0.134)	12.33
Δ_t-1 *Share of Part-Time (Ref.: No Change)*									16.85
Decrease					0.924	(0.077)	0.927	(0.078)	15.28
Increase					0.936	(0.079)	0.943	(0.081)	14.61

	Model 1		Model 2		Model 3		Model 4		
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	RPr
Δ_$t-1$ *Share of Full-Time (Ref.: No Change)*									15.92
Decrease					0.933	(0.078)	0.941	(0.080)	14.95
Increase					1.056	(0.090)	1.063	(0.091)	15.66
Δ_$t-1$ *Share of Apprentices (Ref.: No Change)*									14.66
Decrease					1.009	(0.112)	0.979	(0.109)	14.85
Increase					1.020	(0.134)	1.002	(0.132)	15.86
Δ_$t-1$ *Share of Regular Employees (Ref.: No Change)*									15.95
Decrease					0.935	(0.091)	0.927	(0.090)	15.66
Increase					0.838	(0.077)	0.839	(0.078)	14.83
Share of New Hirings in t+1 (Ref.: 0-5.95)									17.51
5.96 - 14.99							1.058	(0.089)	16.91
15.00 - 27.99							0.963	(0.082)	14.46
≥28.00							0.977	(0.078)	13.27
Δ_$t+1$ *Sex Diversity (Ref.: No Change)*									16.22
Decrease							1.065	(0.086)	15.17
Increase							1.094	(0.084)	15.26
Δ_$t+1$ *Nationality Diversity (Ref.: No Change)*									16.73
Decrease							0.900	(0.091)	12.83
Increase							0.960	(0.078)	13.43
Δ_$t+1$ *Education Diversity (Ref.: No Change)*									16.86
Decrease							0.924	(0.075)	14.71
Increase							0.968	(0.076)	15.13
Δ_$t+1$ *Share of Marginal Employees (Ref.: No Change)*									15.48
Decrease							0.938	(0.091)	15.12
Increase							1.079	(0.102)	16.09
Δ_$t+1$ *Employees Age (Ref.: Stable Age)*									14.39
More than a half Year older							1.086	(0.078)	16.28
More than a half Year younger							0.985	(0.079)	15.25
Δ_$t+1$ *Wage Growth (Ref.: No Change)*									15.80
Negative Wage Growth							1.035	(0.084)	15.29
Positive Wage Growth of up to 5 percent							1.039	(0.082)	16.05
Positive Wage Growth of more than 5 percent							0.997	(0.078)	14.99
Wage Missing Value							0.787	(0.145)	15.43
Δ_$t+1$ *Share of Unknown Education (Ref.: No Change)*									17.28
Decrease							0.796	(0.099)	12.13
Increase							0.813*	(0.080)	12.26
Δ_$t+1$ *Share of Part-Time (Ref.: No Change)*									16.52
Decrease							1.039	(0.093)	15.05
Increase							1.016	(0.087)	15.06
Δ_$t+1$ *Share of Full-Time (Ref.: No Change)*									15.83
Decrease							0.987	(0.086)	15.45
Increase							0.930	(0.079)	15.25
Δ_$t+1$ *Share of Apprentices (Ref.: No Change)*									15.52
Decrease							0.995	(0.129)	14.90
Increase							1.189	(0.138)	16.30
Δ_$t+1$ *Share of Regular Employees (Ref.: No Change)*									15.39
Decrease							0.952	(0.090)	15.58
Increase							1.108	(0.105)	15.76
Constant	0.253***	(0.030)	0.173***	(0.032)	0.226***	(0.049)	0.218***	(0.051)	
Observations	77751		77751		77751		77751		
Pseudo R^2	0.011		0.021		0.024		0.026		
AIC	1581755		1564960		1560916		1558111		
BIC	1582126		1565525		1561731		1559176		

Table 2.D.9: Logistic Regression Models of Survey Participation - 2016

	Model 1		Model 2		Model 3		Model 4		
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	RPr
DV: Response									
Region (Ref.: East Germany)									14.82
West Germany	0.954	(0.046)	0.952	(0.050)	0.948	(0.050)	0.954	(0.051)	13.99
Industry (Ref.: Agriculture / Forestry)									21.83
Mining / Ores / Earths	0.659**	(0.093)	0.614**	(0.095)	0.612**	(0.095)	0.609**	(0.095)	15.50
Nutrition / Textiles / Clothing / Furniture etc.	0.703**	(0.094)	0.678**	(0.094)	0.677**	(0.094)	0.674**	(0.094)	14.92
Wood / Paper / Printing	0.625**	(0.089)	0.581***	(0.086)	0.580***	(0.086)	0.578***	(0.086)	13.91
Chemistry / Plastics / Glass / Construction Materials	0.667**	(0.087)	0.619***	(0.085)	0.614***	(0.084)	0.608***	(0.084)	14.92
Metals / Metal Production	0.637***	(0.085)	0.610***	(0.084)	0.603***	(0.083)	0.595***	(0.083)	14.56
Machines / Electronics / Vehicles	0.712**	(0.092)	0.680**	(0.091)	0.676**	(0.091)	0.671**	(0.091)	15.51
Energy Utilities	0.703**	(0.096)	0.731*	(0.107)	0.721*	(0.106)	0.713*	(0.105)	15.31
Water / Waste Management	0.944	(0.124)	0.873	(0.121)	0.867	(0.121)	0.866	(0.121)	20.65
Construction	0.713*	(0.104)	0.689*	(0.103)	0.685*	(0.103)	0.677**	(0.102)	15.99
Trade / Retail / Repairs	0.488***	(0.068)	0.496***	(0.071)	0.497***	(0.071)	0.500***	(0.072)	10.82
Transport/ Warehouses	0.669**	(0.089)	0.697**	(0.097)	0.714*	(0.100)	0.713*	(0.100)	14.17
Hospitality	0.459***	(0.068)	0.516***	(0.080)	0.529***	(0.082)	0.535***	(0.083)	9.40
Information and Communication	0.563***	(0.079)	0.588***	(0.086)	0.588***	(0.087)	0.584***	(0.087)	11.84
Financial Services / Insurance	0.519***	(0.077)	0.519***	(0.081)	0.514***	(0.080)	0.515***	(0.080)	11.01
Real Estate	0.724*	(0.112)	0.739	(0.118)	0.734	(0.117)	0.733	(0.117)	17.63
Liberal Professions / Scientific / Technical Services	0.767	(0.107)	0.759	(0.110)	0.765	(0.111)	0.753	(0.109)	15.71
Other Commercial Services/ Without Temporary Employment Agencies	0.742	(0.122)	0.780	(0.135)	0.789	(0.137)	0.797	(0.139)	13.89
Temporary Employment Agencies	0.728*	(0.107)	0.783	(0.120)	0.795	(0.122)	0.798	(0.123)	13.92
Public Administration	1.075	(0.154)	1.036	(0.156)	1.047	(0.159)	1.030	(0.157)	21.07
Education / Child Care	0.676**	(0.093)	0.711*	(0.103)	0.729*	(0.107)	0.736*	(0.108)	14.26
Health / Social Services	0.749*	(0.102)	0.767	(0.111)	0.764	(0.111)	0.759	(0.110)	14.69
Art / Entertainment / Recreation	0.492***	(0.073)	0.505***	(0.078)	0.517***	(0.080)	0.518***	(0.080)	10.23
Other Services	0.706*	(0.107)	0.705*	(0.110)	0.702*	(0.110)	0.697*	(0.109)	14.64
Num. of Employees (Ref.: 1-9)									15.80
10-19	0.860*	(0.061)	0.819*	(0.064)	0.874	(0.072)	0.859	(0.073)	14.65
20-49	0.878*	(0.054)	0.823*	(0.065)	0.874	(0.074)	0.857	(0.075)	15.17
50-249	0.763***	(0.049)	0.704***	(0.070)	0.733**	(0.078)	0.717**	(0.078)	13.64
250-499	0.523***	(0.050)	0.468***	(0.065)	0.463***	(0.069)	0.443***	(0.069)	9.95
500-999	0.414***	(0.048)	0.400***	(0.064)	0.389***	(0.067)	0.367***	(0.067)	7.92
≥1000	0.432***	(0.057)	0.431***	(0.077)	0.407***	(0.079)	0.383***	(0.078)	8.56
Avg. Employees Age (Ref.: 0-39)									11.96
39.00-43.49	1.121	(0.085)	1.150	(0.151)	1.154	(0.153)	1.136	(0.150)	13.76
43.50-47.99	1.165*	(0.089)	1.004	(0.140)	0.988	(0.138)	0.967	(0.135)	15.36
≥48.00	1.199*	(0.086)	1.151	(0.145)	1.110	(0.144)	1.082	(0.141)	16.34
Share of Marginal Employees (Ref.: 0)									14.39
0.00-14.99	1.119	(0.080)	1.207	(0.117)	1.296*	(0.150)	1.291*	(0.164)	14.71
≥15	0.991	(0.060)	1.267	(0.154)	1.351*	(0.183)	1.360*	(0.195)	13.94
Wage Distribution (Ref.: First Quartile)									13.17
Second Quartile	1.074	(0.091)	1.040	(0.089)	1.051	(0.090)	1.038	(0.089)	14.28
Third Quartile	1.199*	(0.107)	1.137	(0.103)	1.154	(0.104)	1.143	(0.104)	15.69
Fourth Quartile	1.113	(0.104)	1.044	(0.101)	1.046	(0.101)	1.020	(0.099)	14.13
Missings	1.026	(0.089)	1.152	(0.120)	0.971	(0.220)	1.183	(0.350)	14.48
Establishment Age			1.006	(0.005)	1.006	(0.005)	1.005	(0.005)	13.84
Employees Age × Establishment Age									†
39.00-43.49 × Establishment Age (continuous)			0.997	(0.006)	0.997	(0.006)	0.998	(0.006)	†
43.50-47.99 × Establishment Age (continuous)			1.006	(0.006)	1.006	(0.006)	1.006	(0.006)	†
≥48.00 × Establishment Age (continuous)			1.000	(0.006)	1.001	(0.006)	1.002	(0.006)	†

	Model 1		Model 2		Model 3		Model 4		
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	RPr
Sex Diversity (Ref.: Nondiverse)									14.71
Slightly diverse Establishments			1.039	(0.066)	1.045	(0.070)	1.070	(0.077)	14.56
Diverse Establishment			0.979	(0.078)	0.965	(0.083)	1.000	(0.090)	13.17
Nationality Diversity (Ref.: Nondiverse)									16.21
Diverse			0.874*	(0.058)	0.930	(0.072)	0.935	(0.081)	12.51
Education Diversity (Ref.: Low Level of Diversity)									14.99
Medium Level			1.035	(0.070)	1.108	(0.082)	1.090	(0.084)	14.72
High Level			1.100	(0.085)	1.172	(0.097)	1.170	(0.101)	13.53
Share of Unknown Education (Ref.: 0)									15.76
0.01-100.00			0.867*	(0.059)	0.739**	(0.074)	0.823	(0.098)	11.81
Share of Part-Time (Ref.: 0)									15.15
0.01 - 19.99			1.191*	(0.100)	1.242*	(0.121)	1.208	(0.126)	14.90
≥20			1.076	(0.100)	1.116	(0.116)	1.079	(0.118)	13.38
Share of Full-Time (Ref.: 0 - 37.14)									12.79
37.15 - 66.66			1.153	(0.093)	1.150	(0.093)	1.136	(0.092)	14.46
66.67 - 86.04			1.138	(0.125)	1.129	(0.127)	1.114	(0.125)	14.65
>86.05			1.360*	(0.181)	1.331*	(0.183)	1.323*	(0.185)	15.45
Share of Apprentices (Ref.: 0)									14.36
0.01-100			1.218*	(0.098)	1.205	(0.165)	1.286	(0.206)	14.37
Share of Regular Employees (Ref.: 0 - 71.24)									13.29
71.25 - 87.49			1.089	(0.095)	1.111	(0.098)	1.104	(0.098)	14.84
87.50 - 96.90			1.120	(0.127)	1.141	(0.130)	1.148	(0.133)	14.49
>96.91			1.237	(0.167)	1.221	(0.172)	1.267	(0.184)	14.76
Sampled in t-1 (Ref.: not sampled)									14.79
sampled			0.427***	(0.029)	0.427***	(0.029)	0.427***	(0.029)	13.28
Participated in t-1 (Ref.: not participated)									12.69
participated			14.563***	(1.562)	14.676***	(1.562)	14.706***	(1.604)	51.99
Share of New Hirings in t (Ref.: 0-6.25)									16.94
6.26 - 15.37					0.870	(0.075)	0.861	(0.076)	14.62
15.38 - 29.51					0.853	(0.071)	0.857	(0.073)	13.49
≥29.52					0.870	(0.073)	0.876	(0.075)	12.74
Δ_t-1 *Sex Diversity (Ref.: No Change)*									15.42
Decrease					0.983	(0.077)	0.984	(0.078)	13.67
Increase					1.015	(0.081)	1.034	(0.084)	14.04
Δ_t-1 *Nationality Diversity (Ref.: No Change)*									15.38
Decrease					0.950	(0.085)	0.965	(0.087)	12.81
Increase					0.921	(0.085)	0.944	(0.089)	12.13
Δ_t-1 *Education Diversity (Ref.: No Change)*									15.99
Decrease					0.884	(0.075)	0.885	(0.075)	13.74
Increase					0.867	(0.070)	0.859	(0.070)	13.50
Δ_t-1 *Share of Marginal Employees (Ref.: No Change)*									12.20
Decrease					0.964	(0.093)	0.959	(0.095)	13.59
Increase					0.873	(0.088)	0.878	(0.090)	14.09
Δ_t-1 *Employees Age (Ref.: Stable Age)*									13.17
More than a half Year older					1.007	(0.077)	1.007	(0.077)	14.59
More than a half Year younger					1.141	(0.095)	1.143	(0.095)	15.13
Δ_t-1 *Wage Growth (Ref.: No Change)*									14.35
Negative Wage Growth					1.078	(0.094)	1.045	(0.091)	14.40
Positive Wage Growth of up to 5 percent					1.043	(0.088)	1.021	(0.086)	14.71
Positive Wage Growth of more than 5 percent					1.039	(0.087)	1.016	(0.085)	13.91
Wage Missing Value					1.169	(0.250)	1.179	(0.252)	14.38
Δ_t-1 *Share of Unknown Education (Ref.: No Change)*									12.92
Decrease					1.262*	(0.130)	1.288*	(0.136)	11.93
Increase					1.267	(0.156)	1.312*	(0.167)	15.44
Δ_t-1 *Share of Part-Time (Ref.: No Change)*									15.60
Decrease					0.991	(0.092)	0.998	(0.093)	14.05
Increase					0.956	(0.085)	0.958	(0.087)	13.56

	Model 1		Model 2		Model 3		Model 4		
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	RPr
Δ_$t-1$ *Share of Full-Time (Ref.: No Change)*									15.38
Decrease					0.967	(0.087)	0.962	(0.087)	13.76
Increase					0.907	(0.084)	0.896	(0.083)	13.70
Δ_$t-1$ *Share of Apprentices (Ref.: No Change)*									14.38
Decrease					1.179	(0.158)	1.159	(0.157)	14.86
Increase					0.939	(0.135)	0.944	(0.136)	13.77
Δ_$t-1$ *Share of Regular Employees (Ref.: No Change)*									15.00
Decrease					1.036	(0.096)	1.013	(0.094)	14.11
Increase					0.904	(0.083)	0.907	(0.084)	13.53
Share of New Hirings in t+1 (Ref.: 0-5.95)									16.49
5.96 - 14.99							0.979	(0.090)	15.48
15.00 - 27.99							0.896	(0.080)	13.56
≥28.00							0.835^{*}	(0.071)	12.09
Δ_$t+1$ *Sex Diversity (Ref.: No Change)*									15.45
Decrease							0.886	(0.074)	13.46
Increase							0.968	(0.078)	14.22
Δ_$t+1$ *Nationality Diversity (Ref.: No Change)*									15.42
Decrease							0.972	(0.101)	12.21
Increase							0.987	(0.086)	12.66
Δ_$t+1$ *Education Diversity (Ref.: No Change)*									15.09
Decrease							1.014	(0.088)	13.55
Increase							1.105	(0.087)	14.48
Δ_$t+1$ *Share of Marginal Employees (Ref.: No Change)*									14.66
Decrease							0.994	(0.098)	14.08
Increase							1.031	(0.098)	14.27
Δ_$t+1$ *Employees Age (Ref.: Stable Age)*									14.77
More than a half Year older							0.841^{*}	(0.068)	14.18
More than a half Year younger							0.866	(0.074)	14.31
Δ_$t+1$ *Wage Growth (Ref.: No Change)*									13.31
Negative Wage Growth							1.159	(0.113)	14.17
Positive Wage Growth of up to 5 percent							1.140	(0.103)	14.66
Positive Wage Growth of more than 5 percent							1.185	(0.106)	14.71
Wage Missing Value							0.905	(0.188)	14.10
Δ_$t+1$ *Share of Unknown Education (Ref.: No Change)*									15.91
Decrease							0.797	(0.104)	12.28
Increase							0.879	(0.091)	12.05
Δ_$t+1$ *Share of Part-Time (Ref.: No Change)*									15.14
Decrease							1.118	(0.103)	14.75
Increase							0.911	(0.079)	13.38
Δ_$t+1$ *Share of Full-Time (Ref.: No Change)*									14.60
Decrease							1.141	(0.104)	14.20
Increase							0.972	(0.089)	14.23
Δ_$t+1$ *Share of Apprentices (Ref.: No Change)*									14.46
Decrease							0.838	(0.120)	13.09
Increase							1.037	(0.130)	15.43
Δ_$t+1$ *Share of Regular Employees (Ref.: No Change)*									14.34
Decrease							0.933	(0.083)	14.26
Increase							1.213^{*}	(0.113)	14.50
Constant	0.239^{***}	(0.031)	0.146^{***}	(0.031)	0.155^{***}	(0.037)	0.172^{***}	(0.045)	
Observations	77328		77328		77328		77328		
Pseudo R^2	0.010		0.022		0.025		0.028		
AIC	1482913		1463921		1459635		1455243		
BIC	1483284		1464486		1460449		1456307		

Table 2.D.10: Logistic Regression Models of Survey Participation - 2017

	Model 1		Model 2		Model 3		Model 4		
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	RPr
DV: Response									
Region (Ref.: East Germany)									14.93
West Germany	0.929	(0.042)	0.918	(0.045)	0.919	(0.045)	0.917	(0.046)	14.03
Industry (Ref.: Agriculture / Forestry)									19.69
Mining / Ores / Earths	0.706**	(0.090)	0.796	(0.111)	0.792	(0.110)	0.791	(0.111)	15.75
Nutrition / Textiles / Clothing / Furniture etc.	0.681**	(0.084)	0.697**	(0.088)	0.684**	(0.086)	0.680**	(0.086)	14.03
Wood / Paper / Printing	0.667***	(0.080)	0.704**	(0.087)	0.697**	(0.087)	0.693**	(0.086)	14.31
Chemistry / Plastics / Glass / Construction Materials	0.632***	(0.074)	0.661***	(0.080)	0.650***	(0.079)	0.645***	(0.078)	13.58
Metals / Metal Production	0.646***	(0.076)	0.695**	(0.084)	0.686**	(0.083)	0.682**	(0.083)	14.63
Machines / Electronics / Vehicles	0.743*	(0.087)	0.782*	(0.095)	0.766*	(0.093)	0.761*	(0.093)	15.39
Energy Utilities	0.772*	(0.098)	0.930	(0.126)	0.911	(0.124)	0.899	(0.123)	15.78
Water / Waste Management	0.924	(0.109)	0.970	(0.120)	0.958	(0.119)	0.960	(0.120)	20.10
Construction	0.759*	(0.093)	0.811	(0.102)	0.803	(0.101)	0.803	(0.102)	16.78
Trade / Retail / Repairs	0.542***	(0.068)	0.593***	(0.077)	0.579***	(0.076)	0.580***	(0.076)	11.45
Transport/ Warehouses	0.637***	(0.077)	0.709**	(0.089)	0.708**	(0.089)	0.714**	(0.090)	13.07
Hospitality	0.534***	(0.067)	0.623***	(0.081)	0.625***	(0.082)	0.643***	(0.084)	10.21
Information and Communication	0.567***	(0.073)	0.659**	(0.088)	0.653**	(0.087)	0.649**	(0.087)	11.13
Financial Services / Insurance	0.550***	(0.076)	0.588***	(0.084)	0.586***	(0.084)	0.586***	(0.084)	11.90
Real Estate	0.746*	(0.105)	0.822	(0.120)	0.816	(0.119)	0.809	(0.118)	16.67
Liberal Professions / Scientific / Technical Services	0.932	(0.118)	1.022	(0.133)	1.017	(0.133)	1.006	(0.132)	17.69
Other Commercial Services/ Without Temporary Employment Agencies	0.676*	(0.107)	0.787	(0.130)	0.806	(0.133)	0.814	(0.135)	11.93
Temporary Employment Agencies	0.840	(0.115)	0.977	(0.138)	0.978	(0.138)	0.982	(0.139)	15.44
Public Administration	1.012	(0.121)	0.981	(0.123)	0.957	(0.121)	0.967	(0.123)	19.36
Education / Child Care	0.700**	(0.085)	0.743*	(0.095)	0.739*	(0.095)	0.748*	(0.097)	14.64
Health / Social Services	0.704**	(0.088)	0.768*	(0.101)	0.756*	(0.100)	0.759*	(0.101)	13.60
Art / Entertainment / Recreation	0.593***	(0.073)	0.685**	(0.087)	0.679**	(0.087)	0.683**	(0.088)	11.57
Other Services	0.949	(0.123)	0.997	(0.132)	0.978	(0.130)	0.976	(0.130)	18.60
Num. of Employees (Ref.: 1-9)									15.17
10-19	1.016	(0.062)	1.041	(0.072)	1.051	(0.076)	1.033	(0.078)	16.12
20-49	0.904	(0.049)	0.948	(0.067)	0.958	(0.073)	0.945	(0.075)	14.80
50-249	0.788***	(0.047)	0.878	(0.077)	0.864	(0.082)	0.865	(0.086)	13.41
250-499	0.533***	(0.039)	0.634***	(0.070)	0.601***	(0.073)	0.623***	(0.080)	9.79
500-999	0.518***	(0.046)	0.699**	(0.090)	0.659**	(0.094)	0.694*	(0.104)	9.77
≥1000	0.515***	(0.056)	0.726*	(0.109)	0.674*	(0.112)	0.730	(0.128)	9.71
Avg. Employees Age (Ref.: 0-39)									11.38
39.00-43.49	1.359***	(0.088)	1.664***	(0.195)	1.631***	(0.192)	1.621***	(0.191)	14.73
43.50-47.99	1.381***	(0.091)	1.345*	(0.161)	1.304*	(0.159)	1.277*	(0.156)	15.98
≥48.00	1.197**	(0.075)	1.263*	(0.143)	1.204	(0.139)	1.180	(0.138)	15.28
Share of Marginal Employees (Ref.: 0)									14.20
0.00-14.99	1.131	(0.071)	1.128	(0.095)	1.171	(0.115)	1.121	(0.118)	14.83
≥15	0.976	(0.052)	1.030	(0.101)	1.057	(0.116)	1.016	(0.117)	14.06
Wage Distribution (Ref.: First Quartile)									12.67
Second Quartile	1.050	(0.080)	1.032	(0.079)	1.037	(0.080)	1.031	(0.079)	13.78
Third Quartile	1.298***	(0.101)	1.237**	(0.098)	1.233**	(0.098)	1.213*	(0.096)	16.53
Fourth Quartile	1.076	(0.086)	1.018	(0.084)	1.007	(0.084)	0.985	(0.083)	13.90
Missings	1.178*	(0.091)	1.180	(0.106)	0.935	(0.176)	0.934	(0.218)	15.59
Establishment Age			1.020***	(0.004)	1.019***	(0.004)	1.018***	(0.004)	13.87
Employees Age × Establishment Age									†
39.00-43.49 × Establishment Age (continuous)			0.984**	(0.005)	0.984**	(0.005)	0.984**	(0.005)	†
43.50-47.99 × Establishment Age (continuous)			0.994	(0.005)	0.994	(0.005)	0.995	(0.005)	†
≥48.00 × Establishment Age (continuous)			0.989*	(0.005)	0.989*	(0.005)	0.990*	(0.005)	†

	Model 1		Model 2		Model 3		Model 4		
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	RPr
Sex Diversity (Ref.: Nondiverse)									14.73
Slightly diverse Establishments			1.029	(0.055)	1.049	(0.062)	1.036	(0.064)	14.39
Diverse Establishment			1.038	(0.074)	1.067	(0.082)	1.056	(0.084)	13.72
Nationality Diversity (Ref.: Nondiverse)									16.33
Diverse			0.911	(0.052)	0.963	(0.067)	0.917	(0.069)	12.71
Education Diversity (Ref.: Low Level of Diversity)									15.98
Medium Level			0.934	(0.057)	0.938	(0.063)	0.917	(0.065)	14.59
High Level			0.941	(0.063)	0.952	(0.069)	0.936	(0.074)	13.10
Share of Unknown Education (Ref.: 0)									16.04
0.01-100.00			0.844**	(0.049)	0.915	(0.084)	0.969	(0.100)	11.81
Share of Part-Time (Ref.: 0)									14.62
0.01 - 19.99			1.147	(0.087)	1.146	(0.100)	1.193	(0.113)	14.37
≥20			1.155	(0.095)	1.151	(0.104)	1.189	(0.115)	14.27
Share of Full-Time (Ref.: 0 - 37.14)									13.72
37.15 - 66.66			1.012	(0.073)	1.006	(0.072)	1.001	(0.072)	14.14
66.67 - 86.04			1.131	(0.108)	1.125	(0.109)	1.127	(0.109)	15.43
>86.05			1.169	(0.138)	1.119	(0.136)	1.127	(0.138)	14.12
Share of Apprentices (Ref.: 0)									14.98
0.01-100			0.912	(0.059)	0.837	(0.081)	0.847	(0.097)	13.32
Share of Regular Employees (Ref.: 0 - 71.24)									13.25
71.25 - 87.49			1.092	(0.079)	1.086	(0.079)	1.064	(0.078)	15.78
87.50 - 96.90			0.950	(0.095)	0.948	(0.097)	0.921	(0.095)	14.04
>96.91			0.983	(0.109)	1.009	(0.117)	0.971	(0.114)	14.47
Sampled in t-1 (Ref.: not sampled)									14.99
sampled			0.438***	(0.035)	0.436***	(0.035)	0.437***	(0.035)	12.70
Participated in t-1 (Ref.: not participated)									13.07
participated			12.481***	(1.299)	12.458***	(1.290)	12.612***	(1.299)	49.97
Share of New Hirings in t (Ref.: 0-6.25)									15.80
6.26 - 15.37					1.066	(0.081)	1.066	(0.082)	15.47
15.38 - 29.51					1.111	(0.083)	1.127	(0.085)	15.11
≥29.52					0.881	(0.065)	0.909	(0.067)	11.35
Δ_t-1 *Sex Diversity (Ref.: No Change)*									15.35
Decrease					0.967	(0.068)	0.958	(0.068)	14.24
Increase					0.938	(0.069)	0.930	(0.069)	13.65
Δ_t-1 *Nationality Diversity (Ref.: No Change)*									15.52
Decrease					0.943	(0.074)	0.939	(0.074)	12.86
Increase					0.926	(0.076)	0.918	(0.077)	12.20
Δ_t-1 *Education Diversity (Ref.: No Change)*									15.40
Decrease					1.003	(0.075)	0.992	(0.074)	13.75
Increase					1.022	(0.074)	1.013	(0.074)	14.15
Δ_t-1 *Share of Marginal Employees (Ref.: No Change)*									14.78
Decrease					0.898	(0.076)	0.888	(0.076)	14.06
Increase					0.961	(0.087)	0.952	(0.087)	14.21
Δ_t-1 *Employees Age (Ref.: Stable Age)*									13.82
More than a half Year older					0.944	(0.066)	0.949	(0.067)	14.54
More than a half Year younger					0.988	(0.073)	0.983	(0.072)	14.64
Δ_t-1 *Wage Growth (Ref.: No Change)*									14.79
Negative Wage Growth					0.931	(0.078)	0.924	(0.078)	1339
Positive Wage Growth of up to 5 percent					1.029	(0.079)	1.013	(0.078)	14.81
Positive Wage Growth of more than 5 percent					0.986	(0.075)	0.975	(0.075)	14.08
Wage Missing Value					1.191	(0.217)	1.159	(0.212)	15.40
Δ_t-1 *Share of Unknown Education (Ref.: No Change)*									15.99
Decrease					0.983	(0.093)	1.007	(0.095)	12.74
Increase					0.878	(0.095)	0.895	(0.098)	11.17
Δ_t-1 *Share of Part-Time (Ref.: No Change)*									15.10
Decrease					0.986	(0.078)	1.019	(0.082)	14.23
Increase					1.011	(0.081)	1.041	(0.084)	13.91

	Model 1		Model 2		Model 3		Model 4		
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	RPr
Δ_$t-1$ *Share of Full-Time (Ref.: No Change)*									15.13
Decrease					0.830*	(0.062)	0.833*	(0.063)	13.52
Increase					0.901	(0.070)	0.903	(0.071)	14.37
Δ_$t-1$ *Share of Apprentices (Ref.: No Change)*									14.87
Decrease					1.012	(0.097)	1.004	(0.099)	13.19
Increase					1.159	(0.129)	1.154	(0.130)	13.91
Δ_$t-1$ *Share of Regular Employees (Ref.: No Change)*									14.16
Decrease					1.107	(0.093)	1.102	(0.093)	14.34
Increase					1.140	(0.092)	1.149	(0.093)	14.77
Share of New Hirings in t+1 (Ref.: 0-5.95)									16.09
5.96 - 14.99							0.986	(0.076)	15.46
15.00 - 27.99							0.957	(0.072)	14.67
≥28.00							0.824**	(0.059)	11.75
Δ_$t+1$ *Sex Diversity (Ref.: No Change)*									14.81
Decrease							1.060	(0.077)	14.33
Increase							1.053	(0.073)	14.04
Δ_$t+1$ *Nationality Diversity (Ref.: No Change)*									15.24
Decrease							1.134	(0.100)	13.20
Increase							1.106	(0.078)	12.97
Δ_$t+1$ *Education Diversity (Ref.: No Change)*									14.99
Decrease							1.083	(0.082)	14.05
Increase							1.094	(0.077)	14.18
Δ_$t+1$ *Share of Marginal Employees (Ref.: No Change)*									14.43
Decrease							1.151	(0.099)	14.51
Increase							1.004	(0.080)	14.17
Δ_$t+1$ *Employees Age (Ref.: Stable Age)*									13.73
More than a half Year older							1.010	(0.066)	14.89
More than a half Year younger							0.931	(0.065)	14.08
Δ_$t+1$ *Wage Growth (Ref.: No Change)*									13.45
Negative Wage Growth							1.152	(0.097)	14.60
Positive Wage Growth of up to 5 percent							1.099	(0.087)	14.77
Positive Wage Growth of more than 5 percent							1.033	(0.078)	13.97
Wage Missing Value							1.067	(0.173)	15.40
Δ_$t+1$ *Share of Unknown Education (Ref.: No Change)*									16.21
Decrease							0.940	(0.097)	12.69
Increase							0.809**	(0.064)	11.08
Δ_$t+1$ *Share of Part-Time (Ref.: No Change)*									15.52
Decrease							0.980	(0.080)	14.52
Increase							0.797**	(0.063)	13.30
Δ_$t+1$ *Share of Full-Time (Ref.: No Change)*									16.64
Decrease							1.109	(0.088)	14.65
Increase							0.885	(0.071)	13.74
Δ_$t+1$ *Share of Apprentices (Ref.: No Change)*									14.91
Decrease							1.000	(0.109)	13.06
Increase							0.986	(0.097)	13.94
Δ_$t+1$ *Share of Regular Employees (Ref.: No Change)*									14.27
Decrease							1.001	(0.077)	14.88
Increase							1.017	(0.084)	14.08
Constant	0.200***	(0.023)	0.134***	(0.024)	0.156***	(0.032)	0.162***	(0.036)	
Observations	99742		99742		99742		99742		
Pseudo R^2	0.011		0.024		0.026		0.029		
AIC	1498914		1479884		1476368		1472382		
BIC	1499295		1480464		1477205		1473476		

Table 2.D.11: Logistic Regression Models of Survey Participation - 2018

	Model 1		Model 2		Model 3		Model 4		
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	RPr
DV: Response									
Region (Ref.: East Germany)									13.65
West Germany	1.003	(0.052)	1.009	(0.056)	1.019	(0.057)	1.017	(0.057)	13.67
Industry (Ref.: Agriculture / Forestry)									16.44
Mining / Ores / Earths	0.819	(0.111)	0.866	(0.124)	0.851	(0.122)	0.856	(0.123)	15.01
Nutrition / Textiles / Clothing / Furniture etc.	0.867	(0.113)	0.836	(0.112)	0.829	(0.112)	0.829	(0.112)	13.70
Wood / Paper / Printing	0.844	(0.102)	0.832	(0.103)	0.820	(0.102)	0.815	(0.102)	14.17
Chemistry / Plastics / Glass / Construction Materials	0.826	(0.101)	0.828	(0.104)	0.815	(0.103)	0.815	(0.104)	13.34
Metals / Metal Production	0.873	(0.106)	0.855	(0.107)	0.848	(0.106)	0.843	(0.106)	14.41
Machines / Electronics / Vehicles	0.991	(0.122)	0.963	(0.123)	0.952	(0.122)	0.953	(0.123)	14.66
Energy Utilities	1.061	(0.149)	1.128	(0.169)	1.081	(0.163)	1.082	(0.163)	16.43
Water / Waste Management	1.205	(0.149)	1.162	(0.150)	1.150	(0.149)	1.154	(0.151)	20.12
Construction	0.995	(0.126)	0.987	(0.128)	0.991	(0.129)	0.988	(0.129)	16.16
Trade / Retail / Repairs	0.749*	(0.098)	0.760*	(0.103)	0.753*	(0.102)	0.757*	(0.103)	11.56
Transport/ Warehouses	0.828	(0.103)	0.866	(0.112)	0.881	(0.114)	0.888	(0.116)	12.83
Hospitality	0.651***	(0.084)	0.711*	(0.096)	0.721*	(0.098)	0.727*	(0.099)	10.04
Information and Communication	0.782	(0.106)	0.815	(0.115)	0.800	(0.113)	0.800	(0.114)	10.98
Financial Services / Insurance	0.663**	(0.097)	0.656**	(0.099)	0.642**	(0.097)	0.646**	(0.098)	10.63
Real Estate	0.783	(0.114)	0.800	(0.120)	0.785	(0.118)	0.785	(0.118)	14.67
Liberal Professions / Scientific / Technical Services	0.897	(0.126)	0.897	(0.130)	0.897	(0.131)	0.894	(0.131)	12.84
Other Commercial Services/ Without Temporary Employment Agencies	0.694*	(0.126)	0.730	(0.137)	0.744	(0.140)	0.754	(0.142)	9.97
Temporary Employment Agencies	0.895	(0.139)	0.964	(0.155)	0.967	(0.156)	0.974	(0.157)	12.64
Public Administration	1.227	(0.154)	1.143	(0.151)	1.111	(0.147)	1.129	(0.150)	18.88
Education / Child Care	0.922	(0.116)	0.960	(0.127)	0.968	(0.129)	0.985	(0.132)	14.79
Health / Social Services	1.035	(0.136)	1.079	(0.149)	1.072	(0.149)	1.079	(0.151)	14.31
Art / Entertainment / Recreation	0.725*	(0.093)	0.768*	(0.103)	0.778	(0.104)	0.785	(0.106)	11.10
Other Services	1.138	(0.153)	1.145	(0.160)	1.125	(0.158)	1.141	(0.161)	17.76
Num. of Employees (Ref.: 1-9)									15.34
10-19	0.907	(0.054)	0.907	(0.061)	0.971	(0.067)	0.954	(0.069)	14.54
20-49	0.905	(0.050)	0.892	(0.063)	0.960	(0.072)	0.935	(0.074)	14.27
50-249	0.771***	(0.049)	0.743***	(0.067)	0.787*	(0.075)	0.767**	(0.076)	12.69
250-499	0.509***	(0.043)	0.518***	(0.062)	0.513***	(0.066)	0.501***	(0.067)	9.51
500-999	0.415***	(0.037)	0.450***	(0.058)	0.433***	(0.061)	0.428***	(0.063)	8.28
≥1000	0.478***	(0.056)	0.506***	(0.078)	0.473***	(0.079)	0.464***	(0.082)	9.15
Avg. Employees Age (Ref.: 0-39)									10.88
39.00-43.49	1.178*	(0.079)	1.091	(0.132)	1.080	(0.131)	1.066	(0.129)	12.90
43.50-47.99	1.269***	(0.085)	1.204	(0.147)	1.175	(0.144)	1.173	(0.145)	14.37
≥48.00	1.417***	(0.091)	1.586***	(0.180)	1.514***	(0.174)	1.502***	(0.176)	16.49
Share of Marginal Employees (Ref.: 0)									12.93
0.00-14.99	1.243***	(0.081)	1.465***	(0.125)	1.530***	(0.155)	1.522***	(0.173)	14.16
≥15	1.024	(0.057)	1.396**	(0.144)	1.472***	(0.168)	1.469**	(0.181)	13.86
Wage Distribution (Ref.: First Quartile)									11.66
Second Quartile	1.193*	(0.094)	1.154	(0.092)	1.170	(0.094)	1.154	(0.093)	14.07
Third Quartile	1.152	(0.093)	1.075	(0.089)	1.083	(0.090)	1.064	(0.089)	14.09
Fourth Quartile	1.169	(0.099)	1.099	(0.095)	1.095	(0.097)	1.076	(0.096)	13.52
Missings	1.254**	(0.103)	1.419***	(0.134)	1.212	(0.233)	1.681*	(0.426)	16.03
Establishment Age			1.009*	(0.004)	1.009*	(0.004)	1.008*	(0.004)	12.93
Employees Age × Establishment Age									†
39.00-43.49 × Establishment Age (continuous)			1.001	(0.005)	1.001	(0.005)	1.002	(0.005)	†
43.50-47.99 × Establishment Age (continuous)			1.000	(0.005)	0.999	(0.005)	0.999	(0.005)	†
≥48.00 × Establishment Age (continuous)			0.992	(0.005)	0.991	(0.005)	0.991	(0.005)	†

	Model 1		Model 2		Model 3		Model 4		
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	RPr
Sex Diversity (Ref.: Nondiverse)									13.92
Slightly diverse Establishments			1.073	(0.059)	1.071	(0.063)	1.059	(0.065)	13.73
Diverse Establishment			1.054	(0.077)	1.054	(0.080)	1.048	(0.082)	13.05
Nationality Diversity (Ref.: Nondiverse)									15.73
Diverse			0.886*	(0.052)	0.995	(0.069)	1.010	(0.076)	12.11
Education Diversity (Ref.: Low Level of Diversity)									14.68
Medium Level			1.056	(0.064)	1.118	(0.072)	1.081	(0.074)	14.13
High Level			1.085	(0.073)	1.147	(0.084)	1.117	(0.085)	12.61
Share of Unknown Education (Ref.: 0)									15.19
0.01-100.00			0.924	(0.055)	0.980	(0.089)	0.941	(0.096)	11.59
Share of Part-Time (Ref.: 0)									14.12
0.01 - 19.99			1.104	(0.081)	1.184*	(0.100)	1.274**	(0.116)	13.41
≥20			1.097	(0.090)	1.175	(0.108)	1.264*	(0.125)	13.70
Share of Full-Time (Ref.: 0 - 37.14)									12.76
37.15 - 66.66			1.281***	(0.092)	1.279***	(0.093)	1.281***	(0.094)	14.86
66.67 - 86.04			1.236*	(0.117)	1.241*	(0.119)	1.245*	(0.121)	13.99
>86.05			1.290*	(0.154)	1.260	(0.156)	1.277	(0.161)	12.97
Share of Apprentices (Ref.: 0)									13.89
0.01-100			1.183*	(0.078)	1.189	(0.121)	1.062	(0.126)	13.27
Share of Regular Employees (Ref.: 0 - 71.24)									13.26
71.25 - 87.49			1.083	(0.083)	1.100	(0.085)	1.085	(0.085)	14.72
87.50 - 96.90			1.040	(0.106)	1.080	(0.111)	1.067	(0.110)	12.78
>96.91			1.429**	(0.173)	1.473**	(0.184)	1.448**	(0.185)	14.02
Sampled in t-1 (Ref.: not sampled)									14.61
sampled			0.466***	(0.028)	0.467***	(0.028)	0.466***	(0.028)	11.88
Participated in t-1 (Ref.: not participated)									12.08
participated			11.858***	(1.005)	11.957***	(1.017)	11.983***	(1.023)	47.59
Share of New Hirings in t (Ref.: 0-6.25)									17.19
6.26 - 15.37					0.817**	(0.064)	0.820*	(0.064)	14.10
15.38 - 29.51					0.774***	(0.057)	0.776***	(0.058)	12.54
≥29.52					0.843*	(0.064)	0.846*	(0.065)	11.77
Δ_t-1 *Sex Diversity (Ref.: No Change)*									14.68
Decrease					1.071	(0.074)	1.066	(0.074)	13.50
Increase					1.023	(0.073)	1.020	(0.074)	12.96
Δ_t-1 *Nationality Diversity (Ref.: No Change)*									15.17
Decrease					0.817**	(0.064)	0.817*	(0.064)	11.24
Increase					0.862	(0.068)	0.868	(0.069)	11.57
Δ_t-1 *Education Diversity (Ref.: No Change)*									15.29
Decrease					0.933	(0.067)	0.927	(0.067)	13.15
Increase					0.940	(0.067)	0.935	(0.067)	12.86
Δ_t-1 *Share of Marginal Employees (Ref.: No Change)*									13.74
Decrease					1.007	(0.087)	0.997	(0.086)	13.89
Increase					0.947	(0.091)	0.940	(0.090)	13.30
Δ_t-1 *Employees Age (Ref.: Stable Age)*									13.40
More than a half Year older					0.879	(0.060)	0.879	(0.061)	13.86
More than a half Year younger					0.926	(0.068)	0.924	(0.068)	13.58
Δ_t-1 *Wage Growth (Ref.: No Change)*									13.61
Negative Wage Growth					0.966	(0.082)	0.983	(0.084)	12.90
Positive Wage Growth of up to 5 percent					1.034	(0.083)	1.044	(0.084)	14.15
Positive Wage Growth of more than 5 percent					0.956	(0.075)	0.967	(0.077)	13.20
Wage Missing Value					1.043	(0.193)	1.110	(0.208)	15.54
Δ_t-1 *Share of Unknown Education (Ref.: No Change)*									11.38
Decrease					0.913	(0.084)	0.916	(0.085)	11.40
Increase					0.947	(0.099)	0.942	(0.099)	15.28
Δ_t-1 *Share of Part-Time (Ref.: No Change)*									15.02
Decrease					0.956	(0.073)	0.978	(0.075)	13.00
Increase					0.901	(0.071)	0.930	(0.074)	15.05

	Model 1		Model 2		Model 3		Model 4		
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	RPr
Δ_$t-1$ *Share of Full-Time (Ref.: No Change)*									14.64
Decrease					0.903	(0.069)	0.895	(0.068)	13.22
Increase					0.834*	(0.067)	0.837*	(0.067)	12.95
Δ_$t-1$ *Share of Apprentices (Ref.: No Change)*									14.08
Decrease					0.853	(0.081)	0.829	(0.080)	11.64
Increase					1.059	(0.120)	1.045	(0.119)	14.46
Δ_$t-1$ *Share of Regular Employees (Ref.: No Change)*									13.55
Decrease					1.109	(0.102)	1.115	(0.103)	13.72
Increase					1.164	(0.095)	1.160	(0.095)	13.79
Share of New Hirings in t+1 (Ref.: 0-5.95)									15.99
5.96 - 14.99							0.966	(0.074)	14.08
15.00 - 27.99							0.949	(0.074)	13.11
≥28.00							0.945	(0.074)	11.96
Δ_$t+1$ *Sex Diversity (Ref.: No Change)*									14.30
Decrease							1.036	(0.072)	13.36
Increase							1.048	(0.073)	13.41
Δ_$t+1$ *Nationality Diversity (Ref.: No Change)*									14.77
Decrease							0.951	(0.082)	11.75
Increase							1.015	(0.074)	12.32
Δ_$t+1$ *Education Diversity (Ref.: No Change)*									14.31
Decrease							1.098	(0.083)	13.34
Increase							1.114	(0.081)	13.47
Δ_$t+1$ *Share of Marginal Employees (Ref.: No Change)*									13.57
Decrease							0.995	(0.087)	13.73
Increase							1.018	(0.087)	13.71
Δ_$t+1$ *Employees Age (Ref.: Stable Age)*									14.08
More than a half Year older							0.992	(0.070)	12.69
More than a half Year younger							0.994	(0.073)	13.96
Δ_$t+1$ *Wage Growth (Ref.: No Change)*									14.55
Negative Wage Growth							0.935	(0.080)	13.47
Positive Wage Growth of up to 5 percent							0.929	(0.075)	13.59
Positive Wage Growth of more than 5 percent							0.909	(0.073)	13.14
Wage Missing Value							0.610*	(0.122)	14.98
Δ_$t+1$ *Share of Unknown Education (Ref.: No Change)*									15.09
Decrease							1.085	(0.112)	12.15
Increase							1.025	(0.082)	11.58
Δ_$t+1$ *Share of Part-Time (Ref.: No Change)*									15.09
Decrease							0.825*	(0.066)	13.20
Increase							0.869	(0.067)	12.93
Δ_$t+1$ *Share of Full-Time (Ref.: No Change)*									14.00
Decrease							0.950	(0.074)	13.13
Increase							1.056	(0.080)	13.83
Δ_$t+1$ *Share of Apprentices (Ref.: No Change)*									13.73
Decrease							1.130	(0.128)	13.29
Increase							1.215	(0.122)	13.80
Δ_$t+1$ *Share of Regular Employees (Ref.: No Change)*									13.49
Decrease							1.055	(0.083)	13.94
Increase							0.998	(0.082)	13.68
Constant	0.142***	(0.018)	0.072***	(0.013)	0.089***	(0.019)	0.098***	(0.023)	
Observations	99292		99292		99292		99292		
Pseudo R^2	0.009		0.022		0.026		0.028		
AIC	1476265		1457029		1451477		14488813		
BIC	1476645		1457609		1452313		1449906		

2.D.2 Random Intercept Model

Table 2.D.12: Random Intercept Model, 2011 - 2018 BHP

	Model 1		Model 2		Model 3		Model 4	
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)
Region (Ref.: East Germany)								
West Germany	0.938*	(0.022)	0.937*	(0.023)	0.940*	(0.024)	Did not Converge	
Industry (Ref.: Agriculture / Forestry)								
Mining / Ores / Earths	0.692***	(0.033)	0.710***	(0.038)	0.711***	(0.037)		
Nutrition / Textiles / Clothing / Furniture etc.	0.654***	(0.033)	0.644***	(0.032)	0.646***	(0.032)		
Wood / Paper / Printing	0.677***	(0.025)	0.665***	(0.026)	0.665***	(0.024)		
Chemistry / Plastics / Glass / Construction Materials	0.704***	(0.029)	0.702***	(0.029)	0.700***	(0.027)		
Metals / Metal Production	0.684***	(0.042)	0.689***	(0.040)	0.689***	(0.040)		
Machines / Electronics / Vehicles	0.735**	(0.042)	0.735***	(0.040)	0.733***	(0.040)		
Energy Utilities	0.677**	(0.052)	0.741**	(0.061)	0.733**	(0.057)		
Water / Waste Management	0.931	(0.038)	0.944	(0.036)	0.944	(0.033)		
Construction	0.745***	(0.036)	0.755***	(0.034)	0.760***	(0.033)		
Trade / Retail / Repairs	0.538***	(0.035)	0.561***	(0.038)	0.564***	(0.037)		
Transport/ Warehouses	0.654***	(0.024)	0.698***	(0.026)	0.715***	(0.023)		
Hospitality	0.517***	(0.026)	0.587***	(0.029)	0.604***	(0.029)		
Information and Communication	0.534***	(0.036)	0.580***	(0.039)	0.583***	(0.037)		
Financial Services / Insurance	0.505***	(0.028)	0.517***	(0.030)	0.517***	(0.028)		
Real Estate	0.661***	(0.029)	0.696***	(0.032)	0.693***	(0.031)		
Liberal Professions / Scientific / Technical Services	0.804**	(0.042)	0.827*	(0.050)	0.830*	(0.049)		
Other Commercial Services/ Without Temporary Employment Agencies	0.626***	(0.040)	0.681**	(0.048)	0.698**	(0.048)		
Temporary Employment Agencies	0.739***	(0.040)	0.815*	(0.049)	0.828*	(0.047)		
Public Administration	0.945	(0.059)	0.912	(0.060)	0.918	(0.056)		
Education / Child Care	0.699**	(0.047)	0.732**	(0.054)	0.751**	(0.053)		
Health / Social Services	0.758***	(0.038)	0.798**	(0.043)	0.800**	(0.041)		
Art / Entertainment / Recreation	0.553***	(0.030)	0.599***	(0.035)	0.611***	(0.034)		
Other Services	0.817**	(0.045)	0.835*	(0.048)	0.840*	(0.046)		
Num. of Employees (Ref.: 1-9)								
10-19	0.914**	(0.019)	0.925*	(0.024)	0.968	(0.023)		
20-49	0.854***	(0.016)	0.875***	(0.020)	0.917**	(0.022)		
50-249	0.733***	(0.016)	0.766***	(0.025)	0.787***	(0.023)		
250-499	0.563***	(0.015)	0.612***	(0.028)	0.600***	(0.029)		
500-999	0.487***	(0.018)	0.563***	(0.038)	0.541***	(0.035)		
≥1000	0.523***	(0.021)	0.624***	(0.038)	0.587***	(0.040)		
Avg. Employees Age (Ref.: 0-39)								
39.00-43.49	1.184***	(0.032)	1.166*	(0.068)	1.153*	(0.067)		
43.50-47.99	1.211***	(0.038)	1.129*	(0.045)	1.100*	(0.042)		
≥48.00	1.271***	(0.039)	1.285**	(0.066)	1.229**	(0.064)		
Share of Marginal Employees (Ref.: 0)								
0.00-14.99	1.196***	(0.027)	1.225***	(0.039)	1.222**	(0.054)		
≥15	1.053	(0.023)	1.209***	(0.041)	1.216**	(0.054)		
Wage Distribution (Ref.: First Quartile)								
Second Quartile	1.066*	(0.021)	1.038	(0.020)	1.043	(0.021)		
Third Quartile	1.156**	(0.039)	1.098*	(0.036)	1.099*	(0.037)		
Fourth Quartile	1.060	(0.040)	0.998	(0.038)	0.992	(0.039)		
Missings	1.032	(0.039)	1.113*	(0.044)	1.019	(0.073)		
Establishment Age			1.009**	(0.002)	1.009**	(0.002)		
Employees Age × Establishment Age								
39.00-43.49 × Establishment Age (continuous)			0.999	(0.002)	0.999	(0.002)		
43.50-47.99 × Establishment Age (continuous)			1.001	(0.001)	1.001	(0.001)		
≥48.00 × Establishment Age (continuous)			0.996	(0.002)	0.996	(0.002)		

	Model 1		Model 2		Model 3		Model 4	
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)
Sex Diversity (Ref.: Nondiverse)								
Slightly diverse Establishments			1.021	(0.026)	1.040	(0.025)		
Diverse Establishment			1.068*	(0.025)	1.082*	(0.027)		
Nationality Diversity (Ref.: Nondiverse)								
Diverse			0.868***	(0.014)	0.920*	(0.024)		
Education Diversity (Ref.: Low Level of Diversity)								
Medium Level			1.017	(0.015)	1.051*	(0.019)		
High Level			1.052*	(0.021)	1.086*	(0.027)		
Share of Unknown Education (Ref.: 0)								
0.01-100.00			0.853***	(0.013)	0.891*	(0.033)		
Share of Part-Time (Ref.: 0)								
0.01 - 19.99			1.062	(0.028)	1.109**	(0.033)		
≥20			1.034	(0.026)	1.069	(0.037)		
Share of Full-Time (Ref.: 0 - 37.5)								
37.15 - 66.66			1.120**	(0.028)	1.114**	(0.027)		
66.67 - 86.04			1.148***	(0.029)	1.146***	(0.023)		
>86.05			1.173***	(0.030)	1.156***	(0.030)		
Share of Apprentices (Ref.: 0)								
0.01-100			1.093*	(0.032)	1.072	(0.046)		
Share of Regular Employees (Ref.: 0 - 71.4)								
71.25 - 87.49			1.076**	(0.022)	1.080**	(0.021)		
87.50 - 96.90			1.047	(0.031)	1.046	(0.031)		
>96.91			1.128*	(0.045)	1.096	(0.054)		
Sampled in t-1 (Ref.: not sampled)								
sampeld			0.450***	(0.014)	0.450***	(0.014)		
Participated in t-1 (Ref.: not participated)							Did not Converge	
participated			10.446***	(0.792)	10.420***	(0.794)		
Share of New Hirings in t (Ref.: 0-6.00)								
6.26 - 15.37					0.922*	(0.031)		
15.38 - 29.51					0.901*	(0.039)		
≥29.52					0.868***	(0.019)		
Δ_t-1 *Sex Diversity (Ref.: No Change)*								
Decrease					0.986	(0.019)		
Increase					0.973	(0.021)		
Δ_t-1 *Nationality Diversity (Ref.: No Change)*								
Decrease					0.920*	(0.022)		
Increase					0.940	(0.035)		
Δ_t-1 *Education Diversity (Ref.: No Change)*								
Decrease					0.980	(0.019)		
Increase					0.952	(0.022)		
Δ_t-1 *Share of Marginal Employees (Ref.: No Change)*								
Decrease					1.037	(0.034)		
Increase					1.012	(0.040)		
Δ_t-1 *Employees Age (Ref.: Stable Age)*								
More than a half Year older					0.968	(0.026)		
More than a half Year younger					1.027	(0.026)		
Δ_t-1 *Wage Growth (Ref.: No Change)*								
Negative Wage Growth					0.957	(0.026)		
Positive Wage Growth of up to 5 percent					0.998	(0.022)		
Positive Wage Growth of more than 5 percent					0.978	(0.030)		
Wage Missing Value					1.026	(0.075)		
Δ_t-1 *Share of Unknown Education (Ref.: No Change)*								
Decrease					0.931	(0.056)		
Increase					0.971	(0.046)		
Δ_t-1 *Share of Part-Time (Ref.: No Change)*								
Decrease					0.941*	(0.018)		
Increase					0.957	(0.022)		

	Model 1		Model 2		Model 3		Model 4	
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)
Δ_$t-1$ *Share of Full-Time (Ref.: No Change)*								
Decrease					0.974	(0.035)	Did not Converge	
Increase					0.924*	(0.027)		
Δ_$t-1$ *Share of Apprentices (Ref.: No Change)*								
Decrease					1.003	(0.035)		
Increase					1.026	(0.031)		
Δ_$t-1$ *Share of Regular Employees (Ref.: No Change)*								
Decrease					0.972	(0.046)		
Increase					0.985	(0.043)		
Constant	0.281***	(0.021)	0.194***	(0.023)	0.228***	(0.026)		
/								
var(_cons[Year])	440019646 ***	(26.42)	41506641 ***	(25.44)	41712594 ***	(25.75)		
Observations	636105		636105		636105			

2.E Nonresponse reduction - BHP

2.E.1 Parameter Tuning

Table 2.E.1: Parameter Tuning and Software Package

Algorithm	Tuned Parameters	Tested Values	Software Package	Classification vs Regression	Notes
Logistic Regression	-	-	STATA - logistic		
Lasso	-	-	R - glmnet		
Ridge	-	-	R - glmnet		
GAM	-	-	R - GAM		
GAMSEL	– spline – lambda	10 50	R - gamsel		
CART	– cp	0.0001, 0.0005, 0.001, 0.005, 0.01, 0.05, 0.1, 0.5	R - Caret - rpart	Regression	
C-Tree	– mincriterion	0.99, 0.95, 0.90, 0.85, 0.75	R - Caret - ctree	Classification	
MOB	alpha minsplit criterion	0.05 1500 AIC	R - glmtree	Classification	
BART	default	default	R - bartmachine	Classification	
Random Forest	– mtry – node.size	3 1, 20, 100, 1000	R - Random Forest	Regression	OOB-prediction
XG Boost	– max_depth – nrounds – eta	3, 5, 8 100, 300, 500 0.01, 0.1, 0.2, 0.3, 0.5	R - Caret - xgbTree	Classification	

Note: Parameters that are not specified in the table above are set to the default values of the package.

2.E.2 Correlation between New Hires and Vacancies

Due to different definitions and operationalizations of vacancies and new hires (marginal employees, apprentices, different time intervals etc.) the correlation of the number of vacancies and new hires varies between the used variables. The table below summarizes pearson's correlations coefficient of four different settings. All in all, there is a moderate correlation between new hires and vacancies measured by the IAB-JVS.

Table 2.E.2: Correlation between Hirings and Vacancies

Hiring	**Vacancy**	**Correlation**
All Hirings (IAB-JVS - f10)	Survey answer (IAB-JVS f20 + f40)	0.39
Hirings contributing to social security (IAB-JVS - f11_04)	Survey answer (IAB-JVS - f20 + f40)	0.35
All Hirings (BHP - ein_ges in t)	Survey answer (IAB-JVS - f20 + f40)	0.25
All Hirings (BHP - ein_ges in t+1)	Survey answer (IAB-JVS - f20 + f40)	0.25

2.E.3 Average Absolute Bias

Table 2.E.3: Average Absolute Bias by Modeling Approach and Set of Explanatory Variables, All Variables BHP 2011-2018

Year	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011	1.423	1.185	1.080	1.033	1.064	1.052	1.250	1.217	1.033	1.147	0.997	0.950	0.945
2012	1.372	1.132	0.923	0.882	0.865	0.893	1.069	1.199	1.088	1.049	0.799	0.823	0.842
2013	1.569	1.387	1.185	1.123	1.163	1.216	1.302	1.407	1.284	1.346	1.167	1.133	1.202
2014	1.531	1.256	0.933	1.018	1.025	0.937	1.224	1.334	1.127	1.295	1.020	1.027	0.928
2015	1.739	1.539	1.206	1.182	1.215	1.192	1.500	1.553	1.420	1.398	1.256	1.176	1.246
2016	1.465	1.140	0.943	0.919	0.905	0.952	1.115	1.208	0.918	0.961	0.958	0.916	0.927
2017	1.665	1.493	1.187	1.205	1.170	1.102	1.375	1.505	1.397	1.402	1.191	1.117	1.117
2018	1.589	1.329	1.076	1.057	1.023	1.192	1.246	1.282	1.034	1.215	1.032	1.014	1.098

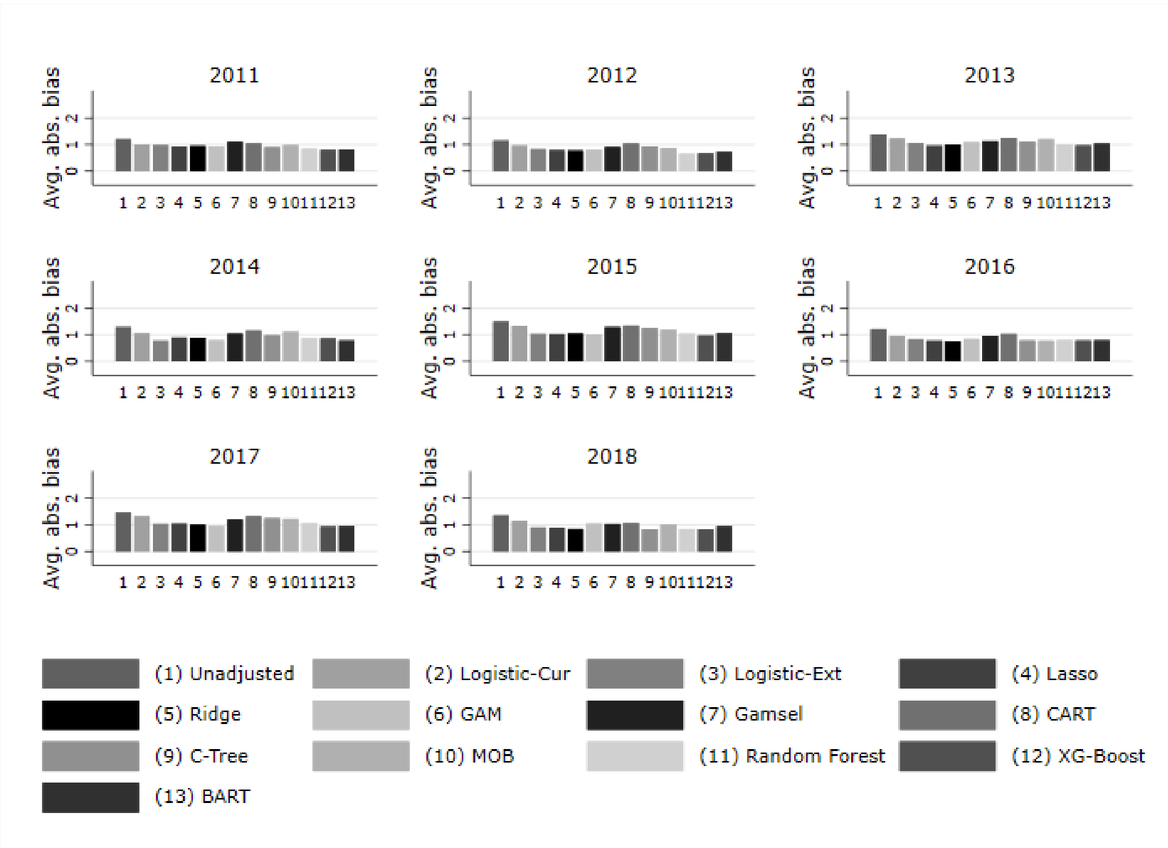

Figure 2.E.1: Average Absolute Bias by Modeling Approach and Set of Explanatory Variables, Employee Characteristics BHP 2011-2018

Table 2.E.4: Average Absolute Bias by Modeling Approach and Set of Explanatory Variables, Employee Characteristics BHP 2011-2018

Year	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011	1.195	0.996	0.931	0.904	0.927	0.912	1.070	1.034	0.889	0.975	0.861	0.783	0.787
2012	1.193	0.997	0.837	0.798	0.779	0.806	0.919	1.082	0.956	0.893	0.679	0.675	0.742
2013	1.455	1.293	1.096	1.000	1.045	1.111	1.166	1.334	1.180	1.282	1.059	1.016	1.098
2014	1.371	1.115	0.793	0.935	0.928	0.823	1.067	1.202	0.984	1.149	0.934	0.908	0.807
2015	1.542	1.393	1.034	1.037	1.065	1.026	1.304	1.349	1.261	1.193	1.091	0.977	1.071
2016	1.249	0.953	0.794	0.767	0.752	0.820	0.911	1.028	0.757	0.771	0.841	0.771	0.786
2017	1.558	1.397	1.097	1.110	1.061	1.019	1.273	1.396	1.285	1.318	1.116	1.004	0.990
2018	1.411	1.174	0.904	0.928	0.870	1.053	1.041	1.142	0.834	1.006	0.887	0.846	0.958

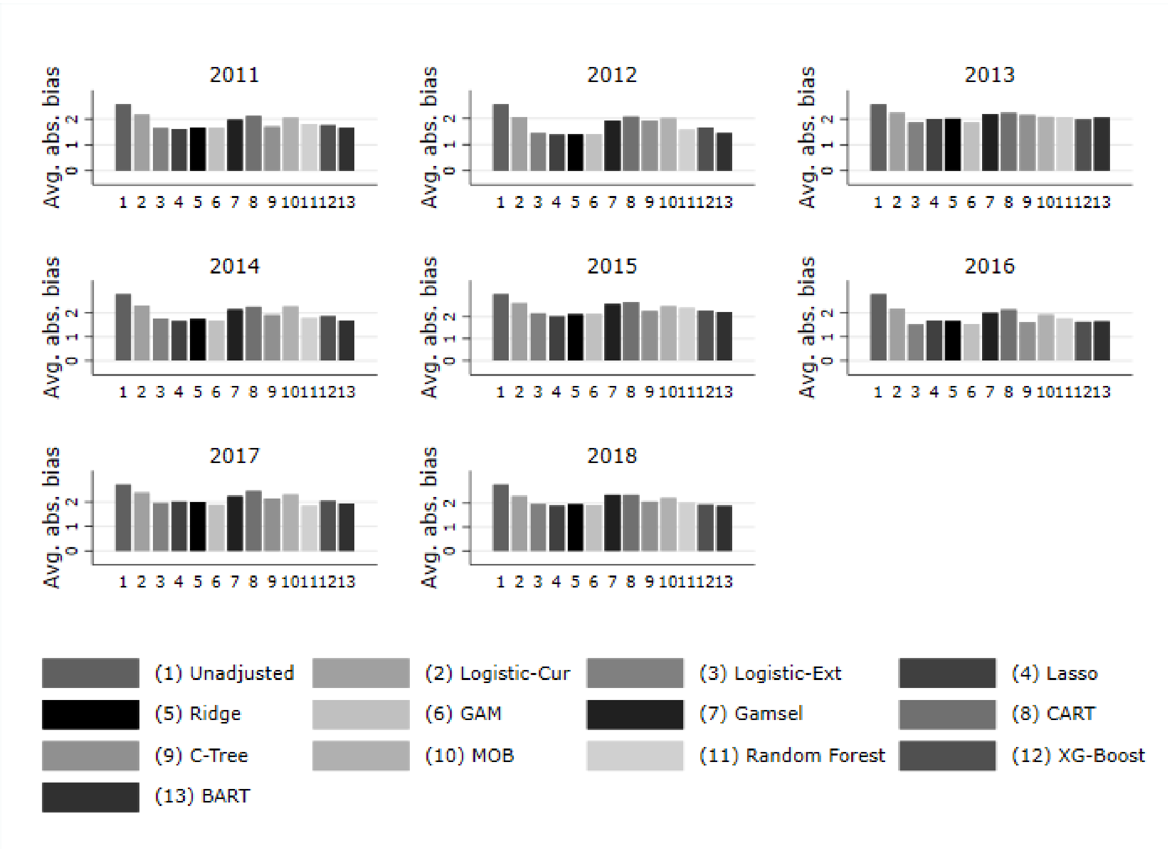

Figure 2.E.2: Average Absolute Bias by Modeling Approach and Set of Explanatory Variables, Establishment Characteristics BHP 2011-2018

Table 2.E.5: Average Absolute Bias by Modeling Approach and Set of Explanatory Variables, Establishment Characteristics BHP 2011-2018

Year	**Unadjusted**	**Logistic Cur**	**Logistic Ext**	**Lasso**	**Ridge**	**GAM**	**Gamsel**	**CART**	**C-Tree**	**MOB**	**Random Forest**	**XG-Boost**	**Bart**
2011	1.785	1.511	1.145	1.117	1.155	1.152	1.368	1.468	1.181	1.420	1.256	1.220	1.152
2012	1.766	1.412	1.002	0.956	0.962	0.965	1.323	1.431	1.327	1.393	1.090	1.154	0.999
2013	1.785	1.553	1.287	1.393	1.396	1.287	1.523	1.551	1.499	1.441	1.436	1.379	1.425
2014	1.928	1.604	1.223	1.154	1.209	1.169	1.491	1.569	1.333	1.584	1.237	1.294	1.166
2015	2.087	1.811	1.485	1.396	1.455	1.464	1.786	1.845	1.564	1.721	1.667	1.581	1.533
2016	1.929	1.507	1.063	1.164	1.155	1.074	1.384	1.484	1.116	1.340	1.230	1.131	1.143
2017	1.873	1.644	1.350	1.394	1.390	1.297	1.546	1.689	1.484	1.595	1.273	1.412	1.343
2018	1.920	1.588	1.355	1.308	1.350	1.325	1.622	1.624	1.427	1.539	1.398	1.336	1.301

2.E.4 Individual Bias Estimates

Table 2.E.6: Bias Estimates of Number of Employees by Year and Weighting Strategy, BHP 2011-2018

Variable	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011													
1-9	2.539	1.944	2.780	2.250	2.344	2.346	3.116	2.308	2.137	1.921	1.260	1.841	2.057
10-19	0.646	0.481	0.888	0.592	0.659	0.646	0.948	0.660	0.674	0.454	0.110	0.460	0.684
20-49	0.803	0.563	0.839	0.799	0.783	0.763	0.971	0.724	0.563	0.628	0.521	0.651	0.663
≥50	1.091	0.900	1.054	0.858	0.902	0.936	1.197	0.925	0.900	0.839	0.629	0.730	0.710
2012													
1-9	0.934	0.435	1.096	1.046	0.774	1.072	1.347	0.489	1.004	0.608	0.015	0.371	0.838
10-19	0.367	0.650	0.259	0.265	0.440	0.347	0.232	0.507	0.291	0.521	0.680	0.662	0.302
20-49	0.428	0.306	0.518	0.552	0.492	0.630	0.611	0.329	0.454	0.467	0.233	0.412	0.476
≥50	0.873	0.779	0.838	0.760	0.723	0.788	0.969	0.667	0.841	0.662	0.462	0.621	0.664
2013													
1-9	0.913	0.581	1.128	0.483	0.714	1.788	1.507	0.430	0.372	0.390	0.406	0.680	0.521
10-19	0.127	0.344	0.107	0.407	0.294	0.231	0.045	0.199	0.470	0.373	0.161	0.250	0.266
20-49	0.375	0.226	0.437	0.308	0.372	0.719	0.579	0.239	0.283	0.242	0.189	0.352	0.252
≥50	0.665	0.700	0.798	0.582	0.636	0.838	0.883	0.391	0.559	0.521	0.378	0.577	0.535
2014													
1-9	0.830	0.644	1.116	0.885	0.884	0.934	1.619	1.313	1.747	1.281	0.004	0.808	1.069
10-19	0.046	0.061	0.241	0.257	0.161	0.212	0.256	0.250	0.679	0.238	0.223	0.135	0.268
20-49	0.134	0.053	0.084	0.052	0.056	0.011	0.354	0.271	0.177	0.259	0.203	0.009	0.125
≥50	0.741	0.759	0.791	0.577	0.668	0.733	1.010	0.791	0.890	0.783	0.429	0.665	0.676
2015													
1-9	1.971	1.369	1.886	1.731	1.659	1.798	2.350	2.479	2.501	2.302	0.883	1.642	1.900
10-19	0.539	0.149	0.369	0.465	0.364	0.422	0.556	0.680	0.794	0.834	0.242	0.391	0.695
20-49	0.549	0.432	0.613	0.549	0.576	0.582	0.735	0.727	0.678	0.666	0.293	0.570	0.573
≥50	0.882	0.789	0.905	0.716	0.719	0.794	1.059	1.073	1.028	0.802	0.348	0.681	0.632
2016													
1-9	1.636	1.648	2.403	1.674	1.658	2.032	2.633	2.067	2.182	1.606	0.639	1.715	1.610
10-19	0.903	0.792	1.072	0.842	0.816	0.974	1.178	1.222	0.989	0.861	0.527	0.754	0.807
20-49	0.122	0.148	0.443	0.180	0.194	0.313	0.486	0.213	0.403	0.185	0.105	0.278	0.195
≥50	0.611	0.708	0.888	0.652	0.647	0.745	0.969	0.632	0.790	0.560	0.217	0.683	0.608
2017													
1-9	0.282	0.516	0.313	0.467	0.505	0.039	0.529	0.777	1.582	0.059	1.061	0.196	1.149
10-19	0.931	0.926	0.758	0.594	0.661	0.462	0.553	0.965	1.485	0.546	0.627	0.359	0.742
20-49	0.055	0.153	0.101	0.236	0.250	0.035	0.265	0.184	0.354	0.096	0.445	0.167	0.524
≥50	0.595	0.563	0.546	0.363	0.405	0.536	0.818	0.372	0.257	0.390	0.011	0.330	0.116
2018													
1-9	1.687	1.649	1.873	1.138	1.164	2.115	1.973	0.436	1.751	2.393	0.516	1.518	1.691
10-19	0.753	0.744	0.908	0.690	0.650	1.109	0.860	0.397	0.805	1.284	0.645	0.976	0.961
20-49	0.197	0.174	0.269	0.030	0.047	0.338	0.285	0.341	0.205	0.487	0.225	0.119	0.276
≥50	0.736	0.731	0.696	0.419	0.467	0.668	0.827	0.380	0.741	0.623	0.096	0.423	0.454

Table 2.E.7: Bias Estimates of Share of Germans by Year and Weighting Strategy, BHP 2011-2018

Variable	**Unadjusted**	**Logistic Cur**	**Logistic Ext**	**Lasso**	**Ridge**	**GAM**	**Gamsel**	**CART**	**C-Tree**	**MOB**	**Random Forest**	**XG-Boost**	**Bart**
2011													
100.00 (Ref.: 0.00-99.99)	3.222	2.277	1.610	1.947	1.887	1.711	2.791	2.620	2.048	1.933	1.570	1.565	1.606
2012													
100.00 (Ref.: 0.00-99.99)	4.173	3.479	2.728	2.793	2.852	3.122	3.900	3.832	2.865	3.397	2.622	2.898	3.089
2013													
100.00 (Ref.: 0.00-99.99)	5.326	4.697	3.584	3.006	3.381	4.049	4.826	5.157	4.561	4.748	3.533	3.712	3.672
2014													
100.00 (Ref.: 0.00-99.99)	4.556	3.632	2.303	2.754	2.799	2.460	3.979	4.065	2.975	3.713	2.226	2.226	3.083
2015													
100.00 (Ref.: 0.00-99.99)	4.399	3.377	2.182	2.540	2.701	2.442	3.742	4.009	3.402	3.275	2.109	2.497	3.155
2016													
100.00 (Ref.: 0.00-99.99)	4.316	3.695	1.848	1.971	2.172	1.977	3.675	4.156	2.161	2.664	1.546	1.299	2.253
2017													
100.00 (Ref.: 0.00-99.99)	4.507	3.661	2.339	2.391	2.552	2.924	4.182	3.824	3.131	3.596	2.658	2.888	2.766
2018													
100.00 (Ref.: 0.00-99.99)	4.779	3.865	2.611	2.285	2.323	3.223	3.962	4.117	2.762	3.534	1.782	2.021	3.293

Table 2.E.8: Bias Estimates of Foundation Year by Year and Weighting Strategy, BHP 2011-2018

Variable	**Unadjusted**	**Logistic Cur**	**Logistic Ext**	**Lasso**	**Ridge**	**GAM**	**Gamsel**	**CART**	**C-Tree**	**MOB**	**Random Forest**	**XG-Boost**	**Bart**
2011													
70s/80s	2.951	1.840	1.272	1.640	1.697	1.264	1.956	2.440	0.969	2.313	1.923	1.951	1.727
90s	1.455	1.024	0.398	0.312	0.346	0.498	0.740	1.076	0.354	1.010	0.705	0.393	0.369
00s/10s	4.405	2.864	1.670	1.952	2.043	1.761	2.696	3.516	1.324	3.323	2.628	2.344	2.095
2012													
70s/80s	2.025	0.826	0.451	0.764	0.818	0.373	1.301	1.795	1.454	1.730	1.168	1.104	0.924
90s	1.238	0.814	0.347	0.100	0.127	0.210	0.609	0.806	0.585	0.516	0.289	0.215	0.027
00s/10s	3.263	1.640	0.798	0.864	0.945	0.583	1.910	2.601	2.039	2.246	1.457	1.319	0.951
2013													
70s/80s	4.185	3.515	3.093	3.382	3.388	2.996	3.704	3.657	4.326	3.595	3.472	3.635	3.316
90s	2.414	2.196	1.832	1.685	1.698	1.832	2.096	2.154	1.520	2.026	2.040	1.638	1.952
00s/10s	6.598	5.711	4.925	5.067	5.085	4.828	5.800	5.811	5.846	5.621	5.512	5.273	5.267
2014													
70s/80s	1.832	0.637	0.102	0.110	0.241	0.089	1.005	1.086	0.766	1.138	0.650	0.692	0.413
90s	3.043	2.450	1.601	1.607	1.788	1.505	2.128	2.119	1.893	1.930	1.488	1.583	1.574
00s/10s	4.875	3.087	1.703	1.717	2.029	1.594	3.132	3.205	2.659	3.067	2.138	2.274	1.987
2015													
70s/80s	3.994	2.858	2.544	2.563	2.747	2.482	3.292	3.464	2.876	3.484	3.222	2.966	2.680
90s	2.211	1.831	0.980	0.830	0.876	1.075	1.599	1.732	1.203	1.516	1.394	1.236	1.269
00s/10s	6.205	4.689	3.525	3.393	3.623	3.557	4.891	5.195	4.079	5.000	4.616	4.202	3.949
2016													
70s/80s	2.619	1.277	0.467	1.015	1.001	0.523	1.566	1.541	1.006	1.975	1.340	0.945	1.003
90s	3.161	2.561	1.710	2.036	2.087	1.665	2.245	2.423	2.031	2.053	2.230	2.181	2.019
00s/10s	5.781	3.838	2.177	3.051	3.088	2.188	3.811	3.965	3.037	4.028	3.570	3.126	3.022
2017													
70s/80s	4.047	3.019	2.841	3.420	3.330	2.751	3.474	4.076	3.911	3.871	3.493	3.335	3.200
90s	1.263	1.104	0.375	0.216	0.273	0.301	0.617	0.782	0.496	0.500	0.348	0.375	0.283
00s/10s	5.310	4.122	3.216	3.636	3.603	3.052	4.091	4.858	4.407	4.370	3.840	3.710	3.483
2018													
70s/80s	3.496	1.986	1.753	2.274	2.339	1.582	2.686	2.542	1.933	2.995	2.305	2.072	1.630
90s	2.351	2.125	1.788	1.577	1.579	1.836	2.026	1.977	2.419	1.695	1.785	1.552	1.798
00s/10s	5.847	4.111	3.541	3.851	3.918	3.418	4.712	4.519	4.351	4.690	4.090	3.624	3.427

Table 2.E.9: Bias Estimates of Share of Apprentices by Year and Weighting Strategy, BHP 2011-2018

Variable	**Unadjusted**	**Logistic Cur**	**Logistic Ext**	**Lasso**	**Ridge**	**GAM**	**Gamsel**	**CART**	**C-Tree**	**MOB**	**Random Forest**	**XG-Boost**	**Bart**
2011													
0.00 (Ref.: 0.01-100)	0.967	0.111	0.839	0.346	0.419	0.821	0.910	0.825	0.561	0.225	0.157	0.075	0.112
2012													
0.00 (Ref.: 0.01-100)	0.749	1.346	1.660	2.044	1.927	1.180	1.001	0.996	1.444	1.728	1.347	1.424	1.869
2013													
0.00 (Ref.: 0.01-100)	0.191	0.614	0.199	0.880	0.915	0.069	0.307	0.076	1.102	0.428	1.050	0.832	0.440
2014													
0.00 (Ref.: 0.01-100)	0.317	0.755	0.041	0.157	0.386	0.258	0.228	0.565	0.089	0.440	0.600	0.443	0.519
2015													
0.00 (Ref.: 0.01-100)	0.829	1.777	0.420	0.956	1.324	0.448	0.884	0.823	1.166	1.364	1.685	1.091	1.055
2016													
0.00 (Ref.: 0.01-100)	0.980	1.094	0.216	0.745	0.877	0.164	0.696	0.765	1.257	1.403	1.440	1.151	0.900
2017													
0.00 (Ref.: 0.01-100)	0.694	0.771	1.215	0.802	0.630	1.447	1.038	0.980	0.232	0.897	0.440	0.961	1.221
2018													
0.00 (Ref.: 0.01-100)	0.522	0.821	0.057	0.792	0.866	0.373	0.797	0.560	1.078	0.954	1.039	0.980	0.379

Table 2.E.10: Bias Estimates of Avg. Age of Employees by Year and Weighting Strategy, BHP 2011-2018

Variable	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011													
0.00-38.99	3.739	3.852	2.194	2.219	2.249	2.271	2.723	2.859	2.179	2.129	2.655	2.255	2.249
39.00-43.49	0.757	0.860	0.545	0.539	0.584	0.373	0.539	0.774	0.787	0.877	0.805	0.708	0.476
43.50-47.99	0.034	0.115	0.458	0.345	0.410	0.478	0.338	0.199	0.251	0.393	0.209	0.506	0.202
≥48.00	3.016	2.877	2.107	2.025	2.076	2.376	2.522	2.284	1.643	1.645	2.058	2.053	1.974
2012													
0.00-38.99	1.988	1.755	0.331	0.131	0.049	0.695	0.493	0.780	0.403	0.462	0.547	0.081	0.094
39.00-43.49	0.079	0.167	0.057	0.219	0.045	0.272	0.030	0.143	0.279	0.034	0.002	0.200	0.088
43.50-47.99	0.418	0.672	1.384	1.371	1.261	1.653	1.068	0.930	1.033	0.830	0.940	1.240	1.440
≥48.00	2.328	2.259	1.110	1.022	1.258	1.230	1.532	1.567	1.715	0.403	1.485	0.959	1.435
2013													
0.00-38.99	4.515	4.484	2.377	1.848	1.860	2.517	2.785	3.430	2.178	2.776	2.735	2.602	2.580
39.00-43.49	0.762	0.711	0.775	0.258	0.266	0.410	0.693	1.106	0.819	1.138	0.454	0.427	0.628
43.50-47.99	0.285	0.007	0.838	0.825	0.895	0.979	0.533	0.094	0.651	0.467	0.553	0.597	0.983
≥48.00	3.469	3.767	2.441	2.415	2.489	3.086	2.625	2.418	2.009	2.105	2.833	2.772	2.935
2014													
0.00-38.99	3.660	3.850	2.132	2.025	2.258	2.004	2.338	2.540	2.900	2.151	2.399	2.187	2.267
39.00-43.49	0.352	0.273	0.242	0.614	0.508	0.488	0.335	0.344	0.008	0.287	0.493	0.242	0.061
43.50-47.99	2.039	1.693	0.943	1.411	1.422	0.932	1.153	1.495	1.251	1.357	1.852	1.503	1.059
≥48.00	1.973	2.429	1.431	1.229	1.344	1.560	1.521	1.388	1.641	1.082	1.040	0.925	1.268
2015													
0.00-38.99	4.694	4.396	3.002	3.304	3.289	2.900	3.536	4.103	3.806	3.945	3.221	2.836	3.205
39.00-43.49	0.998	0.796	1.029	1.268	1.287	0.715	1.203	1.533	1.200	1.609	1.212	1.203	0.957
43.50-47.99	1.673	1.468	0.944	0.979	1.052	0.943	1.138	1.428	1.313	1.411	1.218	1.096	1.077
≥48.00	2.023	2.132	1.029	1.056	0.950	1.242	1.194	1.142	1.293	0.925	0.792	0.537	1.172
2016													
0.00-38.99	3.136	2.983	0.402	0.818	1.064	0.395	1.405	1.488	0.130	0.444	1.359	0.864	0.639
39.00-43.49	0.031	0.132	0.290	0.098	0.056	0.353	0.110	0.097	0.251	0.184	0.289	0.014	0.018
43.50-47.99	0.881	0.857	0.225	0.198	0.171	0.335	0.099	0.199	0.252	0.062	0.083	0.032	0.221
≥48.00	2.224	2.257	0.918	0.918	1.180	1.083	1.416	1.192	0.633	0.321	0.987	0.882	0.878
2017													
0.00-38.99	4.457	4.797	2.806	2.635	2.663	2.677	3.210	3.602	2.949	3.185	2.917	2.358	2.780
39.00-43.49	1.808	1.872	2.188	2.292	2.190	2.057	1.976	2.192	2.592	2.265	2.114	2.083	1.931
43.50-47.99	2.442	2.288	1.618	1.626	1.667	1.459	1.742	2.009	1.982	1.849	1.885	1.662	1.678
≥48.00	0.207	0.636	1.000	1.283	1.194	0.839	0.508	0.599	1.625	0.928	1.082	1.387	0.829
2018													
0.00-38.99	4.846	4.560	2.616	2.710	2.779	2.589	3.267	3.822	2.666	2.880	2.887	2.801	2.670
39.00-43.49	0.679	1.004	0.660	0.451	0.470	0.842	0.594	0.238	0.641	0.442	0.345	0.604	0.749
43.50-47.99	0.560	0.367	0.325	0.027	0.026	0.381	0.061	0.300	0.090	0.099	0.005	0.021	0.105
≥48.00	4.965	5.197	3.602	3.188	3.275	3.811	3.922	3.760	3.397	3.420	3.237	3.384	3.524

Table 2.E.11: Bias Estimates of Share of Female by Year and Weighting Strategy, BHP 2011-2018

Variable	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011													
0.00 - 18.75	0.874	1.492	0.992	1.460	1.203	1.036	0.736	0.760	1.625	0.368	1.161	0.729	1.155
18.76 - 44.43	1.263	1.567	1.335	1.135	1.170	1.292	1.282	1.431	1.077	1.417	1.222	1.231	1.197
44.44 - 71.41	0.999	0.376	0.571	0.553	0.472	0.569	0.997	0.708	0.129	0.697	0.597	0.670	0.418
>71.42	0.609	0.301	0.228	0.878	0.504	0.312	0.450	0.036	0.418	0.352	0.535	0.169	0.375
2012													
0.00 - 18.75	0.397	1.037	0.138	0.569	0.349	0.174	0.174	0.326	0.306	0.590	0.487	0.033	0.442
18.76 - 44.43	1.141	1.184	1.344	1.378	1.315	1.144	1.220	1.173	0.977	0.648	0.855	1.084	1.188
44.44 - 71.41	1.020	1.473	0.815	0.869	0.865	0.701	0.909	0.807	1.462	0.861	1.021	1.019	0.926
>71.42	1.764	1.620	2.021	1.679	1.831	2.019	1.956	2.306	2.132	2.098	1.389	2.136	1.672
2013													
0.00 - 18.75	0.974	1.615	0.576	0.109	0.272	0.201	0.534	0.024	0.494	0.140	0.818	0.231	0.797
18.76 - 44.43	0.744	0.584	0.396	0.595	0.543	0.878	0.620	0.561	0.301	0.817	0.929	0.738	0.840
44.44 - 71.41	0.789	0.060	0.461	0.850	0.770	0.356	0.796	0.786	0.520	0.334	0.034	0.568	0.045
>71.42	2.507	2.258	1.433	1.554	1.585	1.435	1.949	1.323	1.315	1.291	1.713	1.538	1.592
2014													
0.00 - 18.75	0.157	0.894	0.037	0.251	0.198	0.285	0.048	0.092	0.379	0.398	0.502	0.303	0.011
18.76 - 44.43	0.976	0.929	1.235	1.498	1.355	1.456	1.215	1.028	1.054	1.246	0.928	1.370	1.480
44.44 - 71.41	1.052	1.271	1.031	1.056	1.155	0.839	1.067	1.360	1.156	1.110	1.085	1.040	0.822
>71.42	0.081	0.552	0.241	0.693	0.399	0.333	0.100	0.240	0.481	0.263	0.345	0.632	0.648
2015													
0.00 - 18.75	0.902	2.155	0.942	0.887	0.852	0.876	0.680	0.457	0.808	0.523	1.157	0.643	1.014
18.76 - 44.43	0.608	0.323	0.845	1.042	0.866	1.107	0.753	0.910	1.051	0.532	0.722	0.881	0.831
44.44 - 71.41	0.221	0.564	0.340	0.156	0.086	0.465	0.190	0.125	0.319	0.204	0.114	0.150	0.201
>71.42	1.289	1.914	1.447	2.085	1.804	1.518	1.243	1.241	1.540	0.851	1.994	1.674	1.644
2016													
0.00 - 18.75	0.079	0.952	0.572	0.020	0.019	0.632	0.584	0.408	0.270	0.157	0.149	0.049	0.506
18.76 - 44.43	1.011	0.628	0.104	0.548	0.557	0.032	0.338	0.327	0.049	0.612	0.749	0.706	0.272
44.44 - 71.41	0.940	0.478	0.748	0.413	0.315	0.817	0.965	0.833	0.533	0.673	0.560	0.524	0.629
>71.42	0.150	0.803	0.073	0.115	0.261	0.217	0.043	0.098	0.313	0.097	0.040	0.231	0.148
2017													
0.00 - 18.75	0.756	1.700	0.702	0.412	0.426	0.475	0.579	0.169	0.596	0.027	0.833	0.361	0.240
18.76 - 44.43	0.016	0.294	0.344	0.212	0.066	0.614	0.425	0.222	0.042	0.181	0.332	0.197	0.292
44.44 - 71.41	0.333	0.055	0.040	0.128	0.165	0.050	0.330	0.456	0.585	0.517	0.041	0.135	0.004
>71.42	1.073	2.048	1.007	0.752	0.657	1.039	1.333	0.846	1.140	0.671	1.123	0.693	0.536
2018													
0.00 - 18.75	1.056	1.915	1.085	0.817	0.987	0.878	0.933	0.806	0.642	0.373	1.411	0.866	0.959
18.76 - 44.43	0.852	0.732	0.664	0.870	0.880	0.233	0.809	1.008	1.051	0.729	1.304	0.642	0.636
44.44 - 71.41	0.662	0.024	0.327	0.254	0.096	0.101	0.563	0.409	0.579	0.476	0.331	0.404	0.317
>71.42	0.867	1.208	0.749	0.201	0.203	0.747	0.687	0.206	0.171	0.120	0.438	0.629	0.639

Table 2.E.12: Bias Estimates of Share of Fixed-Term Employees by Year and Weighting Strategy, BHP 2011-2018

Variable	**Unadjusted**	**Logistic Cur**	**Logistic Ext**	**Lasso**	**Ridge**	**GAM**	**Gamsel**	**CART**	**C-Tree**	**MOB**	**Random Forest**	**XG-Boost**	**Bart**
2011													
0.00	2.012	1.576	1.924	1.939	1.844	1.847	2.114	1.844	0.894	1.639	1.344	1.606	1.521
0.01 - 15.99	1.370	1.077	1.440	1.381	1.296	1.377	1.554	1.241	1.338	1.050	0.875	1.040	1.105
≥16.00	0.642	0.500	0.484	0.559	0.548	0.470	0.560	0.603	0.444	0.590	0.470	0.566	0.417
2012													
0.00	0.620	0.160	0.712	0.731	0.624	1.167	0.567	0.300	0.280	0.062	0.408	0.600	0.986
0.01 - 15.99	0.142	0.264	0.208	0.125	0.075	0.532	0.138	0.227	0.387	0.063	0.292	0.076	0.254
≥16.00	0.763	0.425	0.504	0.606	0.549	0.636	0.429	0.527	0.668	0.125	0.699	0.676	0.733
2013													
0.00	0.720	0.193	0.880	1.018	1.140	1.564	0.678	0.247	0.442	0.234	0.385	0.638	0.677
0.01 - 15.99	0.505	0.701	0.135	0.235	0.128	0.344	0.133	0.549	0.539	0.376	0.416	0.209	0.035
≥16.00	1.225	0.893	1.015	1.254	1.268	1.220	0.811	0.796	0.980	0.610	0.801	0.847	0.713
2014													
0.00	1.881	1.666	2.304	2.508	2.428	2.568	2.314	1.962	1.930	1.563	1.487	1.507	1.729
0.01 - 15.99	0.138	0.202	0.004	0.021	0.035	0.101	0.154	0.077	0.097	0.059	0.531	0.392	0.141
≥16.00	2.019	1.868	2.308	2.487	2.463	2.467	2.160	1.884	2.026	1.622	2.018	1.898	1.870
2015													
0.00	1.608	0.904	2.139	1.675	1.669	2.257	1.732	1.630	2.031	1.026	0.832	1.275	1.634
0.01 - 15.99	0.480	0.308	0.605	0.424	0.433	0.721	0.694	0.742	0.738	0.536	0.061	0.192	0.518
≥16.00	1.128	0.596	1.534	1.251	1.236	1.536	1.038	0.888	1.293	0.490	0.893	1.083	1.116
2016													
0.00	0.696	0.884	1.642	1.135	1.143	1.573	1.263	0.926	0.733	0.373	0.168	0.626	1.221
0.01 - 15.99	0.427	0.313	0.201	0.311	0.275	0.073	0.168	0.379	0.365	0.594	0.890	0.587	0.341
≥16.00	1.122	1.196	1.843	1.446	1.418	1.646	1.430	1.304	1.097	0.966	1.058	1.213	1.562
2017													
0.00	1.036	0.823	1.476	1.024	0.917	1.710	1.512	1.315	0.496	1.065	0.628	1.277	1.454
0.01 - 15.99	0.259	0.347	0.014	0.135	0.200	0.348	0.164	0.162	0.544	0.052	0.492	0.005	0.047
≥16.00	1.296	1.170	1.462	1.159	1.117	1.363	1.348	1.477	1.040	1.117	1.120	1.272	1.407
2018													
0.00	0.956	0.735	1.378	1.355	1.314	2.031	0.946	0.549	0.476	0.876	0.449	1.110	1.744
0.01 - 15.99	0.234	0.189	0.113	0.138	0.232	0.428	0.014	0.469	0.212	0.220	0.646	0.344	0.232
≥16.00	1.190	0.923	1.265	1.493	1.546	1.604	0.960	1.017	0.688	0.656	1.096	1.454	1.512

Table 2.E.13: Bias Estimates of Share of Full-Time by Year and Weighting Strategy, BHP 2011-2018

Variable	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011													
0.00 - 37.14	1.715	1.696	1.370	0.629	1.158	1.178	1.529	1.954	1.034	2.625	1.881	1.177	0.981
37.15 - 66.66	0.758	0.727	0.493	0.497	0.582	0.109	0.420	0.798	0.252	0.916	0.551	0.326	0.604
66.67 - 86.04	1.250	1.469	0.935	0.575	0.613	0.521	1.050	1.071	1.191	1.233	1.073	0.754	0.365
>86.05	0.292	0.499	0.057	0.442	0.037	0.548	0.059	0.084	0.409	0.476	0.257	0.097	0.012
2012													
0.00 - 37.14	1.918	1.243	1.595	0.477	1.208	0.933	1.438	2.802	0.984	2.742	0.927	1.076	1.005
37.15 - 66.66	1.235	0.698	0.303	0.227	0.378	0.141	0.762	0.800	0.756	1.177	0.425	0.488	0.541
66.67 - 86.04	1.258	1.196	0.919	0.458	0.740	0.003	0.849	1.103	0.765	0.757	0.326	0.021	0.103
>86.05	0.576	0.650	0.372	0.208	0.089	1.077	0.174	0.899	0.537	0.808	0.176	0.609	0.362
2013													
0.00 - 37.14	2.207	1.522	1.820	0.773	0.995	1.655	1.835	3.050	1.631	3.089	1.380	1.109	1.210
37.15 - 66.66	1.168	1.119	0.547	0.075	0.329	0.044	0.663	0.638	1.318	0.743	0.769	0.344	0.165
66.67 - 86.04	0.800	0.495	0.212	0.039	0.082	0.387	0.550	1.104	0.500	1.004	0.042	0.105	0.098
>86.05	0.239	0.092	1.061	0.738	0.584	2.086	0.622	1.308	0.187	1.342	0.652	0.870	0.947
2014													
0.00 - 37.14	2.793	1.506	1.463	0.874	1.367	1.313	2.070	2.717	1.544	2.661	1.532	1.264	1.102
37.15 - 66.66	1.733	1.492	1.156	0.912	1.044	0.886	1.366	1.478	1.507	1.175	1.177	0.760	0.692
66.67 - 86.04	0.858	0.705	0.255	0.132	0.108	0.256	0.479	0.909	0.018	0.738	0.324	0.007	0.116
>86.05	0.203	0.691	0.051	0.095	0.216	0.683	0.225	0.331	0.055	0.748	0.031	0.497	0.294
2015													
0.00 - 37.14	2.794	1.901	1.517	0.923	1.645	1.272	2.575	2.608	2.378	3.012	2.088	1.549	1.137
37.15 - 66.66	2.573	2.294	1.803	1.245	1.516	1.537	2.282	2.269	1.629	2.389	1.475	1.319	1.194
66.67 - 86.04	1.813	1.763	1.091	0.751	0.987	0.649	1.497	1.464	1.341	1.479	1.435	1.092	0.743
>86.05	1.592	2.157	1.377	1.072	0.858	0.914	1.205	1.126	0.592	0.856	0.822	0.862	0.801
2016													
0.00 - 37.14	3.179	1.440	0.990	1.352	1.539	0.694	2.029	2.612	1.653	2.257	1.885	1.544	1.129
37.15 - 66.66	1.372	0.842	0.449	0.314	0.580	0.098	0.725	0.862	0.236	0.776	0.536	0.527	0.113
66.67 - 86.04	0.562	0.080	0.493	0.488	0.390	0.912	0.059	0.112	0.240	0.004	0.338	0.557	0.580
>86.05	1.245	0.518	1.034	1.527	1.350	1.508	1.363	1.638	1.657	1.485	1.687	1.574	1.596
2017													
0.00 - 37.14	1.534	0.557	0.626	0.919	0.962	0.676	0.434	1.253	0.788	1.036	1.079	0.272	0.324
37.15 - 66.66	0.259	0.060	0.364	0.709	0.443	0.561	0.389	0.495	0.642	0.594	0.224	0.765	0.769
66.67 - 86.04	1.634	1.293	1.020	1.137	1.211	0.534	1.023	1.553	1.398	0.975	1.051	0.620	0.607
>86.05	0.358	0.676	0.030	0.491	0.194	0.703	0.200	0.196	0.032	0.655	0.251	0.417	0.486
2018													
0.00 - 37.14	1.992	1.404	1.042	1.430	1.419	0.788	1.562	1.903	1.053	1.753	1.306	0.407	0.718
37.15 - 66.66	1.699	1.748	1.159	1.026	1.398	0.804	1.541	1.568	1.550	1.198	1.431	0.712	0.556
66.67 - 86.04	0.551	0.009	0.247	0.237	0.160	0.979	0.125	0.614	0.384	0.060	0.221	0.732	0.860
>86.05	0.258	0.336	0.130	0.641	0.180	0.962	0.104	0.279	0.114	0.615	0.097	0.427	1.021

Table 2.E.14: Bias Estimates of Share of High-Educated by Year and Weighting Strategy, BHP 2011-2018

Variable	**Unadjusted**	**Logistic Cur**	**Logistic Ext**	**Lasso**	**Ridge**	**GAM**	**Gamsel**	**CART**	**C-Tree**	**MOB**	**Random Forest**	**XG-Boost**	**Bart**
2011													
0.00	0.767	1.009	0.397	0.102	0.440	0.521	0.359	1.717	0.876	1.672	1.289	1.105	1.086
0.01 - 14.99	0.636	0.359	0.923	0.398	0.558	0.704	1.066	0.536	0.384	0.559	0.058	0.011	0.160
≥15.00	1.403	1.368	1.320	0.500	0.998	1.225	1.424	2.253	1.261	2.231	1.231	1.116	1.245
2012													
0.00	1.434	1.293	1.380	1.445	1.452	0.722	1.477	2.364	2.304	2.110	1.274	1.402	1.089
0.01 - 14.99	0.620	0.818	1.070	0.890	0.789	1.273	1.119	0.895	1.275	0.628	0.532	0.629	1.144
≥15.00	2.054	2.111	2.450	2.335	2.242	1.995	2.596	3.259	3.579	2.738	1.806	2.030	2.232
2013													
0.00	3.471	3.151	2.709	2.376	2.520	2.026	2.907	4.687	3.410	4.902	3.179	2.987	2.733
0.01 - 14.99	0.024	0.069	0.381	0.159	0.103	0.714	0.495	0.164	0.112	0.175	0.296	0.101	0.147
≥15.00	3.495	3.220	3.090	2.217	2.623	2.739	3.401	4.523	3.298	4.726	2.883	3.089	2.879
2014													
0.00	3.254	3.009	2.593	2.561	2.999	2.216	2.739	3.045	2.306	2.938	3.218	2.858	2.809
0.01 - 14.99	0.376	0.443	0.125	0.088	0.205	0.147	0.113	0.018	0.467	0.162	0.868	0.806	0.640
≥15.00	2.878	2.566	2.468	2.473	2.793	2.069	2.852	3.027	2.772	2.776	2.349	2.051	2.169
2015													
0.00	1.856	1.854	2.086	1.533	1.752	1.934	2.000	1.673	2.010	2.458	2.275	2.237	2.390
0.01 - 14.99	0.324	0.277	0.537	0.466	0.373	0.527	0.627	0.542	0.688	0.594	0.296	0.031	0.344
≥15.00	2.180	2.131	2.623	2.000	2.125	2.461	2.627	2.216	2.698	3.052	1.980	2.268	2.734
2016													
0.00	1.697	0.852	0.088	0.906	0.961	0.128	0.529	1.494	0.871	1.617	1.729	1.290	0.729
0.01 - 14.99	0.233	0.485	0.699	0.008	0.133	0.486	0.746	0.541	0.006	0.337	0.651	0.037	0.134
≥15.00	1.930	1.337	0.611	0.914	1.094	0.358	1.276	2.034	0.865	1.954	1.077	1.327	0.863
2017													
0.00	3.259	3.233	3.140	3.000	2.831	2.589	2.733	3.190	3.974	2.862	2.971	2.467	2.661
0.01 - 14.99	0.715	0.628	0.794	0.592	0.573	1.016	1.171	0.968	0.335	1.133	0.281	0.768	0.885
≥15.00	3.974	3.862	3.934	3.591	3.405	3.606	3.904	4.158	4.308	3.995	3.252	3.235	3.546
2018													
0.00	2.013	1.663	0.688	1.370	1.036	0.250	1.286	2.323	0.958	1.808	1.694	0.880	0.614
0.01 - 14.99	0.023	0.062	0.067	0.361	0.352	0.146	0.117	0.314	0.048	0.078	0.746	0.553	0.144
≥15.00	2.035	1.600	0.755	1.009	0.684	0.395	1.403	2.009	1.005	1.886	0.948	0.327	0.470

Table 2.E.15: Bias Estimates of Share of Low-Educated by Year and Weighting Strategy, BHP 2011-2018

Variable	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011													
0.00	3.556	2.100	1.796	1.980	1.934	1.716	3.139	2.781	2.506	1.947	1.494	1.540	1.916
0.01 - 11.99	0.410	0.376	0.784	0.649	0.655	0.874	0.802	0.410	0.706	0.424	0.222	0.374	0.889
≥12.00	3.147	1.724	1.012	1.331	1.278	0.842	2.337	2.371	1.801	1.523	1.271	1.166	1.026
2012													
0.00	1.946	0.946	0.298	0.021	0.238	0.060	1.286	1.824	1.186	1.147	0.209	0.596	0.153
0.01 - 11.99	0.315	0.350	0.237	0.194	0.169	0.652	0.098	0.114	0.166	0.058	0.317	0.089	0.350
≥12.00	2.261	1.296	0.536	0.173	0.069	0.713	1.188	1.938	1.020	1.205	0.526	0.686	0.196
2013													
0.00	3.387	1.749	0.406	0.637	0.820	1.022	2.570	2.571	0.808	1.495	1.164	1.310	0.989
0.01 - 11.99	0.570	0.484	0.111	0.210	0.169	0.532	0.023	0.495	0.088	0.129	0.282	0.073	0.189
≥12.00	3.957	2.233	0.295	0.847	0.989	0.490	2.593	3.066	0.896	1.624	1.446	1.382	0.799
2014													
0.00	2.984	1.511	0.027	0.637	0.938	0.260	2.375	2.178	1.825	2.756	0.773	1.105	1.101
0.01 - 11.99	0.334	0.208	0.218	0.257	0.102	0.442	0.210	0.131	0.042	0.184	0.327	0.105	0.340
≥12.00	3.319	1.719	0.245	0.380	0.836	0.182	2.164	2.309	1.783	2.940	1.100	1.210	0.761
2015													
0.00	2.785	1.069	0.445	0.864	0.894	0.559	2.253	2.549	1.963	1.173	0.565	0.596	1.013
0.01 - 11.99	0.255	0.237	0.593	0.613	0.517	0.860	0.591	0.658	0.885	0.520	0.103	0.301	0.482
≥12.00	2.530	0.832	0.148	0.252	0.377	0.301	1.662	1.891	1.079	0.654	0.462	0.295	0.531
2016													
0.00	1.118	0.066	1.344	1.296	0.735	1.217	0.702	1.128	0.263	0.312	1.299	1.618	0.365
0.01 - 11.99	0.863	0.768	0.033	0.143	0.224	0.204	0.163	0.347	0.360	0.361	0.779	0.430	0.000
≥12.00	1.981	0.702	1.312	1.153	0.511	1.422	0.866	1.475	0.623	0.673	0.520	1.189	0.365
2017													
0.00	4.011	2.912	1.163	1.352	1.331	1.629	3.771	3.735	2.477	3.718	1.673	1.842	1.806
0.01 - 11.99	0.365	0.219	0.068	0.230	0.204	0.525	0.217	0.079	0.568	0.036	0.325	0.043	0.208
≥12.00	4.376	3.131	1.095	1.581	1.535	1.104	3.554	3.814	3.044	3.682	1.998	1.884	1.598
2018													
0.00	3.171	1.764	0.658	0.517	0.643	1.280	2.123	1.908	1.530	1.216	0.007	0.289	1.123
0.01 - 11.99	0.010	0.329	0.474	0.279	0.250	0.857	0.306	0.335	0.167	0.415	0.058	0.381	0.604
≥12.00	3.181	1.435	0.183	0.238	0.393	0.423	1.816	2.243	1.363	0.801	0.065	0.093	0.520

Table 2.E.16: Bias Estimates of Share of Marginal Employees by Year and Weighting Strategy, BHP 2011-2018

Variable	**Unadjusted**	**Logistic Cur**	**Logistic Ext**	**Lasso**	**Ridge**	**GAM**	**Gamsel**	**CART**	**C-Tree**	**MOB**	**Random Forest**	**XG-Boost**	**Bart**
2011													
0.00	1.869	1.535	1.494	1.944	1.780	1.555	0.830	1.923	2.013	1.971	1.927	1.799	1.783
0.00-14.99	0.635	0.726	0.165	0.184	0.271	0.153	0.310	0.754	0.446	0.855	0.795	0.641	0.206
≥15	1.234	0.809	1.329	1.760	1.508	1.402	0.520	1.168	1.567	1.116	1.132	1.158	1.577
2012													
0.00	1.836	1.690	1.102	0.928	0.927	0.527	1.146	1.239	1.145	0.646	1.337	0.848	0.423
0.00-14.99	0.371	0.298	0.141	0.117	0.235	0.190	0.196	0.468	0.398	0.676	0.340	0.354	0.233
≥15	1.465	1.392	0.960	0.811	0.692	0.717	0.949	0.772	0.747	0.031	0.996	0.494	0.189
2013													
0.00	1.942	2.244	2.904	2.054	1.996	1.898	1.489	2.053	2.479	2.950	2.454	2.384	2.471
0.00-14.99	0.890	0.995	0.559	1.004	0.976	0.119	0.646	1.151	1.080	0.655	0.679	0.477	0.229
≥15	1.052	1.250	2.345	1.050	1.020	1.780	0.842	0.902	1.399	2.295	1.775	1.907	2.242
2014													
0.00	0.258	0.054	0.126	1.062	0.551	0.467	0.899	1.031	0.890	0.969	0.467	0.027	0.532
0.00-14.99	1.066	0.618	0.037	0.104	0.159	0.133	0.283	0.587	0.053	0.646	0.594	0.390	0.057
≥15	1.323	0.672	0.089	1.166	0.710	0.333	1.182	1.618	0.943	1.615	0.127	0.417	0.589
2015													
0.00	2.310	2.730	1.320	0.730	0.991	1.024	1.458	1.472	1.578	1.245	1.696	1.411	1.321
0.00-14.99	0.133	0.126	0.197	0.049	0.072	0.369	0.128	0.037	0.333	0.333	0.528	0.252	0.293
≥15	2.177	2.604	1.517	0.779	1.062	1.393	1.586	1.435	1.911	0.913	1.168	1.159	1.615
2016													
0.00	0.632	1.414	2.080	1.888	1.501	2.558	2.196	1.553	2.365	0.661	0.828	1.152	2.336
0.00-14.99	0.786	0.230	0.165	0.123	0.080	0.440	0.143	0.651	0.178	0.136	0.491	0.232	0.152
≥15	1.418	1.644	1.915	2.010	1.580	2.118	2.338	2.204	2.543	0.797	1.319	1.384	2.184
2017													
0.00	0.864	1.140	1.046	0.563	0.541	0.354	0.225	0.102	1.327	0.837	0.946	0.266	0.037
0.00-14.99	1.390	1.084	0.648	0.822	0.839	0.054	0.652	1.119	1.525	0.836	0.791	0.512	0.445
≥15	0.526	0.056	0.398	0.259	0.298	0.408	0.426	1.017	0.198	1.674	0.155	0.246	0.482
2018													
0.00	0.588	0.083	0.038	0.230	0.567	1.358	0.061	0.976	0.293	0.139	1.131	0.850	0.404
0.00-14.99	1.171	0.879	0.501	0.689	0.719	0.185	0.814	1.333	0.708	0.875	0.799	0.385	0.046
≥15	0.584	0.797	0.540	0.459	0.152	1.173	0.753	0.357	0.415	0.736	0.332	0.464	0.450

Table 2.E.17: Bias Estimates of Share of Mid-Educated by Year and Weighting Strategy, BHP 2011-2018

Variable	**Unadjusted**	**Logistic Cur**	**Logistic Ext**	**Lasso**	**Ridge**	**GAM**	**Gamsel**	**CART**	**C-Tree**	**MOB**	**Random Forest**	**XG-Boost**	**Bart**
2011													
0.00 - 55.25	1.003	0.205	1.637	0.468	0.665	1.004	0.767	0.275	1.680	0.990	0.216	0.101	0.570
55.26 - 74.99	0.561	0.231	0.684	0.373	0.446	0.693	0.746	0.264	0.549	0.105	0.233	0.009	0.133
75.00 - 88.88	0.000	0.348	0.941	0.515	0.586	0.918	0.823	0.298	0.125	0.486	0.354	0.398	0.579
>88.89	1.564	0.374	0.011	0.420	0.367	0.608	0.802	0.286	1.006	0.400	0.337	0.306	0.142
2012													
0.00 - 55.25	1.550	0.676	0.930	0.927	0.433	0.601	0.105	0.594	0.000	0.393	0.946	0.177	0.087
55.26 - 74.99	0.577	0.356	0.430	0.410	0.269	0.815	0.564	0.647	0.249	0.637	0.333	0.441	0.582
75.00 - 88.88	1.570	1.365	0.782	0.780	0.837	0.534	1.004	1.032	1.684	1.039	1.293	0.881	0.930
>88.89	0.558	0.333	1.282	1.296	1.002	0.320	0.545	0.209	1.435	0.795	0.014	0.263	0.435
2013													
0.00 - 55.25	1.577	0.573	1.304	0.224	0.623	1.048	0.650	0.360	0.352	1.064	0.408	0.093	1.246
55.26 - 74.99	0.352	0.471	0.462	0.380	0.280	0.043	0.353	0.594	1.166	0.976	0.792	0.555	0.453
75.00 - 88.88	0.639	0.537	0.289	0.534	0.223	0.706	0.133	0.145	0.795	0.345	0.274	0.181	0.159
>88.89	0.586	0.435	1.476	1.138	1.125	0.299	0.871	1.100	2.313	2.384	0.659	0.643	1.540
2014													
0.00 - 55.25	1.661	0.674	0.671	0.658	0.525	0.574	0.074	0.609	0.342	0.058	0.704	0.531	0.089
55.26 - 74.99	0.437	0.092	0.152	0.094	0.010	0.089	0.186	0.352	0.541	0.500	0.151	0.249	0.057
75.00 - 88.88	0.669	0.047	0.455	0.582	0.488	0.811	0.213	0.246	0.366	0.054	0.074	0.303	0.117
>88.89	1.429	0.629	0.368	0.018	0.046	0.326	0.324	0.715	0.564	0.388	0.627	0.477	0.150
2015													
0.00 - 55.25	2.386	1.653	0.929	1.553	1.407	1.318	1.230	1.613	1.340	1.637	2.363	1.923	1.487
55.26 - 74.99	0.791	0.168	0.487	0.508	0.560	0.562	0.623	0.500	0.182	0.568	0.301	0.376	0.369
75.00 - 88.88	2.286	2.185	1.462	1.493	1.538	1.191	1.698	1.696	0.972	1.682	2.342	1.895	1.295
>88.89	0.891	0.364	0.047	0.569	0.429	0.688	0.156	0.417	0.550	0.523	0.321	0.404	0.562
2016													
0.00 - 55.25	2.121	1.124	0.941	0.389	0.361	0.338	0.090	0.908	0.110	0.782	0.774	0.339	0.426
55.26 - 74.99	0.380	0.278	0.052	0.116	0.219	0.199	0.169	0.394	0.277	0.817	0.433	0.535	0.130
75.00 - 88.88	0.689	0.018	0.639	0.013	0.026	0.658	0.261	0.054	0.148	0.038	0.297	0.124	0.509
>88.89	1.052	0.865	0.250	0.518	0.554	0.520	0.182	0.460	0.018	1.637	0.043	0.321	0.212
2017													
0.00 - 55.25	2.754	1.913	0.172	0.818	0.868	0.590	0.654	1.448	0.975	0.707	1.906	1.324	0.957
55.26 - 74.99	0.732	0.867	0.817	0.789	0.817	0.463	0.632	0.677	0.866	0.688	0.810	0.500	0.542
75.00 - 88.88	0.695	0.278	0.367	0.200	0.222	0.560	0.291	0.115	0.131	0.245	0.197	0.170	0.236
>88.89	1.328	0.768	0.278	0.230	0.273	0.688	0.313	0.886	0.021	0.264	0.900	0.995	0.651
2018													
0.00 - 55.25	2.423	1.089	0.125	0.482	0.304	0.237	0.581	1.330	0.372	1.268	1.026	0.945	0.423
55.26 - 74.99	0.906	0.632	0.743	0.691	0.646	1.162	0.717	0.439	0.262	0.827	0.297	0.448	0.849
75.00 - 88.88	0.954	0.335	0.121	0.135	0.084	0.577	0.306	0.646	0.064	0.225	0.259	0.083	0.434
>88.89	2.375	1.385	0.738	1.038	0.867	1.976	0.992	1.123	0.571	2.319	1.063	1.310	1.706

Table 2.E.18: Bias Estimates of Share of Part-Time by Year and Weighting Strategy, BHP 2011-2018

Variable	**Unadjusted**	**Logistic Cur**	**Logistic Ext**	**Lasso**	**Ridge**	**GAM**	**Gamsel**	**CART**	**C-Tree**	**MOB**	**Random Forest**	**XG-Boost**	**Bart**
2011													
0.00	0.786	0.573	0.437	0.344	0.684	1.211	1.183	0.791	0.234	0.742	0.079	0.304	0.211
0.01 - 19.99	0.128	0.399	0.361	0.089	0.040	0.294	0.436	0.012	0.154	0.055	0.823	0.410	0.060
≥20	0.658	0.971	0.076	0.433	0.724	0.917	0.746	0.779	0.080	0.797	0.745	0.714	0.271
2012													
0.00	1.262	0.237	1.098	1.254	1.138	1.981	1.694	1.528	0.501	1.523	0.078	0.751	1.311
0.01 - 19.99	0.676	0.419	0.874	0.352	0.353	0.970	0.869	0.590	0.159	0.478	0.066	0.156	0.743
≥20	0.586	0.181	0.224	0.902	0.785	1.011	0.824	0.938	0.342	1.045	0.012	0.595	0.568
2013													
0.00	1.311	1.431	2.284	2.659	2.570	3.372	2.209	1.753	0.760	1.108	0.742	1.452	2.602
0.01 - 19.99	0.196	0.563	0.108	0.138	0.169	0.386	0.003	0.469	0.953	0.726	0.656	0.028	0.158
≥20	1.506	1.995	2.392	2.797	2.740	2.986	2.206	2.222	1.713	1.834	1.398	1.480	2.760
2014													
0.00	0.093	0.073	0.343	0.303	0.337	0.713	0.452	0.472	0.675	0.097	1.236	1.298	0.283
0.01 - 19.99	0.085	0.080	0.497	0.272	0.236	0.577	0.546	0.272	0.149	0.166	0.404	0.189	0.065
≥20	0.178	0.153	0.840	0.575	0.573	0.136	0.094	0.200	0.824	0.069	0.833	1.109	0.348
2015													
0.00	0.649	0.217	0.844	0.643	0.522	0.236	0.964	0.914	0.201	0.775	0.879	0.742	0.884
0.01 - 19.99	0.307	0.098	0.652	0.530	0.552	0.606	0.562	0.449	0.652	0.356	0.160	0.180	0.126
≥20	0.342	0.119	1.496	1.173	1.074	0.842	0.401	0.465	0.451	0.419	0.719	0.922	1.011
2016													
0.00	0.504	0.468	0.356	0.201	0.038	0.401	0.606	0.683	0.093	0.015	1.176	0.536	0.095
0.01 - 19.99	0.658	0.753	0.018	0.830	0.642	0.012	0.046	0.250	0.205	0.205	1.322	0.936	0.544
≥20	1.161	0.285	0.374	0.629	0.680	0.389	0.653	0.933	0.112	0.220	0.146	0.399	0.449
2017													
0.00	1.594	2.063	1.946	1.778	1.552	0.863	1.380	1.478	1.766	1.337	2.289	1.418	1.232
0.01 - 19.99	0.924	1.052	0.799	0.928	1.076	0.405	0.539	0.911	1.430	0.591	1.438	0.726	0.782
≥20	0.670	1.011	1.148	0.850	0.476	0.457	0.841	0.567	0.336	0.746	0.851	0.691	0.450
2018													
0.00	0.623	1.162	1.324	0.755	0.782	0.260	0.521	0.970	0.510	0.436	1.675	1.025	0.394
0.01 - 19.99	0.213	0.189	0.507	0.152	0.065	0.843	0.297	0.268	0.253	0.394	0.277	0.192	0.657
≥20	0.837	1.351	1.831	0.907	0.847	1.103	0.818	0.702	0.763	0.830	1.399	1.217	1.051

Table 2.E.19: Bias Estimates of Share of Regular by Year and Weighting Strategy, BHP 2011-2018

Variable	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011													
0.00 - 71.24	0.604	0.514	0.987	0.572	0.523	0.468	0.924	1.187	0.300	1.191	0.727	0.754	0.501
71.25 - 87.49	1.267	1.186	0.728	0.504	0.531	0.141	0.868	1.054	0.970	0.845	0.608	0.520	0.030
87.50 - 96.90	0.196	0.060	0.171	0.036	0.013	0.152	0.095	0.227	0.005	0.345	0.196	0.128	0.019
>96.91	0.859	0.732	0.430	0.105	0.021	0.480	0.151	0.094	0.675	0.001	0.077	0.107	0.512
2012													
0.00 - 71.24	0.163	0.679	0.214	0.207	0.032	0.547	0.280	1.307	0.273	0.527	0.159	0.288	0.016
71.25 - 87.49	2.307	2.227	1.402	0.859	1.011	0.057	1.398	1.327	1.399	0.914	0.607	0.246	0.420
87.50 - 96.90	0.323	0.246	0.398	0.356	0.329	0.701	0.402	0.176	0.197	0.289	0.318	0.447	0.522
>96.91	2.147	1.302	0.789	0.710	0.714	0.098	1.276	0.156	0.929	0.098	0.447	0.087	0.086
2013													
0.00 - 71.24	0.293	0.535	0.442	0.029	0.275	0.769	0.020	1.117	0.475	0.036	0.570	0.813	0.940
71.25 - 87.49	1.428	1.528	1.122	0.945	0.864	0.025	1.169	0.962	1.716	0.570	0.687	0.438	0.447
87.50 - 96.90	0.229	0.145	0.023	0.171	0.142	0.370	0.001	0.522	0.323	0.147	0.037	0.025	0.185
>96.91	1.363	2.207	1.541	1.087	1.281	0.424	1.148	0.367	2.515	0.681	1.294	1.275	1.201
2014													
0.00 - 71.24	1.909	0.824	1.326	1.686	1.509	0.866	1.429	1.762	1.151	2.092	1.002	1.497	1.482
71.25 - 87.49	1.756	1.535	0.896	0.351	0.709	0.239	1.042	1.355	0.702	0.959	0.781	0.576	0.600
87.50 - 96.90	0.149	0.278	0.372	0.306	0.266	0.499	0.322	0.085	0.368	0.005	0.094	0.133	0.250
>96.91	0.004	0.433	0.802	1.641	1.066	1.604	0.709	0.492	0.817	1.127	0.314	1.054	1.132
2015													
0.00 - 71.24	1.071	1.512	0.058	0.233	0.361	0.714	0.765	1.077	1.598	0.642	0.021	0.008	0.359
71.25 - 87.49	1.163	0.896	0.454	0.073	0.154	0.616	0.719	0.562	0.045	0.248	0.456	0.177	0.345
87.50 - 96.90	0.282	0.314	0.267	0.217	0.230	0.342	0.420	0.338	0.495	0.281	0.030	0.072	0.244
>96.91	1.952	2.093	0.130	0.377	0.438	0.243	1.064	1.301	1.058	0.608	0.405	0.113	0.231
2016													
0.00 - 71.24	2.213	1.673	2.668	2.048	2.109	2.273	2.425	2.410	2.909	1.493	2.558	1.894	2.158
71.25 - 87.49	1.161	0.688	0.025	0.098	0.104	0.708	0.382	0.461	0.086	0.074	0.249	0.253	0.682
87.50 - 96.90	0.289	0.090	0.135	0.118	0.078	0.323	0.105	0.207	0.073	0.021	0.179	0.048	0.217
>96.91	0.763	1.074	2.778	1.832	1.927	3.304	2.148	1.742	3.069	1.588	2.130	2.195	3.057
2017													
0.00 - 71.24	1.872	1.163	1.406	1.831	1.574	0.776	1.337	2.303	1.484	1.549	1.243	0.585	0.339
71.25 - 87.49	2.269	1.774	1.402	0.972	0.969	0.088	1.413	1.816	1.560	1.412	0.819	0.329	0.230
87.50 - 96.90	0.366	0.183	0.083	0.251	0.225	0.290	0.053	0.309	0.382	0.201	0.096	0.044	0.029
>96.91	0.763	0.794	0.079	0.607	0.380	0.977	0.023	0.178	0.458	0.064	0.328	0.299	0.598
2018													
0.00 - 71.24	1.649	1.595	2.264	2.110	1.410	1.646	1.614	1.795	1.237	1.979	1.660	1.187	1.648
71.25 - 87.49	1.510	1.080	1.223	0.784	0.885	0.310	1.367	1.709	1.108	0.573	0.976	0.410	0.186
87.50 - 96.90	0.368	0.512	0.608	0.352	0.391	0.795	0.615	0.142	0.533	0.478	0.418	0.575	0.790
>96.91	0.507	1.027	1.649	1.679	0.917	2.751	0.861	0.228	0.662	1.884	1.102	1.353	2.252

Table 2.E.20: Bias Estimates of Share of Unknown-Educated by Year and Weighting Strategy, BHP 2011-2018

Variable	**Unadjusted**	**Logistic Cur**	**Logistic Ext**	**Lasso**	**Ridge**	**GAM**	**Gamsel**	**CART**	**C-Tree**	**MOB**	**Random Forest**	**XG-Boost**	**Bart**
2011													
0.00 (Ref.: 0.01-100.00)	2.519	1.796	0.411	0.989	1.032	0.372	1.833	1.724	0.153	1.296	1.109	1.158	1.401
2012													
0.00 (Ref.: 0.01-100.00)	2.786	2.030	0.142	1.266	1.029	0.445	2.063	2.434	2.008	1.962	1.013	1.069	1.449
2013													
0.00 (Ref.: 0.01-100.00)	3.213	2.531	0.892	0.746	1.166	1.107	2.385	2.121	1.228	1.191	1.303	1.557	1.884
2014													
0.00 (Ref.: 0.01-100.00)	4.364	3.650	1.817	2.317	2.508	1.714	3.780	4.030	3.433	3.780	2.352	2.331	2.348
2015													
0.00 (Ref.: 0.01-100.00)	4.314	3.306	0.677	1.978	2.156	0.369	3.485	3.948	2.566	3.284	2.029	1.721	1.705
2016													
0.00 (Ref.: 0.01-100.00)	4.084	3.329	1.237	1.806	1.882	1.098	3.191	3.502	2.570	2.981	1.530	1.452	1.270
2017													
0.00 (Ref.: 0.01-100.00)	4.208	3.367	2.018	2.193	2.192	2.151	3.779	3.588	2.455	3.580	2.252	2.708	2.326
2018													
0.00 (Ref.: 0.01-100.00)	4.179	3.022	1.462	1.307	1.429	1.672	2.972	2.593	1.989	2.202	0.905	1.367	1.671

Table 2.E.21: Bias Estimates of Wage Distribution by Year and Weighting Strategy, BHP 2011-2018

Variable	**Unadjusted**	**Logistic Cur**	**Logistic Ext**	**Lasso**	**Ridge**	**GAM**	**Gamsel**	**CART**	**C-Tree**	**MOB**	**Random Forest**	**XG-Boost**	**Bart**
2011													
First Quartile	0.333	0.125	0.856	0.940	0.947	0.906	0.429	0.087	0.319	0.025	0.592	0.463	0.442
Second Quartile	1.199	1.294	0.996	1.002	0.970	1.213	1.177	1.218	1.330	1.024	1.684	1.648	1.370
Third Quartile	0.476	0.072	0.472	0.798	0.880	0.272	0.206	0.109	0.173	0.078	0.053	0.036	0.012
Fourth Quartile	1.698	2.042	2.697	3.049	2.996	2.573	2.427	1.655	2.235	1.828	2.008	2.153	2.355
Missings	0.356	0.551	1.317	1.905	1.960	0.725	1.026	0.415	0.412	0.857	0.321	0.007	0.555
2012													
First Quartile	0.760	0.157	0.691	0.254	0.451	0.934	0.032	0.499	0.348	0.461	0.024	0.182	0.483
Second Quartile	0.252	0.127	0.353	0.490	0.456	0.168	0.232	0.151	0.369	0.286	0.269	0.031	0.272
Third Quartile	1.678	1.346	0.828	0.015	0.115	0.588	0.903	1.457	0.673	1.048	1.039	0.764	0.585
Fourth Quartile	0.022	0.306	0.773	1.104	1.219	1.348	0.559	0.167	0.847	0.021	0.696	0.878	0.993
Missings	1.192	1.070	0.393	1.325	1.108	0.006	0.079	0.941	0.890	0.852	0.588	0.037	0.198
2013													
First Quartile	0.679	0.022	0.462	0.043	0.162	0.885	0.146	0.613	0.365	0.455	0.205	0.022	0.028
Second Quartile	0.527	0.261	0.150	1.096	1.037	0.034	0.265	0.299	0.222	0.617	0.154	0.120	0.045
Third Quartile	2.163	1.729	1.171	0.791	0.920	0.908	1.528	1.685	1.655	1.274	1.527	1.645	1.266
Fourth Quartile	0.162	0.323	0.877	1.418	1.343	0.964	0.698	0.196	0.651	0.664	0.593	0.658	1.041
Missings	1.119	1.122	0.605	1.765	1.298	0.863	0.419	0.578	0.417	0.462	0.985	0.845	0.243
2014													
First Quartile	1.217	0.704	0.323	0.600	0.522	0.194	0.680	0.945	0.291	0.872	0.658	0.513	0.467
Second Quartile	0.426	0.469	0.652	0.433	0.488	0.719	0.600	0.677	0.562	0.721	0.757	0.886	0.539
Third Quartile	1.537	1.476	0.577	0.496	0.192	0.342	0.976	1.356	0.522	1.278	0.844	0.689	0.155
Fourth Quartile	0.850	0.198	0.701	0.891	0.718	0.849	0.093	0.311	0.473	0.250	0.007	0.447	0.344
Missings	1.597	1.440	0.205	1.554	0.945	0.018	0.803	1.399	0.320	1.378	0.951	0.614	0.116
2015													
First Quartile	1.520	1.236	1.279	1.324	1.174	1.219	1.176	1.353	1.324	1.117	1.441	1.336	1.199
Second Quartile	0.790	1.040	0.588	0.228	0.332	0.573	0.822	0.877	0.795	0.757	1.199	0.845	0.794
Third Quartile	2.059	2.098	1.588	1.270	1.312	1.383	1.908	2.000	1.735	1.704	1.795	1.627	1.335
Fourth Quartile	0.191	0.358	1.349	1.851	1.655	1.492	0.974	0.831	1.109	0.873	0.872	1.073	1.427
Missings	1.138	1.544	0.452	1.677	1.185	0.755	0.579	0.694	0.098	0.471	0.681	0.063	0.498
2016													
First Quartile	2.035	1.636	1.388	0.892	0.982	0.860	1.556	1.696	0.849	1.608	1.006	1.022	1.057
Second Quartile	0.213	0.492	0.080	0.104	0.063	0.205	0.174	0.124	0.106	0.048	0.674	0.299	0.072
Third Quartile	1.902	1.230	0.338	0.117	0.255	0.135	1.015	1.074	0.323	0.741	0.750	0.553	0.428
Fourth Quartile	0.701	0.116	0.811	0.764	0.726	0.945	0.242	0.363	0.635	0.035	0.096	0.527	0.904
Missings	0.780	0.202	1.780	1.643	1.515	1.465	0.609	0.135	1.055	0.950	0.322	0.697	1.462
2017													
First Quartile	2.169	1.520	1.068	1.029	0.915	0.558	1.567	1.679	1.308	1.861	0.948	0.861	0.730
Second Quartile	1.017	0.957	1.419	1.443	1.494	1.236	1.327	1.328	1.553	1.602	0.722	0.985	1.094
Third Quartile	2.914	2.756	2.036	1.888	1.900	1.780	2.351	2.612	2.829	2.574	2.096	2.046	1.950
Fourth Quartile	0.426	0.155	0.580	0.613	0.678	0.576	0.319	0.102	0.043	0.094	0.159	0.540	0.750
Missings	0.154	0.124	1.031	1.197	1.187	0.590	0.863	0.496	0.074	0.797	0.267	0.341	0.625
2018													
First Quartile	2.333	1.729	0.904	0.881	0.836	0.572	1.595	1.870	0.842	1.576	0.854	0.599	0.544
Second Quartile	0.327	0.758	0.420	0.040	0.132	0.380	0.469	0.480	0.390	0.329	1.050	0.660	0.494
Third Quartile	0.470	0.173	0.474	1.143	0.944	0.890	0.117	0.279	0.084	0.112	0.262	0.660	0.574
Fourth Quartile	0.627	0.000	0.797	1.206	1.144	1.087	0.196	0.356	0.817	0.054	0.529	0.989	1.295
Missings	0.910	0.798	1.754	3.190	2.792	2.168	1.205	0.756	1.354	1.414	0.596	1.589	1.919

Table 2.E.22: Bias Estimates of Establishment Closure in t+1 by Year and Weighting Strategy, BHP 2011-2018

Variable	**Unadjusted**	**Logistic Cur**	**Logistic Ext**	**Lasso**	**Ridge**	**GAM**	**Gamsel**	**CART**	**C-Tree**	**MOB**	**Random Forest**	**XG-Boost**	**Bart**
2011													
Existence in t+1 (Ref.: Closure in t+1)	2.871	2.873	2.689	2.802	2.821	2.698	2.786	2.895	3.011	2.877	2.833	2.884	2.748
2012													
Existence in t+1 (Ref.: Closure in t+1)	2.961	2.767	2.654	2.833	2.822	2.656	2.761	2.881	3.021	2.959	2.874	2.857	2.807
2013													
Existence in t+1 (Ref.: Closure in t+1)	2.042	1.961	1.774	1.994	1.867	1.655	1.827	2.040	1.799	1.998	2.056	1.884	1.940
2014													
Existence in t+1 (Ref.: Closure in t+1)	2.597	2.543	2.368	2.389	2.408	2.288	2.470	2.468	2.599	2.403	2.521	2.559	2.259
2015													
Existence in t+1 (Ref.: Closure in t+1)	2.503	2.479	2.244	2.052	2.158	2.296	2.426	2.482	2.499	2.558	2.427	2.313	2.320
2016													
Existence in t+1 (Ref.: Closure in t+1)	2.353	2.083	1.447	2.082	1.926	1.551	1.841	2.000	1.725	1.874	1.871	1.865	1.693
2017													
Existence in t+1 (Ref.: Closure in t+1)	3.815	3.593	3.486	3.447	3.448	3.471	3.596	3.783	3.642	3.674	3.400	3.462	3.429
2018													
Existence in t+1 (Ref.: Closure in t+1)	2.176	2.113	2.032	1.669	1.749	1.801	2.079	2.183	2.146	1.957	1.914	1.739	1.840

Table 2.E.23: Bias Estimates of Establishment Foundation in in t-1 by Year and Weighting Strategy, BHP 2011-2018

Variable	**Unadjusted**	**Logistic Cur**	**Logistic Ext**	**Lasso**	**Ridge**	**GAM**	**Gamsel**	**CART**	**C-Tree**	**MOB**	**Random Forest**	**XG-Boost**	**Bart**
2011													
Existance in t-1 (Ref.: Founddation in t)	0.510	0.288	0.165	0.084	0.016	0.049	0.013	0.435	0.258	0.280	0.250	0.275	0.043
2012													
Existance in t-1 (Ref.: Founddation in t)	0.707	0.639	0.022	0.198	0.108	0.053	0.243	0.300	0.389	0.252	0.353	0.102	0.111
2013													
Existance in t-1 (Ref.: Founddation in t)	0.689	0.654	0.093	0.135	0.145	0.174	0.230	0.403	0.288	0.260	0.227	0.220	0.106
2014													
Existance in t-1 (Ref.: Founddation in t)	0.421	0.324	0.163	0.039	0.024	0.234	0.048	0.216	0.049	0.101	0.210	0.128	0.083
2015													
Existance in t-1 (Ref.: Founddation in t)	1.020	0.837	0.493	0.331	0.407	0.677	0.764	0.829	0.680	0.768	0.786	0.618	0.712
2016													
Existance in t-1 (Ref.: Founddation in t)	0.499	0.190	0.355	0.187	0.034	0.208	0.036	0.203	0.219	0.356	0.380	0.060	0.094
2017													
Existance in t-1 (Ref.: Founddation in t)	0.361	0.056	0.654	0.568	0.714	0.558	0.317	0.289	0.327	0.334	0.166	0.365	0.419
2018													
Existance in t-1 (Ref.: Founddation in t)	0.707	0.605	0.398	0.361	0.368	0.346	0.502	0.631	0.383	0.417	0.591	0.441	0.491

Table 2.E.24: Bias Estimates of Industry by Year and Weighting Strategy, BHP 2011-2018

Variable	**Unadjusted**	**Logistic Cur**	**Logistic Ext**	**Lasso**	**Ridge**	**GAM**	**Gamsel**	**CART**	**C-Tree**	**MOB**	**Random Forest**	**XG-Boost**	**Bart**
2011													
Agric./Production	2.671	2.925	1.959	1.566	1.736	1.989	2.512	2.256	2.010	2.040	1.797	1.595	1.590
Service	5.022	5.261	4.115	3.786	3.999	4.177	4.444	4.097	4.577	4.179	3.924	3.963	3.902
Public/Educ./Health/Arts	2.352	2.335	2.156	2.220	2.263	2.188	1.931	1.842	2.567	2.139	2.127	2.368	2.311
2012													
Agric./Production	3.413	3.317	1.595	1.393	1.480	1.991	2.678	2.485	2.603	2.886	1.897	2.268	1.753
Service	5.631	5.429	3.891	3.489	3.592	3.928	4.648	4.426	4.453	4.836	3.720	4.404	3.940
Public/Educ./Health/Arts	2.218	2.111	2.296	2.096	2.112	1.938	1.969	1.941	1.850	1.950	1.822	2.136	2.187
2013													
Agric./Production	0.746	0.389	0.043	0.038	0.171	0.139	0.693	0.697	0.139	0.170	0.181	0.016	0.101
Service	3.284	3.070	2.453	2.578	2.655	2.501	2.919	2.972	2.610	2.426	2.260	2.573	2.725
Public/Educ./Health/Arts	2.538	2.681	2.410	2.616	2.484	2.363	2.226	2.275	2.471	2.256	2.441	2.589	2.624
2014													
Agric./Production	2.576	2.332	0.813	0.915	0.824	1.146	1.809	1.933	1.450	1.608	1.260	1.190	1.123
Service	4.903	5.030	4.086	4.091	4.031	3.976	4.238	4.375	3.788	4.651	3.888	4.130	3.827
Public/Educ./Health/Arts	2.326	2.698	3.273	3.176	3.207	2.830	2.429	2.442	2.339	3.043	2.628	2.940	2.704
2015													
Agric./Production	2.329	2.245	1.152	0.958	1.118	1.305	1.923	1.893	1.357	0.974	1.062	0.992	1.136
Service	5.370	5.373	4.643	4.435	4.495	4.419	4.972	4.835	4.461	4.420	4.438	4.509	4.398
Public/Educ./Health/Arts	3.041	3.128	3.491	3.477	3.377	3.114	3.049	2.941	3.104	3.447	3.376	3.517	3.262
2016													
Agric./Production	2.410	2.096	0.854	0.238	0.321	0.795	1.766	1.825	0.648	1.034	0.563	0.536	0.563
Service	5.011	4.784	3.588	3.285	3.307	3.632	4.196	4.334	3.183	3.550	3.212	3.220	3.256
Public/Educ./Health/Arts	2.601	2.688	2.734	3.048	2.985	2.836	2.430	2.509	2.535	2.517	2.649	2.684	2.694
2017													
Agric./Production	2.068	1.851	0.424	0.603	0.606	0.721	1.440	1.504	0.910	1.295	0.583	0.717	0.928
Service	4.012	4.040	2.778	2.673	2.673	2.738	3.271	3.166	2.514	3.138	2.080	2.926	2.836
Public/Educ./Health/Arts	1.945	2.190	2.354	2.070	2.067	2.017	1.832	1.662	1.604	1.844	1.497	2.210	1.908
2018													
Agric./Production	1.993	1.863	1.205	0.892	1.003	1.341	1.984	1.762	1.231	1.540	1.306	1.099	1.059
Service	4.932	4.844	3.970	3.463	3.629	4.056	4.407	4.405	3.634	4.111	3.742	3.860	3.678
Public/Educ./Health/Arts	2.938	2.981	2.765	2.572	2.626	2.715	2.422	2.644	2.403	2.571	2.436	2.761	2.619

Table 2.E.25: Bias Estimates of East/West Germany by Year and Weighting Strategy, BHP 2011-2018

Variable	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011													
East Germany (Ref.: West Germany)	0.972	0.236	0.463	0.154	0.101	0.357	0.701	0.523	0.286	0.295	0.138	0.082	0.185
2012													
East Germany (Ref.: West Germany)	1.502	0.809	0.970	0.694	0.509	0.812	1.080	1.361	0.852	0.729	0.584	0.590	0.281
2013													
East Germany (Ref.: West Germany)	0.715	0.008	0.105	0.617	0.657	0.240	0.302	0.158	0.491	0.382	0.480	0.102	0.490
2014													
East Germany (Ref.: West Germany)	2.493	1.750	1.791	0.963	1.164	1.534	2.129	2.553	1.783	2.647	1.295	1.325	1.183
2015													
East Germany (Ref.: West Germany)	0.453	0.101	0.231	0.104	0.118	0.110	0.302	0.616	0.068	0.211	0.352	0.199	0.207
2016													
East Germany (Ref.: West Germany)	0.640	0.069	0.491	0.191	0.271	0.558	0.102	0.498	0.129	0.030	0.179	0.090	0.521
2017													
East Germany (Ref.: West Germany)	1.526	1.401	1.427	1.486	1.355	1.248	1.454	1.835	1.478	1.712	1.139	1.252	0.968
2018													
East Germany (Ref.: West Germany)	0.520	0.010	0.161	0.342	0.336	0.137	0.269	0.449	0.057	0.034	0.001	0.223	0.370

2.E.5 Significance of Weighted Biases

Table 2.E.26: Number of Statistically Significant Biases by Year and Weighting Strategy, BHP 2011-2018

Weighting Strategy	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**Average**
Unadjusted	20	16	20	23	31	20	23	26	22.375
Logistic - Cur	17	10	16	14	24	12	24	14	16.375
Logistic - Ext	12	8	10	8	9	8	12	8	9.375
Lasso	7	7	2	8	7	3	11	3	6.000
Ridge	8	7	5	7	5	5	10	6	6.625
GAM	12	11	10	9	10	8	11	13	10.500
GAMSEL	16	10	13	12	19	10	19	13	14.000
CART	18	13	14	19	19	16	23	18	17.500
MOB	13	13	10	16	15	12	20	13	14.000
C-Tree	7	7	8	6	12	9	19	8	9.500
Random Forest	6	6	7	10	9	4	11	6	7.375
XG-Boost	9	4	5	7	8	2	8	4	5.875
BART	8	7	8	7	7	3	11	11	7.750
Total	**56**	**56**	**56**	**56**	**56**	**56**	**56**	**56**	

2.E.6 New Hires

Table 2.E.27: Mean Number of New Hirings in t by Year and Weighting Strategy and in Comparison to Full Sample, BHP 2011-2018

Year	Full Sample	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011	3.763	2.937	3.279	3.411	3.435	3.428	3.395	3.131	3.114	3.300	3.342	3.470	3.523	3.470
2012	3.760	2.846	3.103	3.211	3.185	3.244	3.259	2.975	3.112	3.152	3.217	3.332	3.335	3.309
2013	3.605	2.922	3.148	3.296	3.183	3.170	3.142	2.974	3.148	3.142	3.221	3.280	3.232	3.236
2014	3.609	2.860	3.094	3.194	3.190	3.175	3.224	2.911	3.000	3.029	3.107	3.270	3.185	3.360
2015	3.681	2.894	3.235	3.628	3.185	3.196	3.240	3.197	3.102	3.070	3.224	3.332	3.326	3.421
2016	3.770	2.912	3.163	3.355	3.306	3.296	3.285	2.990	3.071	3.240	3.238	3.404	3.381	3.409
2017	3.900	3.081	3.342	3.568	3.553	3.584	3.546	3.239	3.357	3.557	3.467	3.581	3.474	3.608
2018	4.154	3.161	3.495	3.680	3.729	3.717	3.667	3.363	3.502	3.520	3.660	3.795	3.798	3.800

Table 2.E.28: Mean Number of New Hirings in t+1 by Year and Weighting Strategy and in Comparison to Full Sample, BHP 2011-2018

Year	Full Sample	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011	3.688	2.768	3.072	3.176	3.209	3.196	3.215	2.920	2.916	3.143	3.127	3.268	3.303	3.248
2012	3.607	2.609	2.837	2.961	2.931	2.982	2.999	2.733	2.859	2.883	2.914	3.060	3.048	3.023
2013	3.623	2.905	3.139	3.365	3.198	3.187	3.186	2.992	3.160	3.170	3.173	3.278	3.219	3.262
2014	3.630	2.909	3.125	3.228	3.236	3.226	3.235	2.967	3.058	3.110	3.145	3.325	3.224	3.381
2015	3.737	2.903	3.215	3.567	3.242	3.247	3.275	3.171	3.097	3.117	3.216	3.389	3.387	3.436
2016	3.859	2.928	3.158	3.353	3.318	3.319	3.346	3.006	3.088	3.293	3.222	3.449	3.427	3.427
2017	4.125	3.110	3.375	3.655	3.627	3.665	3.615	3.281	3.430	3.639	3.549	3.647	3.545	3.678
2018	4.080	3.087	3.384	3.561	3.631	3.605	3.556	3.255	3.372	3.451	3.527	3.691	3.666	3.700

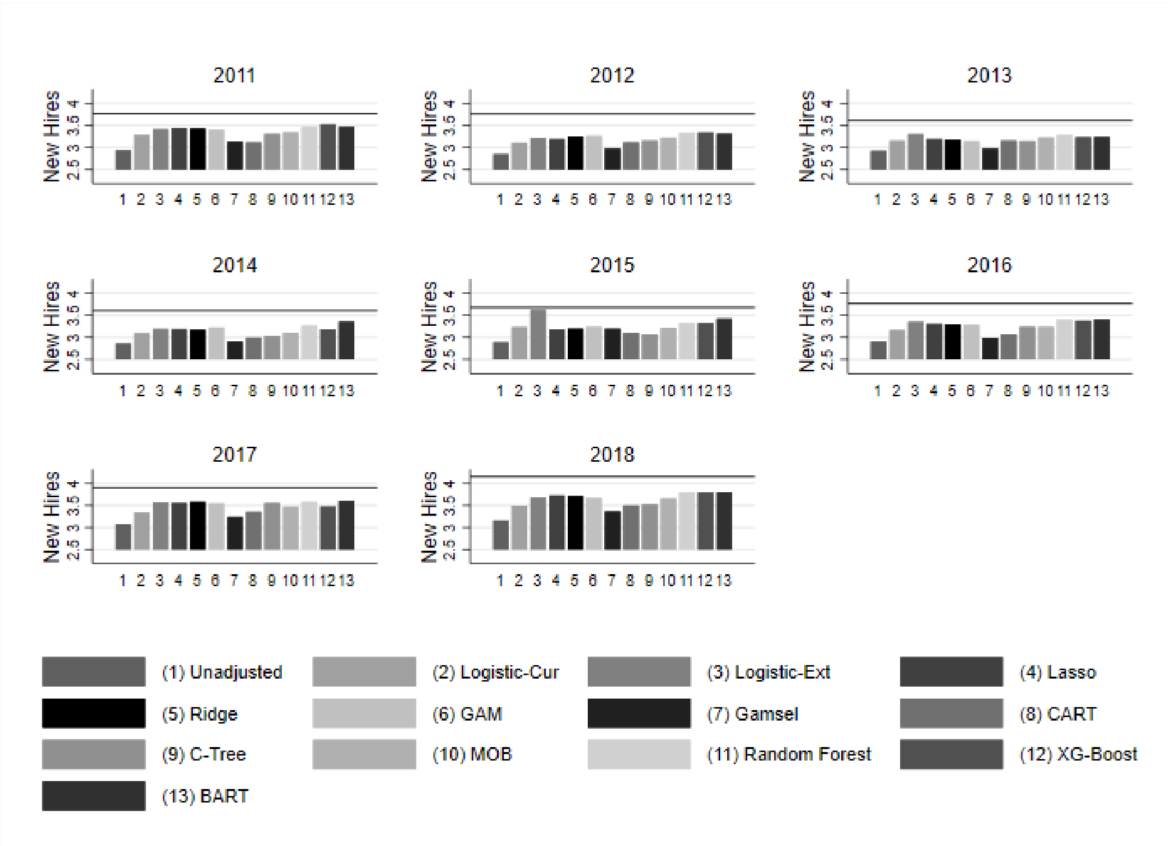

Figure 2.E.3: Mean Number of New Hires in t by Year and Modeling Approach, BHP 2011-2018

2.F Nonresponse reduction - AWFP (Validation Data Set)

2.F.1 Method

The effectiveness of the various nonresponse adjustment methods on the validation dataset is measured using a similar procedure as for the BHP: The absolute bias estimates of multiple variables are measured and aggregated for all variables and the subset of employee and establishment characteristics (see Table 2.1 for an overview). The estimate of respondents is weighted with the nonresponse adjustment weights received by the procedure described in Section 2.5.2.3 on the BHP data. In contrast to the BHP, no "leave-one-out"-approach is applied and the nonresponse adjustment weights received from the full set of explanatory variables are used. The full-sample estimate is weighted with the inverse of the inclusion probability.

2.F.2 Average Bias

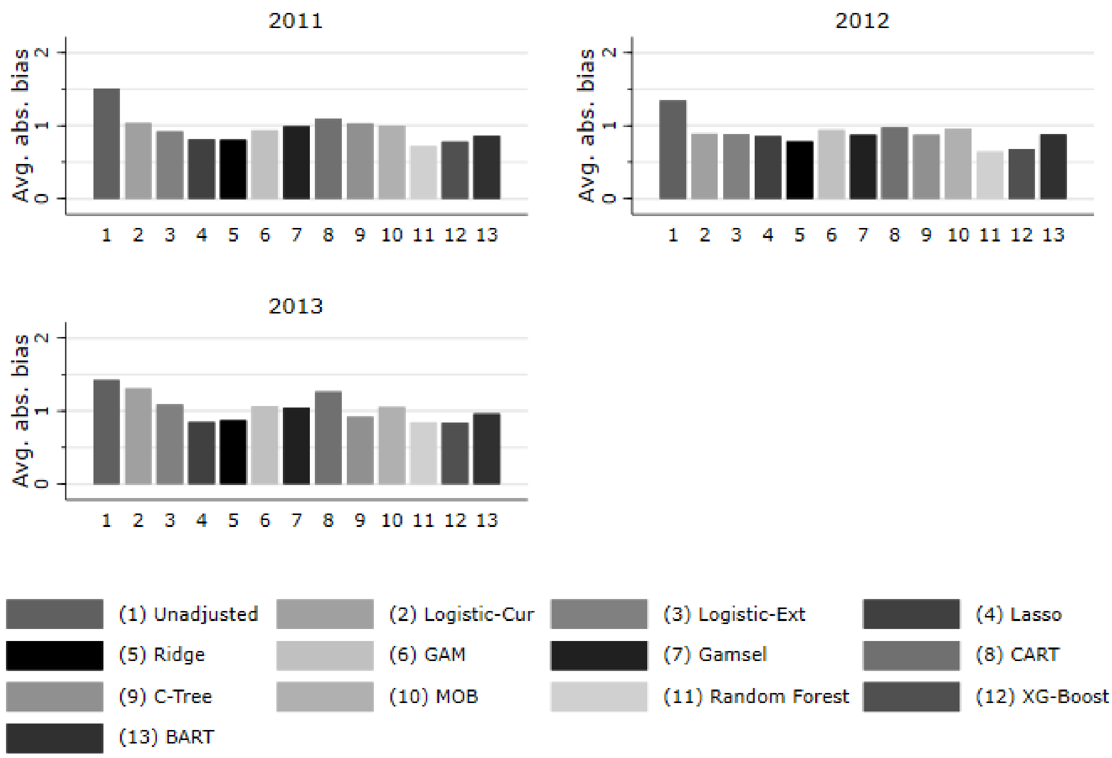

Figure 2.F.1: Average Absolute Bias by Modeling Approach and Set of Explanatory Variables, All Administrative Variables AWFP 2011-2013

Table 2.F.1: Average Absolute Bias by Modeling Approach and Set of Explanatory Variables, All Variables AWFP 2011-2013

Year	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011	1.511	1.036	0.922	0.815	0.810	0.938	0.992	1.094	1.030	1.001	0.719	0.780	0.860
2012	1.345	0.892	0.886	0.858	0.782	0.942	0.877	0.976	0.879	0.957	0.645	0.683	0.883
2013	1.426	1.310	1.087	0.850	0.877	1.072	1.046	1.264	0.921	1.056	0.844	0.838	0.963

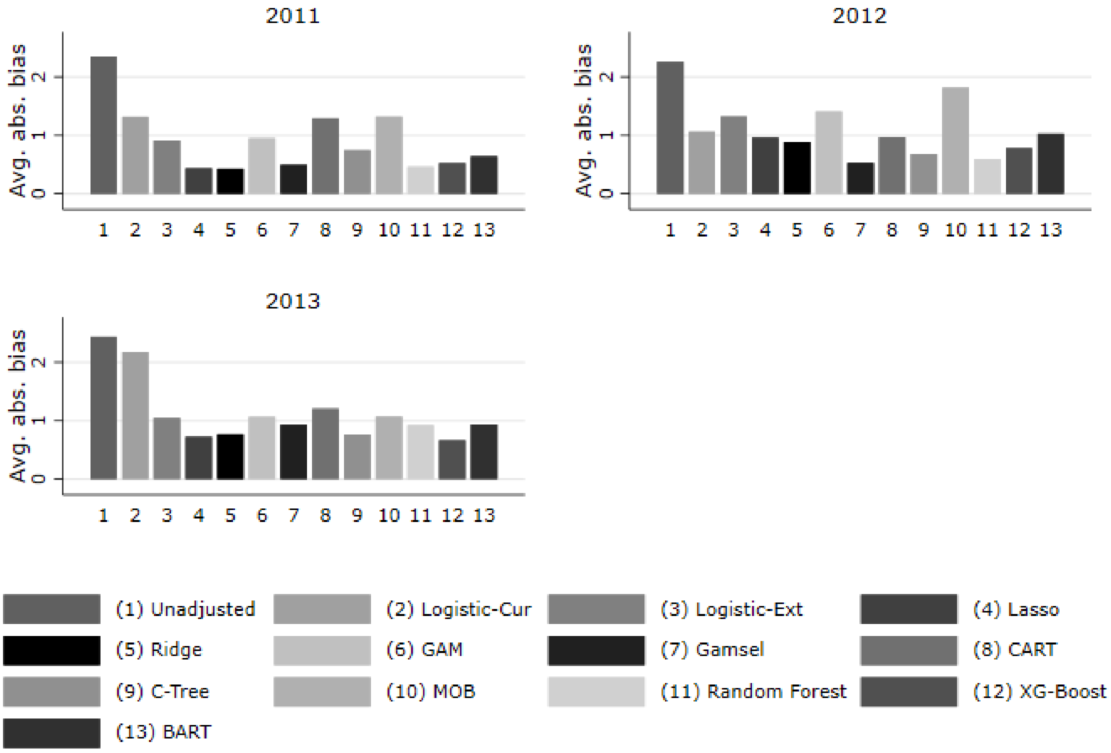

Figure 2.F.2: Average Absolute Bias by Modeling Approach and Set of Explanatory Variables, Establishment Characteristics AWFP 2011-2013

Table 2.F.2: Average Absolute Bias by Modeling Approach and Set of Explanatory Variables, Establishment Characteristics AWFP 2011-2013

Year	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011	2.350	1.315	0.909	0.435	0.423	0.950	0.493	1.289	0.746	1.321	0.461	0.527	0.642
2012	2.260	1.063	1.324	0.962	0.881	1.411	0.530	0.966	0.680	1.821	0.595	0.784	1.029
2013	2.436	2.174	1.045	0.724	0.767	1.064	0.933	1.207	0.762	1.068	0.924	0.664	0.937

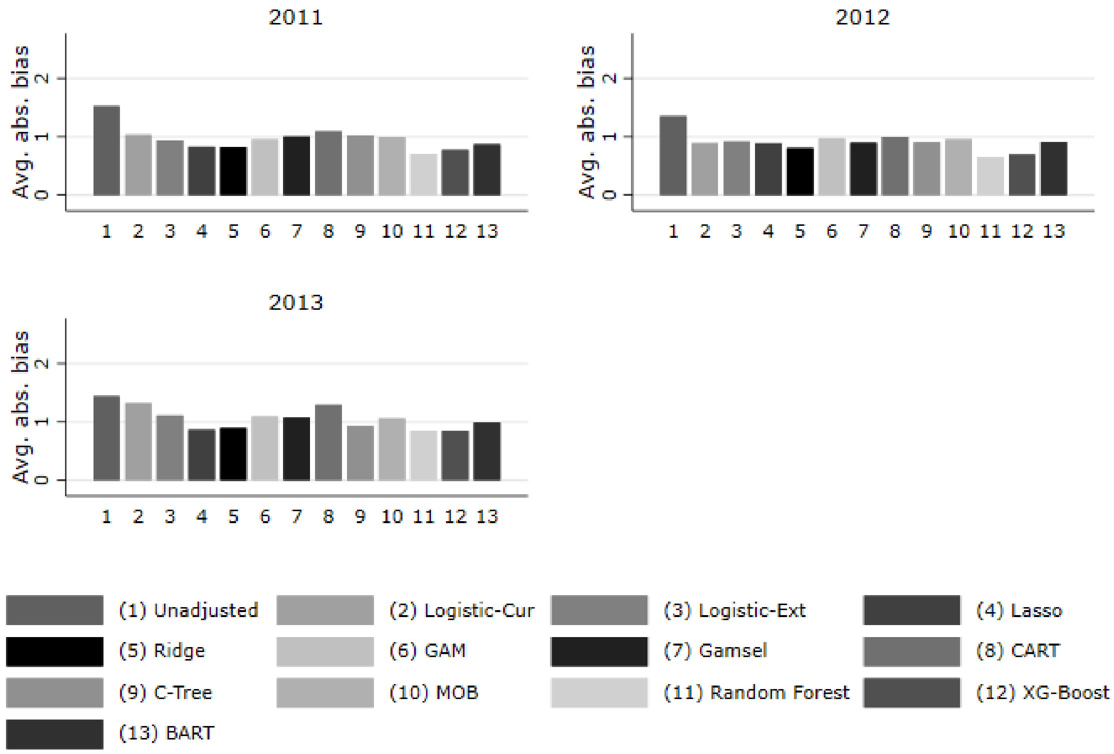

Figure 2.F.3: Average Absolute Bias by Modeling Approach and Set of Explanatory Variables, Employee Characteristics AWFP 2011-2013

Table 2.F.3: Average Absolute Bias by Modeling Approach and Set of Explanatory Variables, Employee Characteristics AWFP 2011-2013

Year	**Unadjusted**	**Logistic Cur**	**Logistic Ext**	**Lasso**	**Ridge**	**GAM**	**Gamsel**	**CART**	**C-Tree**	**MOB**	**Random Forest**	**XG-Boost**	**Bart**
2011	1.525	1.034	0.940	0.826	0.821	0.953	1.002	1.093	1.024	0.995	0.709	0.779	0.869
2012	1.352	0.888	0.916	0.883	0.805	0.970	0.895	0.997	0.902	0.953	0.647	0.696	0.906
2013	1.440	1.322	1.111	0.863	0.894	1.093	1.074	1.289	0.928	1.058	0.848	0.845	0.991

2.F.3 Significance of Weighted Biases

Table 2.F.4: Number of Statistically Significant Biases by Year and Weighting Strategy, AWFP 2011-2013

Weighting Strategy	**2011**	**2012**	**2013**	**Average**
Unadjusted	25	21	21	22.33
Logistic - Cur	14	14	12	13.33
Logistic - Ext	12	12	9	11.00
Lasso	8	11	7	8.67
Ridge	10	9	8	9.00
GAM	13	17	12	14.00
GAMSEL	17	11	13	13.67
CART	17	13	14	14.67
MOB	12	15	13	13.33
C-Tree	9	12	5	8.67
Random Forest	6	6	8	6.67
XG-Boost	9	7	6	7.33
BART	12	11	7	10.00
Total	**60**	**60**	**60**	

2.F.4 Single Biases Estimates

Table 2.F.5: Bias Estimates of Avg. Age of Employees by Year and Weighting Strategy, AWFP 2011-2013

Variable	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011													
0.00-38.99	2.170	0.361	0.312	0.342	0.020	0.370	0.374	1.660	2.153	0.014	0.038	0.244	0.278
39.00-43.49	0.164	0.353	0.193	0.154	0.038	0.044	0.284	0.290	0.834	0.359	0.120	0.099	0.016
43.50-47.99	1.260	0.676	0.131	0.281	0.341	0.155	0.437	0.994	0.243	0.491	0.474	0.263	0.172
≥48.00	0.746	0.668	0.637	0.468	0.322	0.480	0.346	0.376	1.076	0.864	0.556	0.407	0.465
2012													
0.00-38.99	1.146	0.964	1.417	0.814	0.974	1.941	0.672	0.413	0.555	0.575	0.943	1.156	1.646
39.00-43.49	1.397	1.266	1.464	1.244	1.278	1.866	1.560	1.628	2.095	1.723	1.317	1.505	1.835
43.50-47.99	0.637	0.151	0.054	0.191	0.075	0.386	0.064	0.652	0.570	0.366	0.111	0.112	0.154
≥48.00	1.907	0.151	0.102	0.239	0.229	0.310	0.824	1.388	0.971	0.783	0.263	0.237	0.343
2013													
0.00-38.99	1.804	0.224	0.984	1.485	1.151	1.067	0.192	1.291	1.180	0.375	0.604	1.122	1.467
39.00-43.49	0.610	0.391	0.339	0.986	0.836	0.812	0.407	0.266	0.271	0.510	0.641	0.566	0.856
43.50-47.99	1.632	1.066	0.632	0.296	0.416	0.323	0.906	1.273	0.230	0.921	0.765	0.325	0.035
≥48.00	0.782	0.900	1.276	0.795	0.732	0.578	0.691	0.283	1.139	0.036	0.728	0.881	0.577

Table 2.F.6: Bias Estimates of Number of Employees by Year and Weighting Strategy, AWFP 2011-2013

Variable	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011													
1-9	2.979	2.469	3.445	2.942	2.932	3.233	3.646	2.773	3.829	2.567	1.948	2.336	3.335
10-19	0.821	0.773	1.241	0.975	0.984	1.196	1.198	0.894	1.521	0.901	0.635	0.867	1.189
20-49	1.071	0.852	1.184	1.145	1.099	1.210	1.274	0.956	1.228	0.988	0.830	0.935	1.360
≥50	1.088	0.844	1.020	0.822	0.849	0.827	1.173	0.922	1.080	0.677	0.482	0.534	0.786
2012													
1-9	2.150	1.779	2.563	2.524	2.277	3.016	2.617	2.190	1.737	2.060	1.499	1.655	2.522
10-19	0.566	0.448	0.883	0.930	0.751	1.135	0.764	1.064	0.526	0.755	0.592	0.516	0.832
20-49	0.544	0.448	0.685	0.668	0.645	1.001	0.732	0.510	0.499	0.594	0.408	0.538	0.857
≥50	1.040	0.884	0.994	0.926	0.882	0.879	1.121	0.615	0.712	0.711	0.499	0.601	0.832
2013													
1-9	0.946	0.749	1.493	0.997	1.198	2.172	1.633	0.552	1.193	0.789	0.559	1.031	1.488
10-19	0.337	0.488	0.128	0.290	0.193	0.185	0.117	0.319	0.194	0.376	0.291	0.217	0.223
20-49	0.547	0.516	0.783	0.677	0.715	1.127	0.809	0.412	0.663	0.615	0.474	0.771	0.897
≥50	0.735	0.720	0.838	0.610	0.677	0.861	0.941	0.458	0.724	0.550	0.376	0.477	0.814

Table 2.F.7: Bias Estimates of Establishment Foundation Year by Year and Weighting Strategy, AWFP 2011-2013

Variable	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011													
70s/80s	2.870	1.679	1.511	0.557	0.489	0.974	0.280	0.670	0.827	0.538	0.197	0.108	0.563
90s	1.331	0.940	0.015	0.151	0.275	0.529	0.580	1.031	0.210	0.470	0.183	0.435	0.397
00s/10s	4.201	2.619	1.496	0.406	0.213	1.503	0.300	1.702	0.616	0.068	0.014	0.543	0.960
2012													
70s/80s	1.960	0.711	2.364	1.651	1.347	2.288	0.961	0.209	0.807	1.783	0.691	1.367	1.520
90s	0.951	0.485	0.757	0.796	0.675	0.905	0.094	0.571	0.494	0.574	0.785	1.187	0.831
00s/10s	2.912	1.196	3.121	2.446	2.022	3.193	1.055	0.361	1.301	2.356	1.476	2.553	2.352
2013													
70s/80s	4.078	3.397	0.065	0.365	0.647	0.829	1.083	0.228	0.050	0.728	0.811	0.512	0.951
90s	2.269	2.026	1.147	1.125	1.149	0.579	1.711	1.728	0.912	1.041	0.952	0.519	0.984
00s/10s	6.346	5.422	1.212	1.490	1.796	1.408	2.794	1.956	0.961	0.313	1.762	1.032	1.936

Table 2.F.8: Bias Estimates of Mean Tenure by Year and Weighting Strategy, AWFP 2011-2013

Variable	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011													
0.00 - 12.00	3.652	2.813	0.251	0.083	0.429	0.407	1.409	2.472	1.387	1.219	1.347	0.761	0.569
12.01 - 21.58	2.220	2.202	1.878	1.891	1.885	1.622	1.912	1.743	2.811	1.473	1.548	1.669	1.542
21.59 - 33.96	0.585	0.367	0.484	0.708	0.540	0.525	0.036	0.214	0.698	0.039	0.056	0.349	0.715
≥33.97	5.287	4.648	2.613	2.681	2.855	2.553	3.357	4.001	2.122	2.731	2.950	2.780	2.826
2012													
0.00 - 12.00	3.896	3.236	0.749	0.890	0.888	0.498	1.752	2.429	2.031	0.791	1.971	0.945	0.832
12.01 - 21.58	1.062	1.010	0.786	0.845	0.896	0.790	0.849	0.948	0.683	0.887	0.458	0.742	0.844
21.59 - 33.96	0.296	0.359	0.195	0.169	0.184	0.232	0.092	0.281	0.301	0.288	0.284	0.105	0.082
≥33.97	4.661	3.886	1.730	1.903	1.968	1.520	2.693	3.096	3.015	1.966	2.145	1.582	1.758
2013													
0.00 - 12.00	5.822	5.099	3.000	2.742	2.913	3.179	3.796	3.910	2.809	2.874	3.704	3.217	2.865
12.01 - 21.58	0.401	0.198	0.099	0.049	0.147	0.021	0.011	0.126	0.196	0.157	0.439	0.591	0.139
21.59 - 33.96	1.671	1.611	1.166	1.099	1.084	1.324	1.284	1.486	1.234	1.131	1.108	1.097	1.193
≥33.97	4.552	3.685	1.734	1.691	1.976	1.833	2.502	2.299	1.380	1.586	2.157	1.528	1.812

Table 2.F.9: Bias Estimates of Share of Apprentices by Year and Weighting Strategy, AWFP 2011-2013

Variable	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011													
0.00 (Ref.: ≥0.01)	1.831	0.966	2.101	1.500	1.598	2.339	1.797	1.755	1.247	1.196	1.088	1.560	1.868
2012													
0.00 (Ref.: ≥0.01)	0.409	0.003	0.802	0.515	0.637	1.214	0.285	0.140	0.458	0.261	0.490	0.548	0.623
2013													
0.00 (Ref.: ≥0.01)	0.498	0.007	1.113	0.664	0.700	1.768	0.359	0.815	0.182	0.590	0.631	0.581	0.741

Table 2.F.10: Bias Estimates of Share of Females by Year and Weighting Strategy, AWFP 2011-2013

Variable	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011													
0.00 - 10.00	0.860	0.044	0.624	0.285	0.023	0.984	1.047	1.267	0.123	1.384	0.058	0.684	0.526
10.01 - 33.32	0.307	0.662	0.227	0.085	0.010	0.173	0.260	0.301	0.454	0.178	0.344	0.087	0.191
33.33 - 64.28	0.712	0.052	0.287	0.142	0.050	0.276	0.574	0.562	0.361	0.320	0.272	0.266	0.131
≥ 64.29	0.455	0.655	0.563	0.228	0.018	0.535	0.733	1.006	0.939	1.243	0.559	0.506	0.205
2012													
0.00 - 10.00	2.923	2.174	1.699	1.720	1.645	2.754	2.851	3.268	1.770	3.407	1.581	2.191	1.933
10.01 - 33.32	0.161	0.153	0.035	0.099	0.145	0.677	0.091	0.110	0.077	0.446	0.135	0.329	0.425
33.33 - 64.28	0.798	0.154	0.196	0.282	0.176	0.387	0.618	0.851	0.215	1.145	0.165	0.406	0.441
≥ 64.29	1.964	2.173	1.468	1.339	1.324	1.689	2.142	2.526	1.633	1.816	1.611	1.455	1.067
2013													
0.00 - 10.00	0.630	1.477	0.887	0.917	0.940	0.017	0.449	0.317	0.794	0.424	1.233	0.432	0.653
10.01 - 33.32	0.358	0.920	0.674	0.672	0.602	0.035	0.576	0.722	0.674	0.400	0.558	0.203	0.486
33.33 - 64.28	1.145	0.699	0.927	0.827	0.896	0.843	1.061	0.852	0.643	0.737	0.056	0.803	0.942
≥ 64.29	1.416	1.256	1.140	1.072	1.234	0.861	0.934	0.446	0.763	0.760	0.732	1.033	1.110

Table 2.F.11: Bias Estimates of Share of Full-Time Employees by Year and Weighting Strategy, AWFP 2011-2013

Variable	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011													
0.00 - 58.33	1.762	2.008	1.289	1.233	1.368	1.379	1.670	2.164	0.876	1.886	1.812	1.407	0.590
58.34 - 87.49	0.284	0.147	0.294	0.126	0.086	0.376	0.462	0.060	0.786	0.218	0.233	0.331	0.633
87.50 - 99.9	0.032	0.178	0.167	0.239	0.213	0.223	0.122	0.092	0.301	0.094	0.158	0.036	0.229
100.00	2.014	1.683	1.750	1.598	1.667	1.979	2.254	2.132	1.963	2.011	1.421	1.703	1.452
2012													
0.00 - 58.33	0.789	0.010	0.029	0.210	0.156	0.084	0.580	1.084	0.148	0.569	0.105	0.047	0.151
58.34 - 87.49	0.182	0.028	0.286	0.295	0.190	0.560	0.341	0.263	0.285	0.309	0.068	0.324	0.465
87.50 - 99.9	0.017	0.024	0.277	0.315	0.313	0.538	0.194	0.183	0.095	0.022	0.034	0.216	0.379
100.00	0.954	0.041	0.592	0.400	0.658	1.182	1.114	1.164	0.041	0.900	0.002	0.588	0.692
2013													
0.00 - 58.33	2.151	2.182	2.319	1.428	1.778	2.390	2.250	2.869	1.551	2.163	1.505	1.730	1.712
58.34 - 87.49	1.054	0.989	0.685	0.664	0.723	0.065	0.845	1.121	1.197	1.262	0.981	0.550	0.661
87.50 - 99.9	0.045	0.138	0.098	0.161	0.168	0.437	0.070	0.396	0.188	0.004	0.009	0.104	0.322
100.00	1.052	1.056	1.732	0.925	1.223	2.762	1.475	1.352	0.166	0.905	0.515	1.284	1.373

Table 2.F.12: Bias Estimates of Share of High-Educated by Year and Weighting Strategy, AWFP 2011-2013

Variable	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011													
0.00	0.954	0.615	0.527	1.664	1.474	1.011	0.395	0.366	0.359	0.142	0.584	0.182	0.227
0.01 - 24.99	0.449	0.316	0.821	0.859	0.831	0.860	0.805	0.436	0.837	0.512	0.302	0.468	0.849
≥25.00	0.505	0.299	0.294	0.804	0.642	0.151	0.410	0.069	0.479	0.370	0.282	0.286	0.621
2012													
0.00	0.649	1.635	2.330	2.262	1.579	1.046	1.837	1.846	2.485	1.186	1.821	1.523	1.493
0.01 - 24.99	0.076	0.051	0.386	0.526	0.448	0.883	0.434	0.015	0.158	0.300	0.002	0.356	0.841
≥25.00	0.725	1.686	2.716	2.789	2.026	1.929	2.271	1.861	2.643	1.486	1.819	1.880	2.334
2013													
0.00	1.259	1.396	1.189	0.012	0.314	0.084	1.605	2.144	1.742	1.810	0.605	0.822	0.957
0.01 - 24.99	0.638	0.627	0.259	0.115	0.095	0.339	0.274	0.822	0.456	0.374	0.524	0.182	0.226
≥25.00	0.621	0.768	0.930	0.126	0.220	0.256	1.331	1.322	1.286	1.436	0.081	0.641	1.184

Table 2.F.13: Bias Estimates of Share of Mid-Educated by Year and Weighting Strategy, AWFP 2011-2013

Variable	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011													
0.00 - 61.90	0.800	0.045	1.311	0.149	0.497	0.807	0.501	0.561	0.755	1.102	0.241	0.565	0.583
61.91 - 83.32	0.893	0.881	0.972	1.032	1.054	1.127	1.046	0.677	1.094	0.701	0.478	0.921	1.048
83.33 - 99.99	0.772	0.728	1.179	1.345	1.312	1.204	1.081	0.895	1.255	1.023	0.658	0.753	1.120
100.00	2.466	1.564	0.840	2.229	1.869	1.523	1.626	1.011	1.594	0.622	0.895	1.110	1.586
2012													
0.00 - 61.90	0.139	0.657	2.330	1.551	1.421	1.600	1.524	1.630	2.137	1.273	0.467	0.822	1.156
61.91 - 83.32	1.217	1.090	1.005	0.952	0.894	1.212	1.273	1.012	0.721	1.150	0.617	0.736	1.028
83.33 - 99.99	0.254	0.292	0.696	0.712	0.756	1.149	0.660	0.474	0.722	0.627	0.378	0.583	0.928
100.00	1.610	0.725	0.629	0.114	0.229	0.761	0.409	0.144	0.694	0.504	0.527	0.498	0.799
2013													
0.00 - 61.90	0.292	0.984	2.565	0.764	1.086	2.065	1.785	2.140	1.189	2.404	0.499	0.571	1.946
61.91 - 83.32	0.325	0.228	0.301	0.123	0.072	0.433	0.313	0.933	1.214	0.761	0.558	0.295	0.113
83.33 - 99.99	0.419	0.201	0.299	0.219	0.230	0.738	0.039	0.350	0.028	0.017	0.043	0.047	0.390
100.00	1.036	1.413	2.567	0.422	0.783	0.895	2.060	3.422	2.431	3.148	1.100	0.818	1.442

Table 2.F.14: Bias Estimates of Share of Low-Educated by Year and Weighting Strategy, AWFP 2011-2013

Variable	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011													
0.00	2.533	2.149	0.387	1.190	1.198	0.518	1.307	1.793	0.279	1.379	0.654	0.647	0.324
0.01 - 11.99	0.567	0.306	0.613	0.580	0.577	0.608	0.647	0.432	0.725	0.372	0.252	0.371	0.602
≥12.00	1.966	1.843	0.226	0.610	0.621	0.091	0.660	1.361	0.446	1.007	0.402	0.276	0.278
2012													
0.00	4.090	3.054	1.204	1.162	1.717	1.227	2.733	3.115	2.270	2.622	1.337	1.110	1.142
0.01 - 11.99	0.706	0.539	0.700	0.721	0.702	0.819	0.774	0.432	0.486	0.546	0.370	0.505	0.637
≥12.00	3.384	2.516	0.504	0.441	1.015	0.408	1.959	2.683	1.785	2.076	0.967	0.605	0.505
2013													
0.00	2.727	2.159	0.181	0.848	0.661	0.918	1.094	1.472	0.137	1.228	0.826	1.005	0.326
0.01 - 11.99	0.533	0.511	0.722	0.648	0.683	0.879	0.724	0.292	0.605	0.512	0.427	0.556	0.749
≥12.00	2.194	1.649	0.541	0.199	0.022	0.039	0.371	1.181	0.468	0.715	0.399	0.449	0.423

Table 2.F.15: Bias Estimates of Share of Marginal by Year and Weighting Strategy, AWFP 2011-2013

Variable	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011													
0.00	1.196	0.679	0.144	0.147	0.024	0.298	0.045	0.536	0.752	0.189	0.004	0.284	0.457
0.01-14.99	0.815	0.851	0.391	0.265	0.342	0.181	0.457	0.799	0.005	0.780	0.609	0.431	0.301
≥15.00	0.380	0.172	0.535	0.412	0.318	0.479	0.502	0.263	0.756	0.970	0.605	0.715	0.759
2012													
0.00	2.389	1.481	0.987	1.030	0.998	0.260	1.245	0.035	0.698	0.048	1.258	0.402	0.840
0.01-14.99	0.673	0.824	0.544	0.426	0.561	0.223	0.460	0.626	0.498	0.193	0.132	0.115	0.167
≥15.00	1.716	0.657	0.443	0.604	0.437	0.483	0.785	0.661	0.200	0.241	1.126	0.287	1.007
2013													
0.00	0.711	0.977	0.702	0.055	0.161	0.379	0.096	0.213	0.186	0.007	0.047	0.193	0.586
0.01-14.99	1.103	0.996	0.404	0.493	0.472	0.343	0.630	1.139	0.649	0.588	0.319	0.192	0.096
≥15.00	0.393	0.019	0.298	0.548	0.312	0.036	0.534	1.352	0.835	0.596	0.272	0.386	0.490

Table 2.F.16: Bias Estimates of Share of Part-Time by Year and Weighting Strategy, AWFP 2011-2013

Variable	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011													
0.00	2.014	1.683	1.750	1.598	1.667	1.979	2.254	2.132	1.963	2.011	1.421	1.703	1.452
0.00 - 12.48	0.150	0.280	0.043	0.084	0.058	0.078	0.003	0.216	0.239	0.216	0.286	0.172	0.087
12.49 - 41.64	0.401	0.045	0.419	0.281	0.240	0.522	0.582	0.184	0.848	0.340	0.105	0.467	0.775
41.65 - 100.0	1.762	2.008	1.289	1.233	1.368	1.379	1.670	2.164	0.876	1.886	1.812	1.407	0.590
2012													
0.00	0.954	0.041	0.592	0.400	0.658	1.182	1.114	1.164	0.041	0.900	0.002	0.588	0.692
0.00 - 12.48	0.186	0.141	0.373	0.431	0.432	0.607	0.351	0.017	0.216	0.199	0.175	0.353	0.487
12.49 - 41.64	0.021	0.089	0.190	0.179	0.071	0.491	0.184	0.063	0.405	0.132	0.073	0.188	0.356
41.65 - 100.0	0.789	0.010	0.029	0.210	0.156	0.084	0.580	1.084	0.148	0.569	0.105	0.047	0.151
2013													
0.00	1.052	1.056	1.732	0.925	1.223	2.762	1.475	1.352	0.166	0.905	0.515	1.284	1.373
0.00 - 12.48	0.041	0.052	0.137	0.186	0.198	0.441	0.130	0.334	0.192	0.076	0.058	0.135	0.360
12.49 - 41.64	1.140	1.075	0.724	0.689	0.753	0.068	0.905	1.184	1.193	1.334	1.048	0.581	0.699
41.65 - 100.0	2.151	2.182	2.319	1.428	1.778	2.390	2.250	2.869	1.551	2.163	1.505	1.730	1.712

Table 2.F.17: Bias Estimates of Share of Regular by Year and Weighting Strategy, AWFP 2011-2013

Variable	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011													
0.00 - 69.57	1.096	1.046	1.550	1.135	1.213	1.170	1.474	1.412	1.152	1.605	1.336	1.498	1.477
69.58 - 86.20	1.375	1.193	0.742	0.475	0.609	0.315	0.903	1.171	0.311	0.891	0.546	0.559	0.492
86.21 - 96.16	0.063	0.197	0.371	0.262	0.247	0.339	0.339	0.018	0.454	0.112	0.051	0.112	0.185
≥96.17	0.216	0.050	1.179	0.922	0.850	1.194	0.910	0.259	1.294	0.602	0.841	1.051	1.171
2012													
0.00 - 69.57	0.891	0.269	0.556	1.484	0.920	1.364	1.003	0.527	0.409	0.432	1.353	0.976	1.908
69.58 - 86.20	1.698	1.541	0.865	0.303	0.510	0.359	0.893	0.829	0.864	0.551	0.083	0.063	0.023
86.21 - 96.16	0.353	0.419	0.630	0.563	0.574	0.883	0.568	0.208	0.287	0.403	0.548	0.554	0.806
≥96.17	2.236	1.390	0.791	1.225	0.856	0.122	1.329	0.094	0.986	0.580	0.722	0.359	1.079
2013													
0.00 - 69.57	2.295	1.563	1.661	1.887	1.529	1.287	2.109	3.140	2.002	2.101	1.458	1.244	1.183
69.58 - 86.20	2.516	2.416	1.977	1.799	1.653	1.006	2.180	2.175	1.905	1.835	1.272	1.208	1.248
86.21 - 96.16	0.370	0.097	0.063	0.054	0.010	0.361	0.036	0.645	0.163	0.226	0.021	0.028	0.208
≥96.17	0.591	0.950	0.253	0.035	0.133	0.641	0.108	0.319	0.067	0.041	0.207	0.063	0.144

Table 2.F.18: Bias Estimates of Quartile of Wage Distribution by Year and Weighting Strategy, AWFP 2011-2013

Variable	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011													
First Quartile	0.468	1.028	1.240	1.160	1.364	1.156	1.012	0.400	1.669	0.294	1.093	0.993	0.942
Second Quartile	0.361	0.397	0.502	0.024	0.069	0.231	0.099	0.080	0.549	0.037	0.196	0.220	0.491
Third Quartile	1.058	0.333	0.056	0.446	0.327	0.157	0.059	0.433	0.880	0.047	0.078	0.176	0.289
Fourth Quartile	1.500	0.376	1.163	1.384	1.354	1.376	1.205	0.413	1.319	0.075	1.217	0.940	1.125
Missings	0.386	0.588	0.369	0.198	0.268	0.295	0.351	0.500	1.079	0.378	0.149	0.343	0.962
2012													
First Quartile	0.883	0.013	0.066	0.429	0.029	0.170	0.634	1.120	0.881	1.278	0.272	0.691	0.551
Second Quartile	0.734	0.359	0.275	0.226	0.077	0.190	0.282	0.362	0.323	0.190	0.236	0.103	0.258
Third Quartile	1.627	0.122	0.455	0.308	0.213	0.361	0.140	0.689	0.376	0.507	0.030	0.370	0.588
Fourth Quartile	0.671	0.578	0.028	0.339	0.417	0.833	0.011	0.695	1.447	0.929	0.794	0.069	0.255
Missings	0.808	0.084	0.824	1.302	0.525	0.834	0.202	0.625	0.132	0.348	0.799	0.887	1.137
2013													
First Quartile	0.679	0.427	0.683	0.179	0.172	0.744	0.226	1.111	0.703	1.017	0.138	0.202	0.371
Second Quartile	0.514	1.078	0.993	0.994	1.043	0.822	0.647	0.883	0.853	0.852	0.596	0.627	0.828
Third Quartile	2.346	1.026	0.896	1.292	1.165	1.053	1.527	1.812	1.382	1.701	1.374	1.215	1.242
Fourth Quartile	0.270	0.936	0.197	0.691	0.321	0.014	0.038	1.822	0.417	1.531	0.017	0.213	0.294
Missings	1.423	1.311	0.784	0.809	0.615	0.960	0.692	1.640	0.243	1.362	0.899	0.599	0.337

Table 2.F.19: Bias Estimates of by Year and Weighting Strategy, AWFP 2011-2013

Variable	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011													
0.00 - 14.69	3.518	1.813	1.880	1.635	1.769	1.955	2.587	2.152	1.411	2.412	1.738	1.903	1.991
14.70 - 25.30	1.251	1.206	1.136	0.964	1.028	1.107	1.330	1.293	1.232	1.548	0.910	1.124	1.265
25.31 - 39.53	0.495	0.113	0.085	0.036	0.106	0.047	0.227	0.055	0.360	0.143	0.028	0.032	0.141
≥39.53	1.772	0.494	0.659	0.635	0.635	0.801	1.031	0.914	0.540	0.720	0.800	0.747	0.586
2012													
0.00 - 14.69	0.668	0.785	1.020	1.118	0.977	0.019	0.415	0.689	1.380	0.116	0.659	0.457	0.585
14.70 - 25.30	0.182	0.306	0.020	0.212	0.213	0.027	0.025	0.075	0.164	0.096	0.401	0.280	0.197
25.31 - 39.53	0.123	0.274	0.034	0.280	0.142	0.395	0.124	0.098	0.371	0.225	0.046	0.401	0.382
≥39.53	0.726	0.817	0.966	1.186	0.906	0.387	0.565	0.666	1.173	0.246	0.212	0.578	0.771
2013													
0.00 - 14.69	1.522	0.366	0.844	0.485	0.692	1.408	1.294	0.319	0.663	0.561	1.180	1.475	0.844
14.70 - 25.30	1.886	2.145	2.476	2.473	2.420	2.398	2.252	1.842	2.241	1.860	1.876	2.369	2.100
25.31 - 39.53	0.063	0.320	0.124	0.127	0.073	0.629	0.218	0.022	1.052	0.097	0.488	0.253	0.416
≥39.53	0.427	1.459	1.756	1.861	1.655	1.619	1.175	1.501	0.525	1.396	1.184	1.148	1.672

Table 2.F.20: Bias Estimates of Establihsments Closure in t+1 by Year and Weighting Strategy, AWFP 2011-2013

Variable	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011													
Establishment exists in t+1 (Ref.: Establishment closed in t+1)	2.222	2.082	0.454	0.465	0.558	0.588	1.138	2.108	1.108	2.073	1.490	1.149	0.652
2012													
Establishment exists in t+1 (Ref.: Establishment closed in t+1)	2.057	1.862	0.007	0.195	0.201	0.191	0.665	0.620	0.380	2.083	1.125	0.519	0.340
2013													
Establishment exists in t+1 (Ref.: Establishment closed in t+1)	1.917	1.793	0.611	0.673	0.511	0.668	0.387	1.075	0.881	1.910	1.256	0.996	0.032

Table 2.F.21: Bias Estimates of Establihsments Foundation in t-1 by Year and Weighting Strategy, AWFP 2011-2013

Variable	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011													
Establishment exists in t-1 (Ref.: Establishment founded in t)	0.004	0.114	0.356	0.521	0.422	0.442	0.222	0.126	1.291	0.263	0.499	0.481	0.585
2012													
Establishment exists in t-1 (Ref.: Establishment founded in t)	0.227	0.169	0.025	0.032	0.038	0.047	0.095	0.138	0.016	0.015	0.026	0.060	0.095
2013													
Establishment exists in t-1 (Ref.: Establishment founded in t)	0.130	0.128	0.177	0.268	0.212	0.229	0.085	0.009	0.533	0.056	0.181	0.283	0.268

Table 2.F.22: Bias Estimates of Industry by Year and Weighting Strategy, AWFP 2011-2013

Variable	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011													
Agric./Production	2.503	1.917	1.672	0.827	0.834	1.368	0.264	1.471	0.270	1.940	0.189	0.219	0.903
Service	4.792	1.941	2.014	0.543	0.617	1.898	0.569	2.694	0.513	4.025	0.477	0.697	0.925
Public/Educ./Health/Arts	2.289	0.024	0.342	0.284	0.217	0.530	0.305	1.223	0.783	2.085	0.666	0.478	0.023
2012													
Agric./Production	3.270	1.918	2.139	0.960	1.213	1.721	0.271	1.943	0.649	2.653	0.320	0.183	1.171
Service	5.325	1.973	2.471	1.483	1.551	2.618	0.352	2.672	1.018	4.314	0.128	0.126	1.648
Public/Educ./Health/Arts	2.055	0.055	0.332	0.523	0.339	0.897	0.081	0.730	0.369	1.661	0.192	0.309	0.476
2013													
Agric./Production	0.573	3.230	2.707	0.963	0.993	2.307	0.996	0.478	0.845	0.005	1.493	1.231	1.563
Service	3.208	3.171	2.938	0.465	0.789	2.799	0.322	2.849	0.731	2.604	0.371	0.594	1.888
Public/Educ./Health/Arts	2.634	0.059	0.230	0.498	0.204	0.492	0.673	2.371	1.576	2.598	1.122	0.637	0.324

Table 2.F.23: Bias Estimates of West/East Germany by Year and Weighting Strategy, AWFP 2011-2013

Variable	Unadjusted	Logistic Cur	Logistic Ext	Lasso	Ridge	GAM	Gamsel	CART	C-Tree	MOB	Random Forest	XG-Boost	Bart
2011													
East Germany (Ref.: West Germany)	0.942	0.522	0.320	0.165	0.185	0.718	0.777	0.581	1.096	0.426	0.433	0.630	0.772
2012													
East Germany (Ref.: West Germany)	1.584	1.199	0.705	0.572	0.539	0.840	1.199	1.453	1.088	0.950	0.613	0.749	0.822
2013													
East Germany (Ref.: West Germany)	0.769	0.344	0.316	0.672	0.606	0.267	0.344	0.169	0.368	0.355	0.365	0.171	0.487

2.G Absolute Relative Nonresponse Bias

Estimation

As a robustness check, we estimate the absolute relative nonresponse bias as a further metric for the evaluation. This measure relates the absolute bias to the full sample estimate:

$$\text{Abs. } \widehat{\text{rel. NR}} \text{ bias}_i = \frac{\text{Abs. } \widehat{\text{NR bias}}_i}{\hat{Y}_{i,n}} \tag{2.13}$$

where $\hat{Y}_{i,r}$ denotes the estimator for the i^{th} statistic of interest based on the respondents and $\hat{Y}_{i,n}$ is the estimator based on the full sample.

Similar to the absolute nonresponse bias, the absolute relative nonresponse bias is estimated for each category of each administrative variable shown in Table 2.1 (columns 2 and 3).
Average absolute relative nonresponse bias is defined as:

$$\text{Avg. ab}\widehat{\text{s. rel.}}\text{ NR bias} = \frac{\sum_{i=1}^{K} \text{Abs. } \widehat{\text{rel. NR}} \text{ bias}_i}{K} \tag{2.14}$$

Results

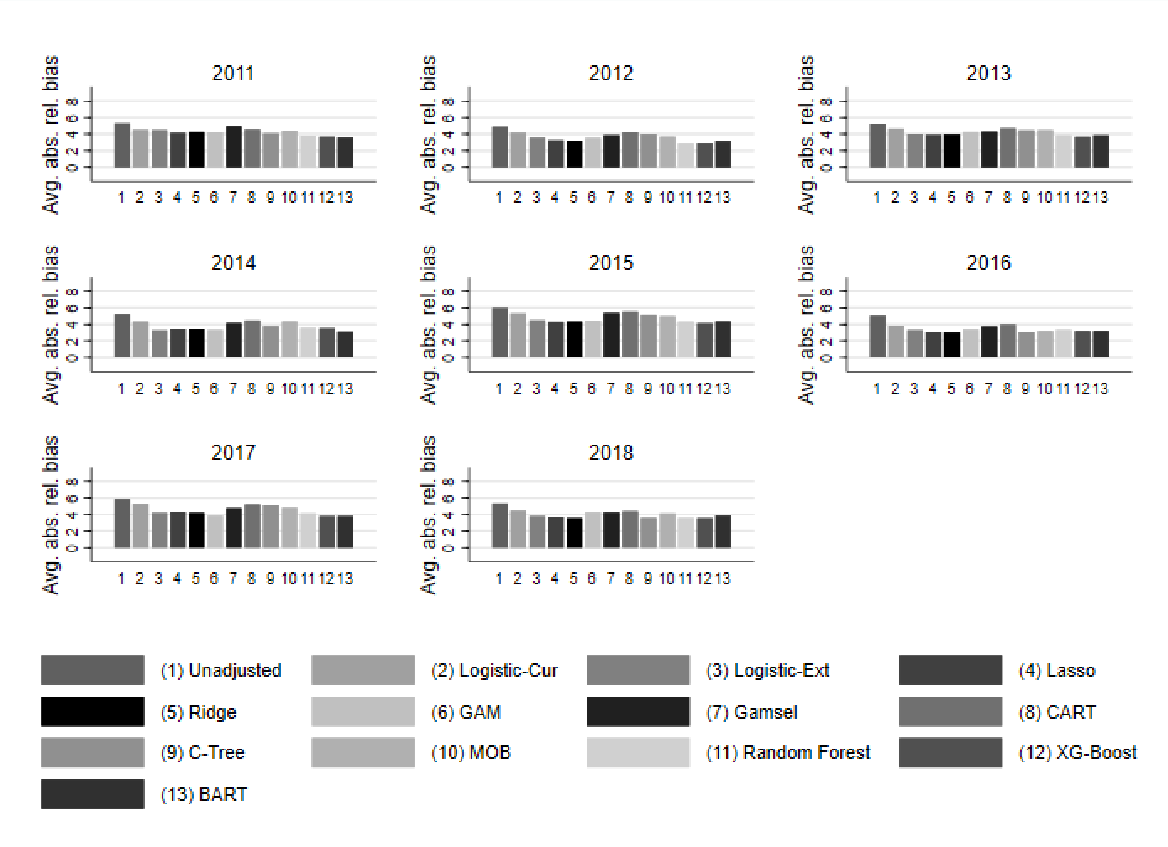

Figure 2.G.1: Average Absolute Relative Bias by Modeling Approach and Set of Explanatory Variables, All Variables BHP 2011-2018

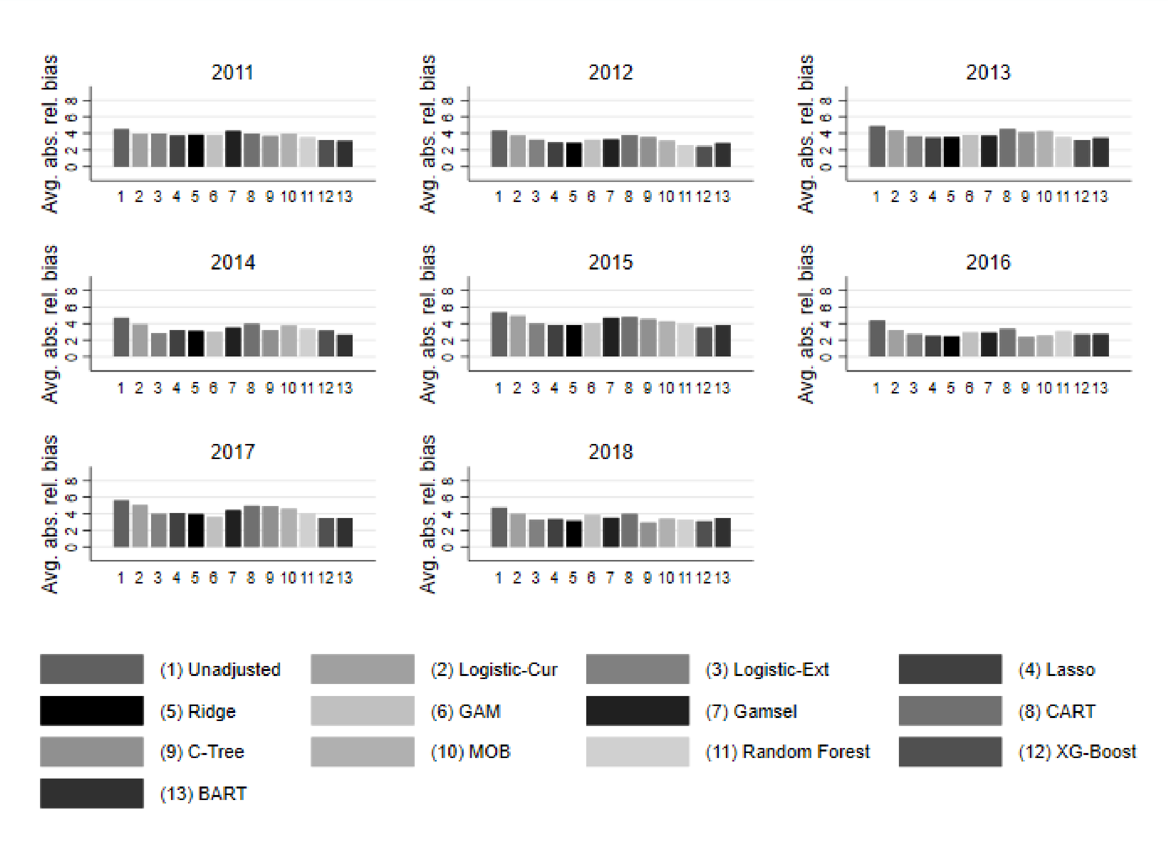

Figure 2.G.2: Average Absolute Relative Bias by Modeling Approach and Set of Explanatory Variables, Employee Characteristics BHP 2011-2018

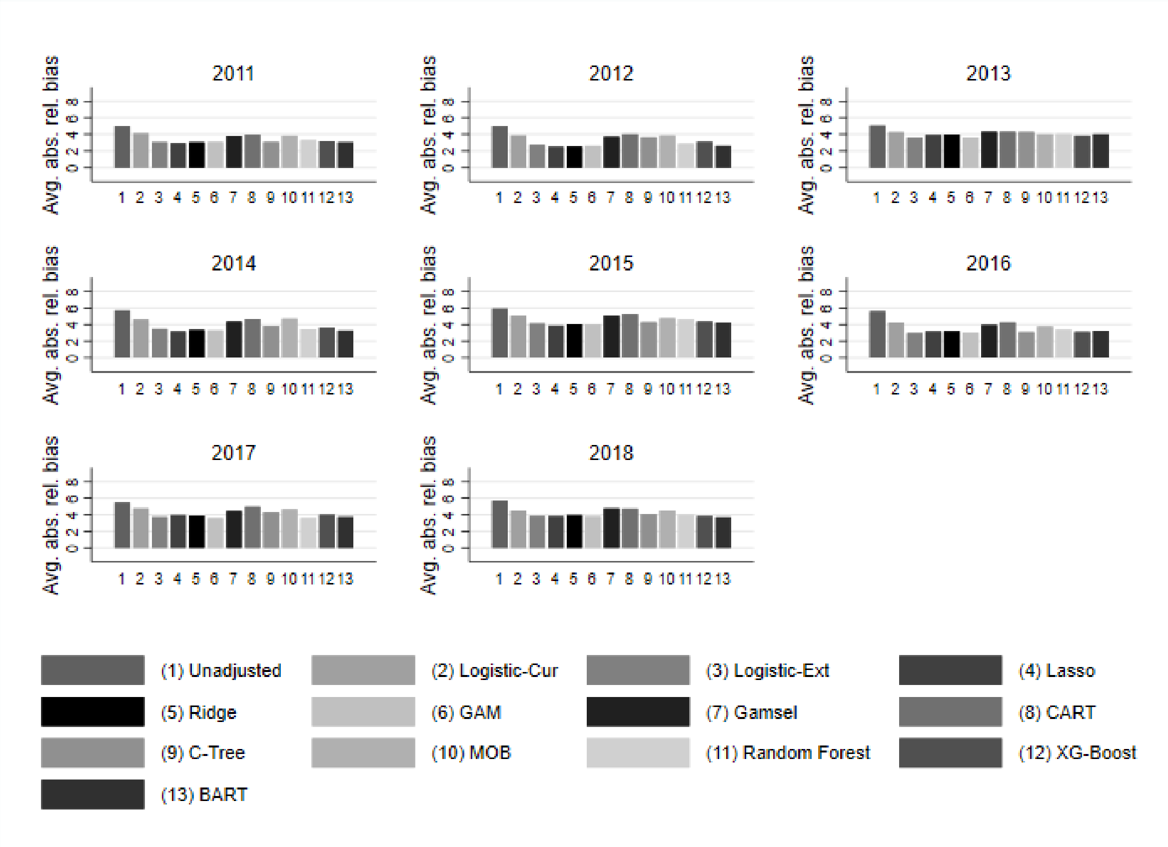

Figure 2.G.3: Average Absolute Relative Bias by Modeling Approach and Set of Explanatory Variables, Establishment Characteristics BHP 2011-2018

Table 2.G.1: Average Absolute Relative Bias by Modeling Approach and Set of Explanatory Variables, All Variables BHP 2011-2018

Year	**Unadjusted**	**Logistic Cur**	**Logistic Ext**	**Lasso**	**Ridge**	**GAM**	**Gamsel**	**CART**	**C-Tree**	**MOB**	**Random Forest**	**XG-Boost**	**Bart**
2011	0.053	0.045	0.045	0.041	0.042	0.042	0.050	0.046	0.041	0.044	0.038	0.037	0.036
2012	0.049	0.042	0.035	0.032	0.032	0.035	0.039	0.042	0.040	0.037	0.029	0.030	0.032
2013	0.052	0.046	0.040	0.039	0.040	0.042	0.043	0.047	0.045	0.045	0.038	0.036	0.038
2014	0.052	0.043	0.033	0.034	0.034	0.033	0.042	0.045	0.038	0.043	0.036	0.035	0.031
2015	0.060	0.053	0.045	0.043	0.043	0.045	0.054	0.055	0.051	0.049	0.043	0.041	0.044
2016	0.050	0.038	0.033	0.030	0.030	0.034	0.037	0.040	0.030	0.032	0.033	0.032	0.032
2017	0.059	0.053	0.042	0.043	0.042	0.038	0.048	0.052	0.051	0.048	0.041	0.038	0.038
2018	0.053	0.045	0.038	0.037	0.036	0.043	0.043	0.044	0.036	0.041	0.036	0.036	0.039

Table 2.G.2: Average Absolute Relative Bias by Modeling Approach and Set of Explanatory Variables, Employee Characteristics BHP 2011-2018

Year	**Unadjusted**	**Logistic Cur**	**Logistic Ext**	**Lasso**	**Ridge**	**GAM**	**Gamsel**	**CART**	**C-Tree**	**MOB**	**Random Forest**	**XG-Boost**	**Bart**
2011	0.045	0.040	0.040	0.037	0.038	0.038	0.043	0.040	0.037	0.039	0.035	0.032	0.031
2012	0.043	0.037	0.032	0.029	0.029	0.032	0.033	0.038	0.035	0.031	0.026	0.024	0.028
2013	0.049	0.043	0.036	0.035	0.035	0.038	0.037	0.045	0.041	0.042	0.035	0.032	0.034
2014	0.047	0.039	0.028	0.032	0.031	0.030	0.035	0.040	0.032	0.038	0.033	0.032	0.027
2015	0.053	0.049	0.040	0.038	0.039	0.040	0.047	0.048	0.045	0.043	0.039	0.035	0.038
2016	0.044	0.032	0.027	0.025	0.024	0.029	0.029	0.033	0.024	0.026	0.031	0.027	0.027
2017	0.056	0.050	0.040	0.041	0.040	0.036	0.044	0.049	0.049	0.046	0.041	0.035	0.035
2018	0.047	0.040	0.033	0.033	0.031	0.039	0.035	0.040	0.029	0.034	0.033	0.031	0.035

Table 2.G.3: Average Absolute Relative Bias by Modeling Approach and Set of Explanatory Variables, Establishment Characteristics BHP 2011-2018

Year	**Unadjusted**	**Logistic Cur**	**Logistic Ext**	**Lasso**	**Ridge**	**GAM**	**Gamsel**	**CART**	**C-Tree**	**MOB**	**Random Forest**	**XG-Boost**	**Bart**
2011	0.050	0.041	0.031	0.029	0.030	0.031	0.038	0.040	0.031	0.038	0.033	0.032	0.031
2012	0.050	0.039	0.027	0.025	0.025	0.026	0.037	0.040	0.036	0.038	0.029	0.031	0.026
2013	0.051	0.043	0.036	0.039	0.040	0.036	0.043	0.043	0.043	0.040	0.040	0.038	0.040
2014	0.057	0.046	0.035	0.032	0.033	0.033	0.044	0.047	0.038	0.047	0.034	0.036	0.033
2015	0.059	0.050	0.041	0.039	0.041	0.040	0.050	0.052	0.043	0.048	0.046	0.044	0.042
2016	0.056	0.043	0.030	0.032	0.032	0.030	0.040	0.043	0.031	0.038	0.034	0.031	0.032
2017	0.055	0.048	0.037	0.040	0.039	0.036	0.045	0.050	0.043	0.046	0.036	0.040	0.038
2018	0.057	0.045	0.038	0.038	0.039	0.038	0.048	0.047	0.041	0.045	0.040	0.039	0.037

2.H Mean Squared Error

To test a combined measure of bias and variance, we additionally estimate the mean squared error for each of the weighting schemes. The mean squared error is calculated as the sum of the squared nonresponse bias and the variance of the weighted respondent-based estimate. The variance estimation uses Taylor Series Linearization.

$$\widehat{\text{MSE}}_i = \left|\widehat{\text{NR bias}}_i\right| + \widehat{\text{Var}}_{i,r} \tag{2.15}$$

In line with the absolute (relative) bias, the mean squared error is estimated for each category of each administrative variable shown in Table 2.1 (columns 2 and 3). In addition, the average MSE across different groups is generated:

$$\text{Avg.}\,\widehat{\text{MSE}} = \frac{\sum_{i=1}^{K} \widehat{\text{MSE}}_i}{K} \tag{2.16}$$

Results

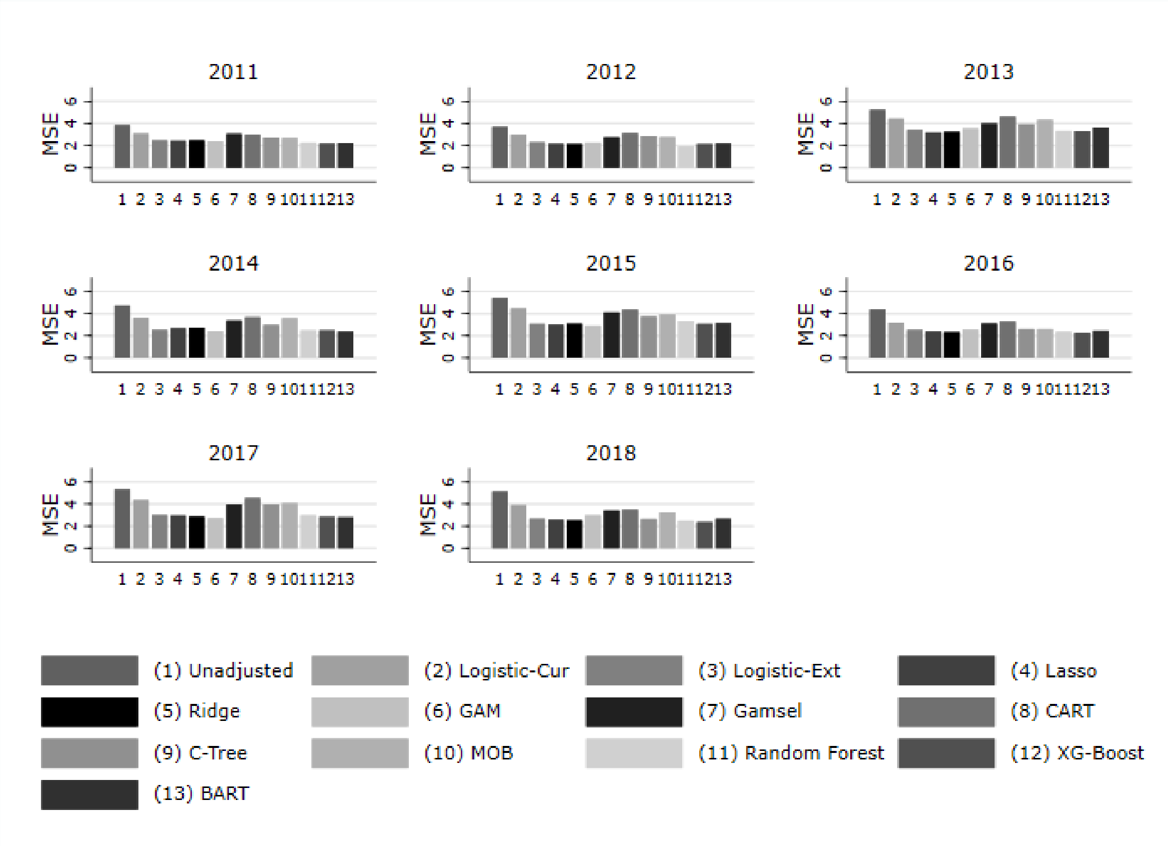

Figure 2.H.1: Mean Squared Error by Modeling Approach and Set of Explanatory Variables, All Variables BHP 2011-2018

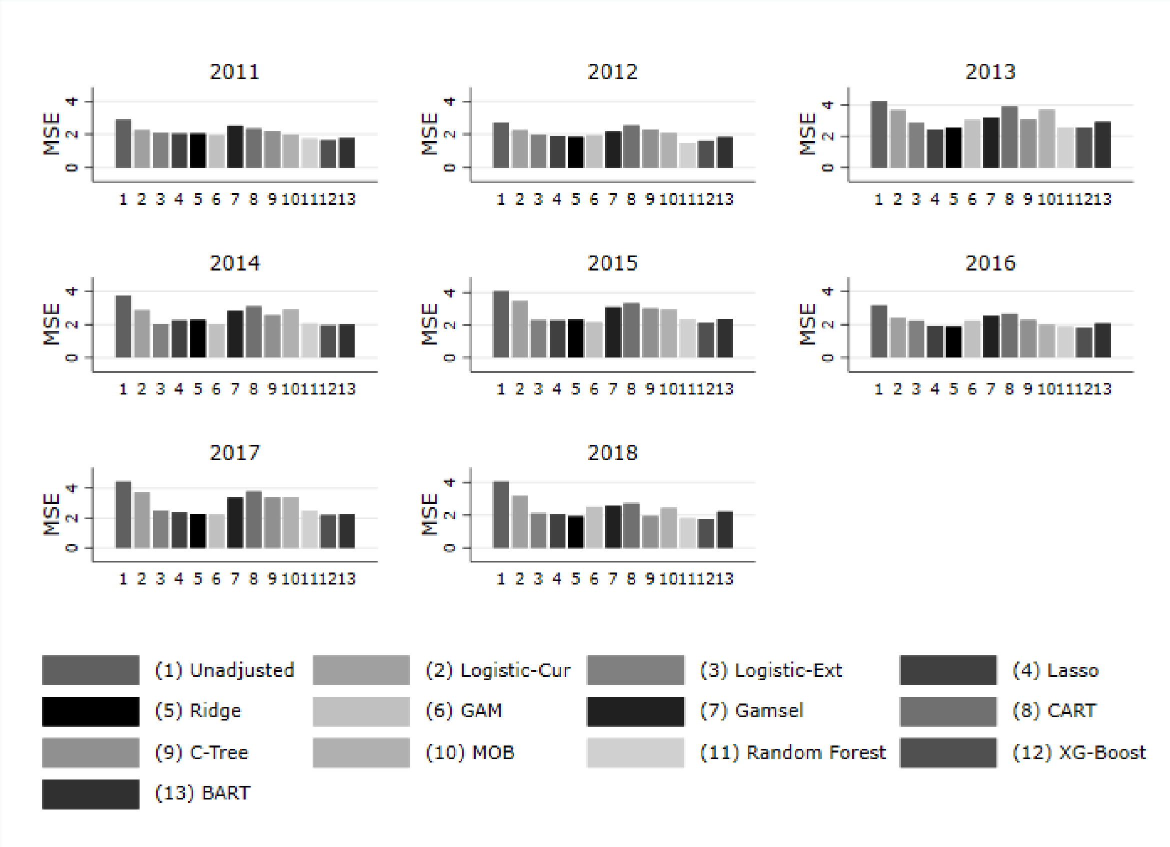

Figure 2.H.2: Mean Squared Error by Modeling Approach and Set of Explanatory Variables, Employee Characteristics BHP 2011-2018

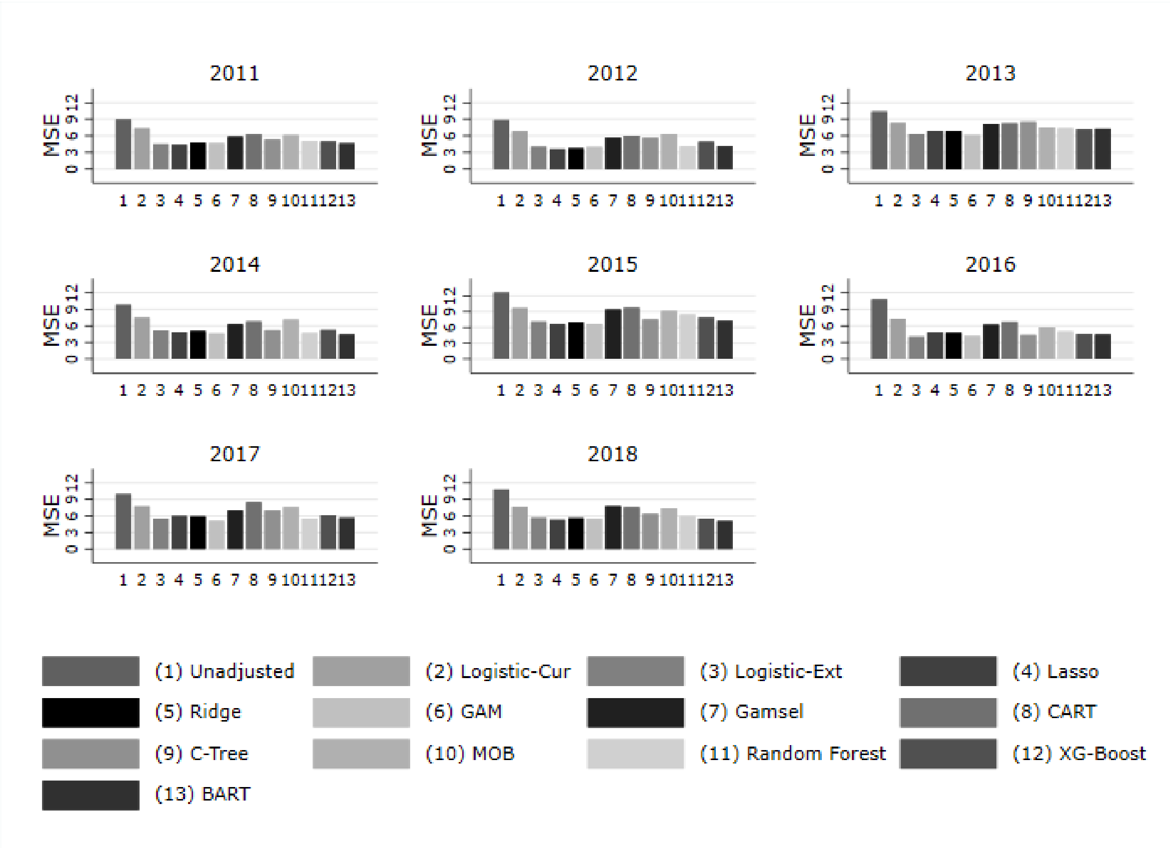

Figure 2.H.3: Mean Squared Error by Modeling Approach and Set of Explanatory Variables, Establishment Characteristics BHP 2011-2018

Table 2.H.1: Mean Squared Error by Modeling Approach and Set of Explanatory Variables, All Variables BHP 2011-2018

Year	**Unadjusted**	**Logistic Cur**	**Logistic Ext**	**Lasso**	**Ridge**	**GAM**	**Gamsel**	**CART**	**C-Tree**	**MOB**	**Random Forest**	**XG-Boost**	**Bart**
2011	3.849	3.083	2.478	2.423	2.471	2.389	3.059	2.976	2.692	2.653	2.267	2.183	2.231
2012	3.688	2.989	2.299	2.172	2.140	2.268	2.730	3.108	2.839	2.752	1.913	2.138	2.200
2013	5.229	4.413	3.413	3.162	3.235	3.535	3.995	4.612	3.939	4.319	3.334	3.299	3.618
2014	4.726	3.607	2.525	2.671	2.726	2.432	3.381	3.688	2.980	3.598	2.483	2.480	2.396
2015	5.440	4.485	3.077	2.994	3.087	2.915	4.123	4.378	3.752	3.941	3.336	3.077	3.159
2016	4.390	3.190	2.526	2.389	2.335	2.542	3.114	3.309	2.609	2.596	2.379	2.250	2.442
2017	5.329	4.372	2.996	2.967	2.870	2.716	3.965	4.536	3.961	4.068	2.975	2.842	2.813
2018	5.128	3.896	2.674	2.589	2.516	2.986	3.409	3.504	2.649	3.227	2.486	2.374	2.669

Table 2.H.2: Mean Squared Error by Modeling Approach and Set of Explanatory Variables, Employee Characteristics BHP 2011-2018

Year	**Unadjusted**	**Logistic Cur**	**Logistic Ext**	**Lasso**	**Ridge**	**GAM**	**Gamsel**	**CART**	**C-Tree**	**MOB**	**Random Forest**	**XG-Boost**	**Bart**
2011	2.877	2.273	2.083	2.044	2.038	1.956	2.522	2.345	2.191	1.990	1.733	1.647	1.775
2012	2.707	2.254	1.970	1.897	1.838	1.941	2.169	2.550	2.304	2.072	1.497	1.602	1.828
2013	4.248	3.667	2.859	2.445	2.540	3.042	3.203	3.913	3.063	3.704	2.562	2.557	2.922
2014	3.746	2.867	2.021	2.251	2.279	2.010	2.824	3.091	2.555	2.917	2.055	1.953	2.002
2015	4.071	3.485	2.305	2.296	2.340	2.190	3.108	3.345	3.025	2.948	2.360	2.154	2.378
2016	3.156	2.402	2.236	1.926	1.872	2.238	2.520	2.653	2.281	1.988	1.879	1.812	2.060
2017	4.441	3.729	2.510	2.382	2.285	2.254	3.380	3.777	3.372	3.389	2.485	2.205	2.268
2018	4.048	3.176	2.100	2.064	1.920	2.500	2.570	2.723	1.942	2.431	1.818	1.770	2.203

Table 2.H.3: Mean Squared Error Bias by Modeling Approach and Set of Explanatory Variables, Establishment Characteristics BHP 2011-2018

Year	**Unadjusted**	**Logistic Cur**	**Logistic Ext**	**Lasso**	**Ridge**	**GAM**	**Gamsel**	**CART**	**C-Tree**	**MOB**	**Random Forest**	**XG-Boost**	**Bart**
2011	8.923	7.314	4.536	4.402	4.734	4.651	5.862	6.272	5.311	6.117	5.054	4.981	4.613
2012	8.807	6.831	4.018	3.608	3.716	3.970	5.661	6.020	5.632	6.304	4.087	4.937	4.142
2013	10.355	8.309	6.305	6.910	6.862	6.112	8.131	8.262	8.513	7.531	7.366	7.177	7.256
2014	9.848	7.467	5.161	4.861	5.061	4.638	6.291	6.806	5.203	7.154	4.720	5.230	4.452
2015	12.592	9.705	7.108	6.640	6.992	6.702	9.421	9.771	7.547	9.130	8.435	7.892	7.239
2016	10.836	7.306	4.039	4.808	4.754	4.131	6.218	6.732	4.324	5.769	4.991	4.534	4.438
2017	9.969	7.729	5.535	6.021	5.924	5.133	7.023	8.500	7.035	7.613	5.533	6.166	5.662
2018	10.766	7.656	5.674	5.332	5.632	5.520	7.788	7.581	6.342	7.384	5.975	5.527	5.101

Chapter 3

The Impact of Mail, Web, and Mixed-Mode Data Collection on Participation in Establishment Surveys[1]

3.1 Abstract, Keywords, Acknowledgements

Abstract: Over the past 30 years, self-administered establishment surveys have increasingly transitioned away from using mail to more online and mixed-mode data collection. To examine the potential impact of this transition on survey participation, we evaluate several mail and web single- and mixed-mode designs implemented experimentally in a large-scale job vacancy survey. We find that neither response rates nor nonresponse bias significantly differed between the alternative designs. Subgroup analyses revealed that larger establishments were more likely to participate via web than mail in single-mode designs, but that all establishment size classes showed a preference for the mail mode in a concurrent mixed-mode design. Potential cost savings (over 50% per respondent) were evident when utilizing the web mode in either a single- or sequential mixed-mode design. Qualitative follow-up interviews indicated a general preference for web surveys due to easier handling, smoother collaboration between colleagues, avoidance of a cumbersome mail return, and being seen as a modern sustainable solution.

Keywords: business survey, mail survey, web survey, mixed-mode data collection, nonresponse bias

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Conference, the 2021 European Sociological Association Conference, the 2022 Federal Computer Assisted Survey Information Collection Workshop, the 2022 European Conference on Quality in Official Statistics, the 2022 Business Data Collection Methodology Workshop, the 2022 German Online Conference, the 2023 workshop of the Method Section of the German Sociological Association, and an internal IAB seminar. This study design and analysis was not preregistered.

3.2 Introduction

Establishment surveys are a crucial source of official statistics around the world and form the basis for research in various scientific fields, such as business, economics, and sociology. However, establishment surveys face several challenges (Bavdaž et al., 2020), including declining rates of voluntary participation and increased risk of nonresponse bias (e.g., König et al., 2021; Küfner et al., 2022b; U.S. Bureau of Labor Statistics, 2023a), and rising data collection costs. To address these challenges, efforts have focused on using more cost-effective web-based data collection (e.g., S. B. Cohen et al., 2006; Erikson, 2007; Snijkers et al., 2011; Thompson et al., 2015), a trend which accelerated due to the COVID-19 pandemic (e.g., J. Jones et al., 2023). Many self-administered establishment surveys have also shifted to using a mix of web and mail modes, deployed either in a concurrent or sequential mixed-mode design (e.g., Dillman, 2017; Snijkers & Jones, 2013; Snijkers et al., 2011; Thompson et al., 2015).

One example of a high-profile voluntary self-administered establishment survey is the IAB Job Vacancy Survey (IAB-JVS) conducted by the Institute for Employment Research (IAB) in Germany. Since 2002, the IAB-JVS has implemented a concurrent mail-web mixed-mode design, where paper questionnaires are mailed to establishments with the option of online completion (Bossler et al., 2020). However, this design has become increasingly expensive due to declining response rates and forced sample size increases in order to meet data reporting requirements of the European Commission (Eurostat) (Bossler et al., 2022). To evaluate the impacts of adopting an alternative mode design on response rates, nonresponse bias, and costs in the IAB-JVS, three different self-administered mode designs were experimentally implemented and compared to the standard concurrent design: a single-mode web design, a single-mode mail design, and a sequential web-to-mail mixed-mode design.

To our knowledge, no study to date has experimentally examined the impact of these self-administered data collection mode designs on response rates, nonresponse bias, and survey costs in a voluntary establishment survey. Such information is useful for survey practitioners, as previous experimental evidence tends to be based on special populations (e.g., small employers) rather than more general ones (Bremner, 2011; Ellis et al., 2013; Hardigan et al., 2012; Harris-Kojetin et al., 2013). In addition, the majority of these studies are pre-2013 and do not reflect recent changes in Internet availability and usage by businesses (OECD, 2023), nor do they reflect the effects that the pandemic has had on increased working from home. Thus, up-to-date experimental evidence is lacking on the impact of various self-administered mode designs on survey participation and costs in voluntary surveys of the general establishment population.

To address these research gaps, we report the results of the IAB-JVS mode design experiments conducted in the fourth quarter of 2020 during the pandemic. This study goes above and beyond the analysis of response rates and costs by utilizing extensive administrative data to study nonresponse bias and correlates of survey participation. To gain further insights into the perceived impact of mode (design) on establishment survey participation, results from 46 short qualitative interviews and 12 in-depth qualitative interviews are analyzed and presented. In short, the following research questions are addressed:

- *RQ1: Do response rates differ between web and mail single-mode and mixed-mode designs in an establishment survey?*
- *RQ2: To what extent do web and mail single- and mixed-mode designs affect nonresponse bias?*
- *RQ3: Are certain types of establishments more likely to participate via web or mail modes?*
- *RQ4: What is the impact of the various self-administered mode designs on survey costs?*
- *RQ5: How do mail and web modes influence the decision to participate in an establishment survey, and how do establishments perceive the advantages and disadvantages of web and mail modes?*

The remainder of the article is structured as follows: Section 3.3 reviews the existing literature on self-administered mode designs in establishment surveys and Section 3.4 introduces our hypotheses. Section 3.5 describes the experimental design, data sources used, and analysis plan. Section 3.6 presents the results of the experiments. Section 3.7 summarizes insights drawn from qualitative interviews conducted with several establishments, and Section 3.8 concludes with a summary of the main findings and implications for survey practice.

3.3 Background

3.3.1 Web and Mail Modes in Establishment Surveys

Historically, self-administered establishment surveys were often conducted via mail (Christianson & Tortora, 1995). However, due to technological advances, mail establishment surveys have gradually been replaced by web surveys. For example, the U.S. Survey of Occupational Injuries and Illnesses, conducted by the Bureau of Labor Statistics, has stopped using mail as their primary mode in favor of online data collection (U.S. Bureau of Labor Statistics, 2020a). Statistics Netherlands has also adopted a strategy that encourages online completion, providing mail questionnaires only upon request or for nonresponse follow-ups (Snijkers et al., 2018). The U.S. Economic Census was exclusively carried out online in 2017 (U.S. Census Bureau, 2023b) and 2022 (U.S. Census Bureau, 2023c). These are just three examples of the global trend to replace (or significantly reduce) mail surveys with web surveys (see also Buiten et al., 2018). The upward trend of web-based data collection was further intensified during the COVID-19 pandemic, where face-to-face interviewing was partially replaced by online data collection (e.g., J. Jones et al., 2023) and new high-frequency online panel surveys emerged (e.g., Office for National Statistics, 2022b; U.S. Census Bureau, 2022a). In Germany, however, many long-running establishment surveys rely to a large extent on traditional modes such as mail, CATI, or face-to-face and haven't completed (or begun) the transition to web modes (see Bossler et al., 2020; Egeln et al., 2023; Gensicke et al., 2022).

The growing popularity of web surveys is largely driven by costs. For example, the costs associated with printing, mailing, and data entry for thousands of paper questionnaires can be avoided with web surveys, though web surveys do come with fixed costs (e.g., software, programming) and it is still often necessary to print and mail invitation/reminder letters for general populations. Other advantages of web surveys include automated question filtering, real-time plausibility checks, and interactive features (e.g., video clips), which are not possible in mail surveys. Nevertheless, there are still many advantages to using mail surveys. For example, in a world where surveys are primarily conducted online, receiving a mail questionnaire could garner special attention, highlighting the integrity and legitimacy of the survey. Moreover, some establishments might find web surveys burdensome or infeasible due to Internet or IT security restrictions and would prefer to work with a paper questionnaire, and even come to expect them in government surveys. Those that are accustomed to the tradition of responding to mail surveys as part of their normal routine may be especially reluctant to switch over to an online platform (Haraldsen et al., 2011). In addition, establishments may use mail questionnaires to screen the questions (e.g., Giesen, 2007) or prepare their answers, even if using web as the final reporting tool.

3.3.2 Mixed-Mode Approaches

Given that some establishments may be less likely to participate in one mode than in a different mode, a common strategy is to implement multiple modes, as in a mixed-mode design, which should appeal to more establishments (e.g., De Leeuw, 2005; Dillman & Messer, 2010; Dillman et al., 2009). Here, we make a distinction between mixed-mode data collection designs, where multiple modes are used to collect the survey data, and mixed-mode contact strategies, which use multiple modes to contact and recruit units, but may use a different mode design to collect the survey data (e.g., Langeland, 2019; Sakshaug et al., 2019). Our focus is on the former. Two types of mixed-mode (data collection) designs can be distinguished: concurrent and sequential (De Leeuw, 2005, 2018). In a concurrent design, at least two modes of data collection are offered to establishments in parallel. The main advantage of a concurrent design is that establishments are offered the full range of response options from the outset and are free to choose their preferred mode without influence from the survey institute. A disadvantage is that the choice itself may be considered a burdensome task. In a meta-analysis of mode design experiments in the context of voluntary household surveys, Medway and Fulton (2012) found that concurrent mail-web mixed-mode designs produce lower response rates than single-mode mail designs. Thus, giving people the freedom to choose between modes might put them off from participating at all. Recent evidence, however, has found no difference in response rates between concurrent mail-web mixed-mode surveys and mail-only surveys (Olson et al., 2019). But whether this finding applies to voluntary establishment surveys – a question we explore in the present study – is largely unknown. A second disadvantage of concurrent designs is that many respondents may opt for one of the more expensive mode alternatives, which can drive-up survey costs (e.g., Ellis et al., 2013; Hardigan et al., 2012).

In a sequential design, a single mode is offered initially (i.e., the starting mode) followed by a secondary mode for nonresponse follow-up, and possibly a tertiary mode for remaining nonrespondents. A typical sequential design consists of deploying the most cost-effective mode first, followed by a costlier secondary mode (e.g., Snijkers & Jones, 2013). Given that only one mode is offered at the outset, there is no burden of choosing between different modes. Web is a common starting mode given its relatively low cost. Implementing such a "push-to-web" strategy (e.g., Dillman, 2017) can therefore lead to potential cost savings if a significant proportion of establishments take-up the web starting mode, thus reducing the number of costlier follow-ups (e.g., Ellis et al., 2013; Gleiser et al., 2022). However, a potential downside of all mixed-mode surveys is that differential measurement error can occur if respondents answer differently depending on which mode they use (De Leeuw, 2018). The risk of measurement mode effects tends to be higher when mixing self-administered and interviewer-administered modes (Klausch et al., 2013). Although the present study does not investigate measurement mode effects, we note that this is an understudied topic in the establishment survey literature and warrants further research.

3.3.3 Experiments in Self-Administered Establishment Surveys

Most research on self-administered mode designs comes from the household survey literature, though there are some studies that have experimented with web and mail single- and mixed-mode designs in the establishment survey context (Willimack & McCarthy, 2019). Erikson (2007) compared a sequential web-to-mail design to a concurrent mail-web design in a Statistics Sweden survey and found that the web take-up rate was significantly higher in the sequential design (46.1% vs. 5.2%), but that the concurrent design yielded an overall higher response rate before the nonresponse follow-up phase started (full results not reported). Bremner (2011) showed that a single-mode web design resulted in a lower response rate (59%) compared to a concurrent mixed-mode design (89%) offering mail, telephone data entry, and a web response option in a mandatory UK survey of small employers, with only 9% of the concurrent sample responding online. Ellis et al. (2013) compared a sequential web-to-mail design with a concurrent mail-web mixed-mode design in a voluntary U.S. survey of local prison and jail administrators, showing that the response rate in the first field phase was slightly lower in the web starting mode (73%) than in the concurrent mixed-mode design (78%), but the difference became negligible after the second phase. Similar results were reported by Harris-Kojetin et al. (2013) in a voluntary survey of long-term care providers. Hardigan et al. (2012) compared a concurrent mail-web mixed-mode design with a single-mode mail design, both using mail contacts, and a single-mode web design using e-mail contacts in a voluntary survey of practicing dentists in Florida. The response rates of the concurrent (25%) and single-mode mail designs (26%) exceeded that of the single-mode web design (11%), though only 2% of the concurrent sample selected the web mode.

Downey et al. (2007) analyzed multiple single- and mixed-mode designs in a mandatory U.S. survey of occupational injuries and illnesses, finding the highest response rate for a concurrent mail-web design (78.4%), followed by a sequential web-to-mail design (73.5%), and single-mode web designs with or without the explicit option to request a mailed questionnaire (71.1% and 71.3%, respectively). The web take-up rate was significantly lower in the concurrent design (21.7%) compared to the single-mode designs (with and without the explicit option to request a mailed questionnaire) and the sequential mode design (46.1%, 49.5%, and 47.2%, respectively). Similar results were found in a replication study conducted one year later. Millar et al. (2018) report the effects of transitioning from a single-mode mail design to a sequential web-to-mail design in the first and second waves of the U.S. Emergency Medical Services for Children Program's Performance Measures Survey. The response rate increased by 13.1%-points compared to the first wave. However, because of other adjustments made to the survey design (e.g., the contact strategy), the increase cannot be attributed solely to the push-to-web design. Haas et al. (2021) compared a single-mode web, a single-mode mail, and a concurrent mail-web mixed-mode design in a voluntary establishment survey in Germany. Although they experimented with two different questionnaire topics, the results clearly indicated that the single-mode web design yielded a lower response rate (6.2% and 5.6%) compared to the single-mode mail (13.9% and 11.7%) and concurrent designs (13.7% and 11.8%). These results provide the most recent evidence of the advantages to using mailed questionnaires in self-administered establishment surveys.

In summary, there is strong evidence that mixed-mode designs (concurrent and sequential) yield higher response rates compared to single-mode designs, and especially single-mode web, in self-administered establishment surveys, and that web take-up rates tend to be higher in sequential web-to-mail and single-mode web designs, relative to concurrent mail-web mixed-mode designs (Bremner, 2011; Downey et al., 2007; Erikson, 2007; Haas et al., 2021; Hardigan et al., 2012; Millar et al., 2018). These effects appear to be consistent across both voluntary and mandatory surveys. The empirical evidence is mixed with respect to whether a concurrent or sequential mixed-mode design yields higher response rates for establishment surveys, with studies finding either no substantial difference (Ellis et al., 2013) or slightly higher response rates in concurrent mixed-mode designs (Downey et al., 2007; Erikson, 2007; Harris-Kojetin et al., 2013). What is lacking from the literature are more recent studies that experiment with the full range of self-administered mode designs, including single-mode and mixed-mode, on general establishment populations, and that also analyze the effects of these mode designs on nonresponse bias. The present study addresses these research gaps.

3.4 Hypotheses

Based on the above literature review and other theoretical considerations (e.g., Bavdaž, 2010b; Willimack & Nichols, 2010), we derive several hypotheses regarding the impact of the mode design on survey participation, nonresponse bias, and costs, described below. Furthermore, we formulate subgroup hypotheses regarding establishment size and industry.

3.4.1 Hypotheses on the Effects of Mode Design on Response Rates, Nonresponse Bias, and Costs

As discussed in the survey literature (e.g., De Leeuw, 2005, 2018), offering multiple modes either sequentially or concurrently can facilitate participation for establishments that may be unable or less willing to participate in a particular mode. Because the evidence in the establishment literature shows higher response rates for sequential and concurrent mixed-mode designs compared to single-mode designs, particularly web-only designs, we hypothesize:

M1: A concurrent mail-web mixed-mode design leads to a higher response rate than a single-mode mail or web design.

M2: A sequential web-to-mail mixed-mode design leads to a higher response rate than a single-mode mail or web design.

The recent household literature is inconclusive about what type of mixed-mode design, concurrent or sequential, is optimal for maximizing response rates (e.g., De Leeuw, 2018; Olson et al., 2019; Wolf et al., 2021). The establishment survey literature suggests, if anything, a slight advantage to concurrent mixed-mode designs (see Section 3.3.3). In line with the establishment survey literature, we hypothesize that a concurrent mail-web mixed-mode design increases the response rate compared to a sequential web-to-mail mixed-mode design:

M3: A concurrent mail-web mixed-mode design leads to a higher response rate than a sequential web-to-mail mixed-mode design.

The literature review indicated an increasing trend of establishments participating in web surveys compared to mail surveys (see Section 3.3.1), which may reflect the advantages of online surveys described above. Keeping with this trend, we expect that establishments will respond at a higher rate in the single-mode web design compared to the single-mode mail design:
M4: A single-mode web design leads to a higher response rate than a single-mode mail design.

Because we pursue push-to-web approaches with the single-mode web and the sequential web-to-mail mixed-mode designs, we expect a higher web take-up rate in these designs compared to the concurrent mail-web mixed-mode design. This expectation is also based on the literature review (see Section 3.3.3), which shows that web take-up rates are increased by using push-to-web strategies. Conversely, the same logic applies to the single-mode mail design, where we expect a higher mail take-up rate than in the concurrent mail-web mixed-mode design:
M5: The web take-up rate will be highest for the single-mode web design, followed by the sequential web-to-mail and concurrent mail-web mixed-mode designs.
M6: The mail take-up rate for the single-mode mail design will be higher than for the concurrent mail-web mixed-mode design.

Theoretical considerations and empirical evidence suggest that a higher response rate is likely to result in lower nonresponse bias, on average (e.g., König et al., 2021; Küfner et al., 2022a). Taking this into account, and as a consequence of hypotheses M1, M2, M3, and M4, mixed-mode designs should have lower nonresponse bias than single-mode designs, concurrent mail-web mixed-mode designs should have lower nonresponse bias than sequential web-to-mail mixed-mode designs, and single-mode web designs should have lower nonresponse bias than single-mode mail designs, on average:
M7: A concurrent mixed-mode design has lower nonresponse bias compared to a single-mode design.
M8: A sequential mixed-mode design has lower nonresponse bias compared to a single-mode design.
M9: A concurrent mail-web mixed-mode design has lower nonresponse bias compared to a sequential web-to-mail mixed-mode design.
M10: A single-mode web design has lower nonresponse bias compared to a single-mode mail design.

Since web surveys have lower variable costs for postage, printing, and data entry than mail surveys, the higher the proportion of web respondents, the lower the per-respondent (variable) costs should be. In addition, increased response rates should have a positive impact on per-respondent costs. However, our focus is on variables costs (rather than fixed costs), which leads us to the following hypothesis:

M11: The per-respondent costs are highest for the single-mode mail design, followed by the concurrent mail-web mixed-mode design, the sequential web-to-mail mixed-mode design, and the single-mode web design.

3.4.2 Hypotheses on the Effects of Mail and Web Modes on Survey Participation

Pertinent to research question 3 (RQ3), we test several hypotheses regarding which establishment subgroups are more likely to participate via web or mail modes. We test these hypotheses using both single-mode designs and the concurrent mail-web mixed-mode design.

Establishment Size

The literature finds that larger establishments are more likely to respond via web than mail (e.g., Dickey & Riberas, 2007; C. Jones & Phipps, 2010; Kaiser, 2001; Thompson et al., 2015). This finding could be driven by at least two factors. First, larger establishments might have more trouble routing the paper questionnaire to the responsible person(s) (Haraldsen et al., 2011). This may have been made even more difficult due to the pandemic with a larger share of employees working from home. In contrast, login information for a web survey can be shared quite easily via email. Furthermore, some establishment surveys (e.g., those run via the respondent portal by the U.S. Census Bureau (2022b)) also have built-in delegation functions that facilitate collaboration among different employees within establishments, though this is not yet the case with the IAB-JVS. Second, establishment size is likely correlated with the quality of IT infrastructure and PC skills of employees (OECD, 2023). In extreme cases, very small establishments might run their business operations completely without a computer. In short, we expect larger establishments to be more likely to participate via web compared to their smaller counterparts:

H1a: Larger establishments are more likely to participate in a single-mode web than single-mode mail design.

H1b: Larger establishments are more likely to participate via web than mail in a concurrent mail-web mixed-mode design.

Industry

Establishments in some industries might differ in their likelihood to participate in mail or web surveys depending on their employees' level of interaction with computers and the Internet in their daily work.

For example, establishments in the agricultural and construction industries may use computers less in their daily work and therefore be less familiar with web applications compared to establishments in the information/communication and finance/insurance industries. These latter establishments are more likely to have highly developed IT infrastructure systems and benefit from the advantages of web surveys, such as easy transfer from digital documents to the online questionnaire, compared to those in the agricultural and construction industries (see also Dickey & Riberas, 2007; Kaiser, 2001). Another industry that might have a higher likelihood of participation via the mail mode is public administration. As the visual design of the IAB-JVS questionnaire mimics official forms, which are often still paper-based in Germany, establishments in the public administration industry should be familiar with this kind of questionnaire and data requirements. For this reason, a mail survey could increase the likelihood of participation compared to a web survey. All of these considerations lead us to the following hypotheses:

H2a: Establishments in the agricultural industry are less likely to participate in a single-mode web than single-mode mail design.

H2b: Establishments in the agricultural industry are less likely to participate via web than mail in a concurrent mail-web mixed-mode design.

H3a: Establishments in the construction industry are less likely to participate in a single-mode web than single-mode mail design.

H3b: Establishments in the construction industry are less likely to participate via web than mail in a concurrent mail-web mixed-mode design.

H4a: Establishments in the public administration industry are less likely to participate in a single-mode web than single-mode mail design.

H4b: Establishments in the public administration industry are less likely to participate via web than mail in a concurrent mail-web mixed-mode design.

H5a: Establishments in the information/communication industry are more likely to participate in a single-mode web than single-mode mail design.

H5b: Establishments in the information/communication industry are more likely to participate via web than mail in a concurrent mail-web mixed-mode design.

H6a: Establishments in the finance/insurance industry are more likely to participate in a single-mode web than single-mode mail design.

H6b: Establishments in the finance/insurance industry are more likely to participate via web than mail in a concurrent mail-web mixed-mode design.

3.5 Data and Methods

3.5.1 Data

3.5.1.1 IAB Job Vacancy Survey

Since 1989, the IAB Job Vacancy Survey (IAB-JVS) has collected data on labor demand and particularly job vacancies and recruiting processes in Germany (Bossler et al., 2020, 2022). It is a voluntary, annual, and cross-sectional establishment survey consisting of a stratified (by region, industry, and size) random sample drawn from the the population of all establishments with at least one employee contributing to social security in Germany. The IAB-JVS forms the basis for regular reporting of survey estimates on job vacancies to Eurostat, which compiles European-wide vacancy statistics. The data used in this study are available from the Research Data Centre (RDC) of the Federal Employment Agency in Germany. Restrictions apply to the availability of these data, which are not publicly available. For more information on data access, see https://fdz.iab.de/en.aspx.

The IAB-JVS started as a single-mode mail survey and is conducted in the fourth quarter of every year since 1990. A concurrent web survey option was introduced in 2002 and included with the mailed questionnaire. Since then, establishments have been able to choose either mode of participation. In 2006, short follow-up telephone surveys were introduced in the three following quarters to update the number of job vacancies. However, this study focuses exclusively on the fourth quarter survey. Establishments in the IAB-JVS receive up to two mailings. The first mailing includes a package with the invitation letter, paper questionnaire, login information to the web survey, notice of the participation deadline (ca. 31st of October), prepaid return envelope, and an additional document with survey instructions and item definitions. This first mailing is sent at the end of September each year. The second mailing is designed as a post-due-date reminder for nonresponding establishments sent after the survey deadline containing the same package of materials (with adjustments to wording and deadline) as the first mailing and is sent in mid-November. The post-due-date reminder gives a new deadline of 23rd of December. Thus, strictly speaking, the IAB-JVS uses a concurrent mail-web mixed-mode design with one invitation letter and one post-due-date reminder.

3.5.1.2 Experimental Design

To examine the effects of using alternative mode designs, an experiment was conducted in the fourth quarter of the 2020 IAB-JVS. The full sample consisted of 132,433 establishments, which were randomly assigned to four experimental groups taking into account collapsed establishment size and industry classes (see Appendix Section 3.C for an overview of summary statistics for each experimental group). Figure 3.1 depicts the experimental design. The field period started on the 26th of September and officially ended on the 6th of January 2021 (65 questionnaires were received after the

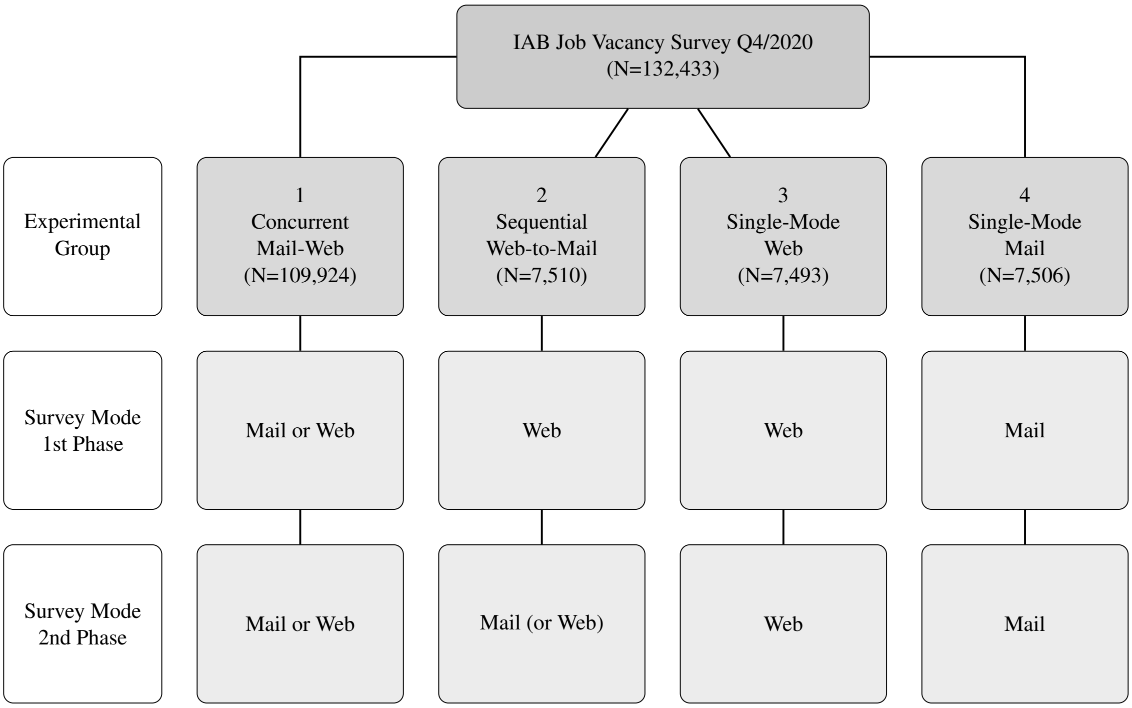


Figure 3.1: Experimental Design

6th of January but these are treated as nonrespondents in the analysis). The post-due-date reminder for all nonresponding establishments, regardless of mode design, was sent on the 16th of November 2020.

The first experimental group (i.e., control group) was conducted using the standard IAB-JVS mode design, i.e., a concurrent mail-web mixed-mode design with paper questionnaire and login information to the web questionnaire included in both contact attempts (invitation and post-due-date reminder). The majority of establishments (N=109,924) were allocated to this group.

The other three experimental groups consisted of a sequential web-to-mail mixed-mode design, a single-mode web design, and a single-mode mail design. For the sequential web-to-mail design, the invitation letter referred to the web survey whereas the post-due-date reminder offered establishments the additional option of responding via the enclosed mailed questionnaire. For the single-mode mail design, both the invitation and post-due-date reminder contained a printed version of the questionnaire without the possibility of web completion. Except for the experimental manipulations, all field procedures were administered identically in all groups.

3.5.1.3 Establishment History Panel

The forthcoming analysis uses data from the Establishment History Panel (BHP), an administrative database of all establishments in Germany, to investigate nonresponse bias and correlates of survey participation (Ganzer et al., 2022). The BHP is an annual and cross-sectional aggregation of employee records to the reference date (30th of June). As we use the 2020 BHP, we have administrative data for respondents and nonrespondents about one quarter before the IAB-JVS field period started. The response indicator from the IAB-JVS can be linked to the BHP via a unique establishment identifier for 127,338 establishments. Because of bankruptcies, changes in ownership or legal forms, or due to mergers or splits, the linkage was unsuccessful in 3.85% of cases. These observations are not included in the analysis of nonresponse bias (RQ2) and survey participation (RQ3) but are part of the response rate (RQ1) and cost (RQ4) analyses.

The BHP contains variables regarding basic establishment characteristics, including establishment size, industry, region, and various (aggregate) employee characteristics, such as the average age of employees, the share of fixed-term employees, and the average wage of employees. Since these variables are likely to be correlated with several IAB-JVS survey variables, such as the number of newly hired employees, number of vacancies, and number of hirings with fixed-term contracts, nonresponse bias in the BHP variables can serve as reasonable proxies for nonresponse bias in the survey variables. This strategy to estimate nonresponse biases using administrative data has been applied in many other methodological studies (e.g., Eckman & Haas, 2017; Kreuter et al., 2010; Küfner et al., 2022b). All used BHP variables are categorized into roughly equal-sized groups with the exception of binary variables. The variables do not have any missing values. Appendix Sections 3.B and 3.C provide an overview of the BHP variables and summary statistics for each administrative variable by mode design group.

3.5.2 Methods

3.5.2.1 Response Rates

To address the first research question (RQ1), we report and compare the response rate of each mode design. In this analysis, a respondent is defined as an establishment that answers at least two essential Eurostat questions on the number of employees and job vacancies and submits their answers by clicking on the "submit" button in the web survey or by mailing the paper questionnaire back to the survey institute. Both essential questions are placed at the beginning of the questionnaire (see Appendix Section 3.A.2 for the exact wording of these questions). Response rates are computed using the AAPOR RR1 definition (American Association for Public Opinion Research, 2016), which is simply the number of respondents divided by the full sample (see Appendix Section 3.D.1 for the corresponding formula).

3.5.2.2 Nonresponse Bias

To assess the impact of mode designs on nonresponse bias (RQ2), bias estimates are calculated for multiple BHP variables. Nonresponse bias is defined as the difference between the estimate of interest for respondents and the estimate of interest for the full sample, which are proportions for the categorized BHP variables:

$$\widehat{\text{NR bias}}_i = \hat{Y}_{i,r} - \hat{Y}_{i,n} \tag{3.1}$$

where $\hat{Y}_{i,r}$ denotes the estimator for the i^{th} statistic of interest based on the respondents and $\hat{Y}_{i,n}$ is the estimator based on the full sample.

Further, we also construct and compare measures of absolute bias and average absolute bias for summarized comparisons. Absolute nonresponse bias is defined as:

$$\text{Abs.}\widehat{\text{ NR bias}}_i = \left|\widehat{\text{NR bias}}_i\right| \tag{3.2}$$

and average absolute nonresponse bias is defined as:

$$\text{Avg. }\widehat{\text{abs. NR}}\text{ bias} = \frac{\sum_{i=1}^{K} \text{Abs.}\widehat{\text{ NR bias}}_i}{K}\ , \tag{3.3}$$

with K being the total number of statistics of interest considered.

The average absolute nonresponse bias measure is computed separately across all statistics of interest for the establishment characteristic variables, the (aggregate) employee characteristic variables, and across all BHP variables (see also Table 3.B.1 of the Appendix for an overview). To avoid the disproportionately large sample size of the concurrent mail-web mixed-mode group from driving the average absolute bias results, we use a repeated downsampling approach to ensure the group is analyzed with the same sample size as the other groups (around 7,500). The resulting resamples are also used for computing confidence intervals for the average absolute bias estimates in this group. To estimate confidence intervals for the other experimental groups, we use bootstrapped standard errors based on 500 replicates and a normal approximation. For the downsampling as well as the bootstrapping approach we take industry and establishment size as strata into account. We compute only the overall estimates of nonresponse bias for each experimental group, but no mode-specific estimates of bias for the individual modes used in the mixed-mode designs. As a sensitivity check, we also compute the median absolute nonresponse bias for the mode design groups.

3.5.2.3 Modeling Survey Participation

To model survey participation and the likelihood to participate in web and mail surveys (RQ3) (see Section 3.4.2), we use two separate approaches. First, we model the likelihood of participation in single-mode web and single-mode mail designs by combining both groups and examining the predicted probabilities of response for different establishment characteristics (establishment size and industry) in the different mode designs with the covariates fixed at their global means. A logistic regression model of the response indicator (1=response; 0=nonresponse) is fitted with interaction terms between the experimental mode group and the establishment characteristics. To test for differences in the predicted probabilities between the single-mode web and the single-mode mail designs with respect to the covariates, we show the results of a Wald test (see Mize, 2019). The following formula is used to predict the probability of participation based on the logistic regression:

$$Pr(R_k = 1) = \frac{1}{1 + \exp\left(-(\alpha + \beta \mathbf{x}_k^\top + \zeta [\mathbf{x_k}\,\mathbf{m_k}]^\top + \gamma \mathbf{z}_k^\top)\right)} \tag{3.4}$$

where Pr is the probability of the response indicator R_k for the k^{th} establishment ($R_k = 1$ = response, $R_k = 0$ = nonresponse), $\mathbf{x_{k,t}}$ is a vector of variables (establishment characteristics and experimental mode indicator), and β the corresponding vector of coefficients, $(\mathbf{x_{k,t}}\,\mathbf{m_{k,t}})$ is a vector of establishment characteristics interacting with the experimental mode indicator, ζ the corresponding vector of coefficients, and $\mathbf{z_{k,t}}$ is a set of additional control variables with γ as the vector of corresponding coefficients.

Second, we examine which subgroups are more likely to participate via web or mail in the concurrent mail-web mixed-mode design. Here, we fit a multinomial logistic regression model where the dependent variable is web response, mail response, and nonresponse (reference group). Based on the multinominal regression, we estimate predicted probabilities for industry and establishment size with the covariates fixed at their global means. To assess the statistical significance of the difference between the predicted web and mail probabilities, we test the difference between web and mail using a Wald test. We formulate the multinomial logistic regression model to predict the probabilities in the following way:

$$Pr(R_k = i) = \frac{\exp(\alpha_i + \beta_i \mathbf{x}_k^\top + \gamma_i \mathbf{z}_k^\top)}{1 + \sum_{j=2}^{3} \exp(\alpha_j + \beta_j \mathbf{x}_k^\top + \gamma_j \mathbf{z}_k^\top)} \quad \text{for } i = 2,\ 3 \tag{3.5}$$

where Pr is the probability of the response indicator R_k for the k^{th} establishment ($R_k = 1$ = nonresponse, $R_k = 2$ = web response, $R_k = 3$ = mail response), $\mathbf{x}_k$ is a vector of variables of interest for the k^{th} establishment, and β_i the corresponding vector of coefficients for the i^{th} response outcome, and $\mathbf{z}_k$ is a vector of additional control variables for the k^{th} establishment, with γ_i as their corresponding vector of coefficients for the i^{th} response outcome.

In both models we include categorized foundation year as a control variable to account for the tenure of the establishment.

Design weights are incorporated into the analysis of response rates, nonresponse bias, and survey participation to account for unequal probabilities of selection. We also account for stratification when estimating linearized standard errors for the response rate comparison and survey participation models. All computations were conducted in Stata 17 (StataCorp, 2021).

3.5.2.4 Survey Costs

To assess the impact of mode designs on survey costs (RQ4), we consider the following variable costs: postage, printing of invitation and reminder letters and paper questionnaires, envelopes, and data entry. Since exact costs are not available or cannot be published due to contractual regulations, the analysis is based on assumed costs. These assumed costs come from consultations with the survey institute, online research, and experiences from other surveys. Variable costs account for only a portion of the total costs of each survey design and are typically more pronounced for mail modes. Costs related to survey management, set-up costs, and data processing are not included (see Appendix Table 3.G.1 for a list of mode-related fixed costs). Nevertheless, variable costs are an important component of survey costs and provide some indications of the cost-effectiveness of the different mode designs. In the forthcoming analysis, we report the per-respondent costs for each experimental group.

3.6 Results

3.6.1 Response Rates

Figure 3.2 presents the design-weighted response rates for each experimental group. A tabular version with absolute numbers and unweighted response rates are shown in Appendix Section 3.D. Comparing the mode designs, there is neither a substantial nor a statistically significant difference between the response rates of the concurrent mail-web mixed-mode design (15.0%), the sequential web-to-mail mixed-mode design (14.5%), the single-mode web design (14.6%), and the single-mode mail design (13.5%). Hence, there is no support for hypotheses M1, M2, M3, and M4. Both the response rate of the single-mode web design (14.6%) and the web take-up rate in the sequential web-to-mail mixed-mode design (7.9%) are higher than the web take-up rate of the concurrent mixed-mode design (4.9%), which lends further support to the performance of "push-to-web" strategies in establishment surveys and supports M5. In line with M6, the response rate of the single-mode mail design (13.5%) exceeds the mail take-up rate of the concurrent mixed-mode design (10.1%).

3.6.2 Nonresponse Bias

Figure 3.3 shows the average absolute nonresponse bias across all BHP administrative variables. Tables and figures for the average absolute nonresponse bias and the median absolute nonresponse bias are shown separately for the establishment and employee characteristic variable groups in Appendix Section 3.E. Moreover, nonresponse biases for individual variables are presented in Appendix Section

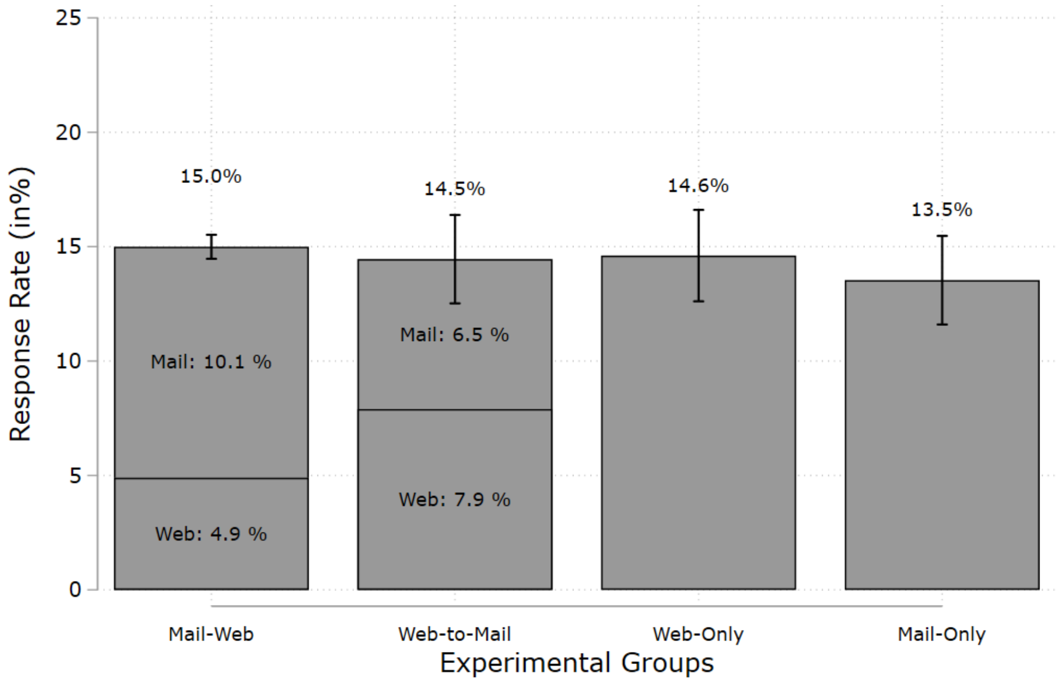


Figure 3.2: Response Rate (Weighted) and 95% Confidence Interval by Mode Design, IAB-JVS 2020

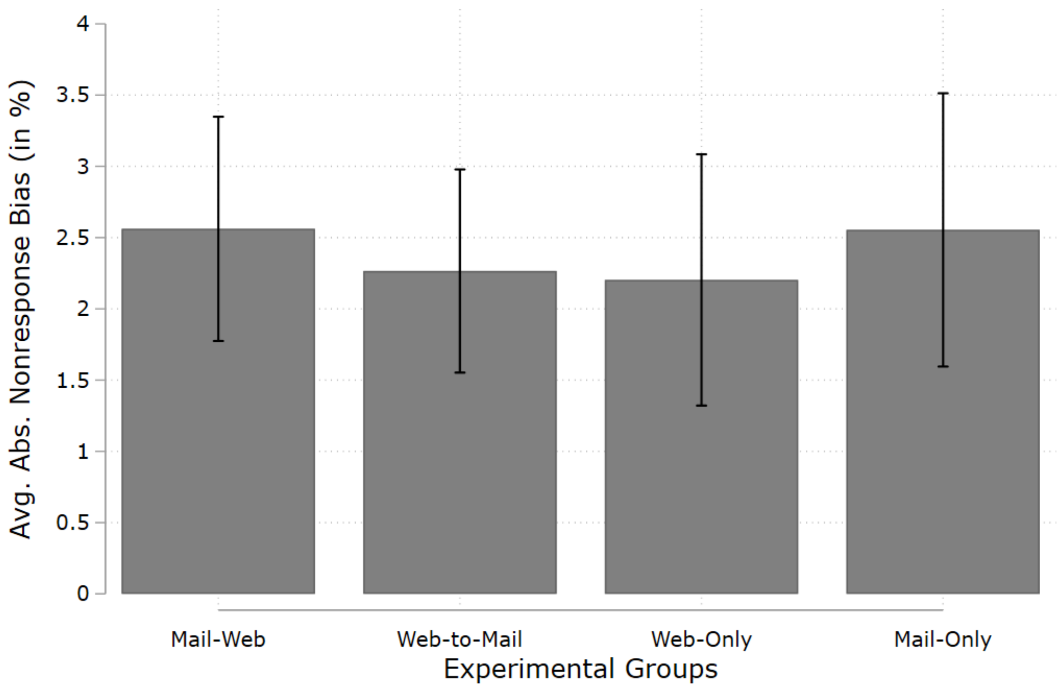


Figure 3.3: Average Absolute Nonresponse Bias Estimates and 95% Confidence Intervals, by Mode Design, for All BHP Administrative Variables

3.E.3.

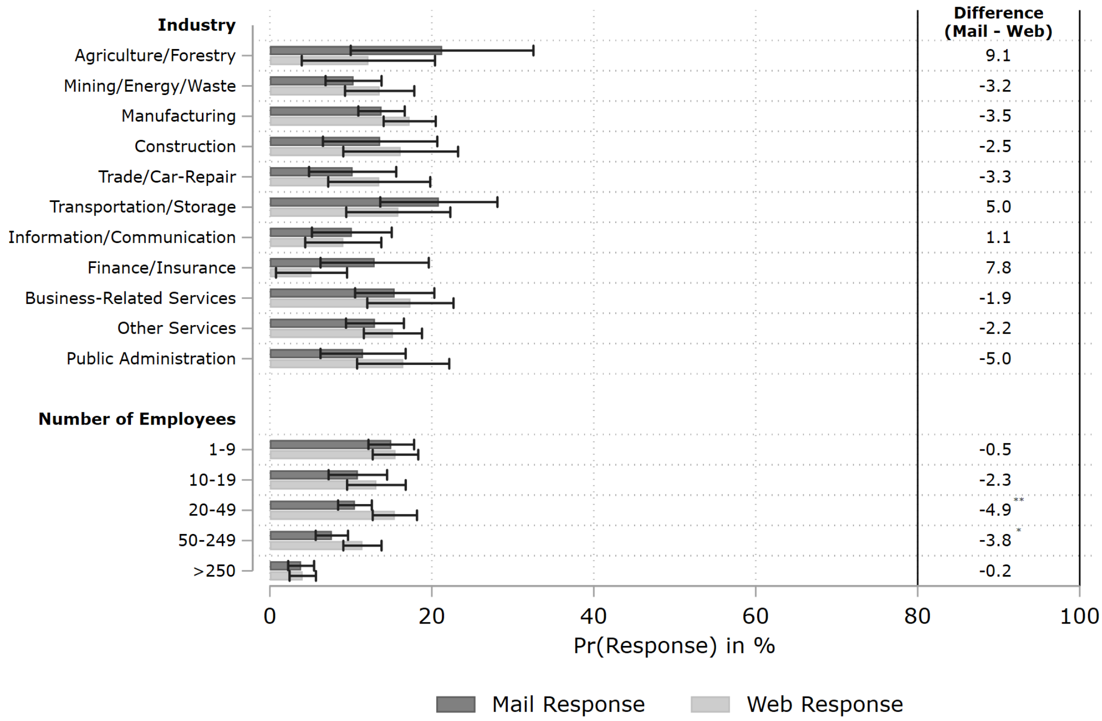
Overall, the results show rather low levels of aggregate nonresponse bias. The average absolute nonresponse bias across all BHP administrative variables is less than 3% for all mode designs. Further, there are no statistically significant differences between the mode designs. Similarly, there are no substantial differences in average absolute bias between the mode designs with respect to the establishment characteristic variables (e.g., size, industry, region) or the (aggregate) employee characteristic variables (e.g., average age of employees, share of female employees) when both variable groups are examined separately. Thus, the different mode designs yield respondents that are generally comparable with respect to establishment and workforce characteristics. Similar conclusions hold for the median absolute nonresponse bias results.

For individual variables, a few notable biases can be observed. The raw nonresponse biases for establishment size categories are particularly large in the single-mode mail design with the largest bias occurring for the smallest establishment size group (7.25%). Specifically, establishments with less than 10 employees are overrepresented by 7.25 percentage points, which is higher than in the other mode design groups. The single-mode web (-1.79%) and the single-mode mail (-2.08%) designs have smaller negative biases for the service industry compared to the sequential web-to-mail (-7.94%) and concurrent mail/web mixed-mode designs (-5.32%), indicating that the service industry is more accurately represented by respondents in the single-mode designs. We observe a strong and significant nonresponse bias for establishments founded after 2010 in the mail-only group (-9.12%), meaning that these younger establishments are underrepresented in the respondent pool. Moreover, participating establishments with the highest proportion of high-educated employees in the sequential web-to-mail mixed-mode design are overrepresented by 6.58 percentage points.

In summary, the results do not show strong differences between the different mode designs with respect to aggregate nonresponse bias across all administrative variables, contradicting our hypotheses M7, M8, M9, and M10. Lastly, the biases of individual variables show only few meaningful differences between the mode designs. For instance, the single-mode mail design overrepresents the smallest establishments and underrepresents the youngest establishments to a greater extent than the other mode designs.

3.6.3 Predictors of Survey Participation by Mode

Figure 3.4 shows the predicted probabilities of survey participation in the single-mode web and mail designs for the establishment characteristics based on the logistic regression model of survey participation. With respect to establishment size, larger establishments (except for the largest establishments with more than 250 employees) are more likely to participate in a web survey than in a mail survey compared to smaller establishments. This higher likelihood of participation is statistically significant



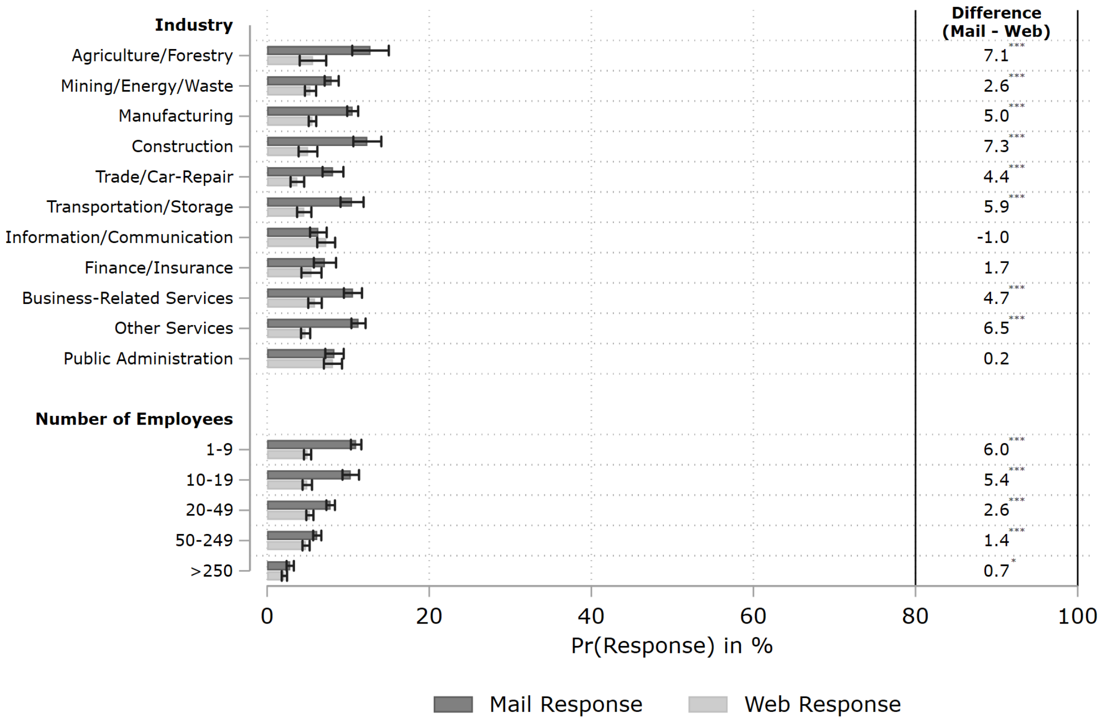
Notes: The additional column shows the difference between the predicted probability of mail and web participation and the corresponding result of a Wald test. Significance Levels: *** = p < 0.001; ** = p < 0.01; * = p < 0.05.

Figure 3.4: Predicted Probabilities and 95% Confidence Intervals of Survey Participation in Single-Mode Web and Single-Mode Mail Designs by Establishment Characteristics, IAB-JVS 2020

and thus supports H1a. The agriculture, construction, public administration, information/communication, and finance/insurance industries show no reliable relationship with either mode, thus yielding no support for H2a, H3a, H4a, H5a, and H6a, respectively.

Figure 3.5 shows the predicted probabilities and confidence intervals from the multinomial regression model of participation in the web and mail modes of the concurrent mixed-mode design with nonresponse as the reference category. The corresponding regression tables are provided in Appendix Section 3.F. The results show that the predicted probabilities for mail participation are higher than for web participation for the different establishment characteristics (except for the information/-communication industry). For instance, larger establishments are more likely to participate by mail than by web in the concurrent mixed-mode design, which contradicts H1b. However, the difference between the predicted probabilities of web and mail shrinks with increasing establishment size, from 6.0 percentage points (Mail: 11.0%; Web: 5.0%) for the smallest establishments to 0.7 percentage points (Mail: 2.8%; Web: 2.1%) for the largest establishments. This implies that smaller establishments have a higher likelihood to participate by mail, while larger establishments are almost equally likely to participate by web or mail.

With respect to industry participation, establishments in the agricultural and construction industries have a higher probability of participating by mail than by web, yielding support for H2b and



Notes: The additional column shows the difference between the predicted probability of mail and web participation and the corresponding result of a Wald test. Significance Levels: *** = p < 0.001; ** = p <0.01; * = p < 0.05.

Figure 3.5: Predicted Probabilities and 95% Confidence Intervals of Survey Participation by Mail and Web in the Concurrent Mail-Web Mixed-Mode Design by Establishment Characteristics, IAB-JVS 2020

H3b, respectively. There is no statistically significant difference in the predicted probabilities of web and mail participation for establishments in the public administration, information/communication, and the finance/insurance industries. Hence, there is no support for hypotheses H4b, H5b, and H6b. However, it is interesting that these three industries are the only ones where the predicted probabilities of mail participation are not significantly higher than web participation. This could be a sign that these industries are more open to choosing the web mode compared to other industries.

3.6.4 Survey Costs

Table 3.1 shows a summary of all analyzed costs per mode design and Appendix Table 3.G.2 provides more details on the specific costs associated with each mode design. The analysis shows that the single-mode mail design leads to the highest costs per respondent (35.20 €), which includes costs of each contact attempt and data entry. This is followed by the concurrent mail-web mixed-mode design (29.69 €), which includes costs for postage and printing, but fewer data entry costs. Due to the higher number of web respondents and less expensive mailings, the sequential web-to-mail mixed-mode (21.55 €) and the single-mode web (13.93 €) designs are the least expensive mode designs. These results support hypothesis M11 and highlight the potential cost savings of switching to a push-to-web design in establishment surveys.

Table 3.1: Survey Costs by Experimental Group

	Mail-Web	Web-to-Mail	Web-Only	Mail-Only
Invitation	192,367.00 €	6,608.80 €	6,593.84 €	13,135.50 €
Post-Due-Date Reminder	174,217.15 €	12,181.75 €	6,123.92 €	11,877.25 €
Re-Postage Mail	12,389.15 €	492.90 €	0.00 €	1,124.50 €
Data Entry	15,816.11 €	631.03 €	0.00 €	1,567.66 €
Total Costs	*394,835.01 €*	*19,914.48 €*	*12,717.76 €*	*27,804.91 €*
Costs per Sampled Unit	*3.59 €*	*2.65 €*	*1.70 €*	*3.70 €*
Costs per Respondent Unit	*29.69 €*	*21.55 €*	*13.93 €*	*35.20 €*

Notes: Postage Mail Package: 1.55 €; Postage Web Package: 0.80 €; Print Mail Package: 0.20 €; Print Web Package: 0.08 €; Postage for Return Mail Respondent: 1.55 €; Data Entry Mail Respondent: 1.98 €; Data Entry Web Respondent: 0.00 €

3.7 Qualitative Insights

To augment the quantitative results, qualitative interviews were conducted to understand how establishments view web and mail modes when deciding whether to participate in a voluntary survey. To this end, we conducted 46 short structured interviews and 12 semi-structured in-depth qualitative interviews with interviewees recruited from participants and non-participants of the 2020 fourth quarter mode design experiment discussed above. The short structured interviews aimed to gather information on establishment mode preferences and the perceived advantages and disadvantages of web, mail, and telephone modes. Selected establishments were balanced across establishment size, industry, region, and experimental groups (see Appendix Table 3.H.1 for an overview of the sample characteristics). Human resources representatives and managers within the establishments responsible for responding to the IAB-JVS served as interviewees. These interviews were embedded in routine questionnaire pretests and carried out via telephone from February to May 2022 by trained interviewers.

The in-depth interviews were conducted to understand the impact of mode on response processes and the decision to participate. The sample, consisting of eight interviews with respondents and four with nonrespondents, was balanced in terms of establishment size, industry, region, and experimental group as outlined in Appendix Table 3.H.1. The interviews, conducted by the authors of this article between March and May 2022, lasted between 31 and 55 minutes. Using a semi-structured interview guide (see Appendix Section 3.H.4 for the complete interview guidelines), sessions were held via video or telephone. To counteract potential recall issues concerning specific response decisions and processes from the IAB-JVS conducted 1.5 years ago, we introduced the relevant mode design scenarios when needed. More methodological details are provided in Appendix Section 3.H.

For both qualitative study arms, most respondents (26 out of 46 short interviews, and 11 out of 12 in-depth interviews) preferred the web mode over the mail mode, or were indifferent. Interestingly, four establishments that responded by mail in the mixed-mode groups stated a preference for web surveys in the qualitative interviews. A possible explanation for this paradoxical preference is that these establishments see the advantages of participating by web, but in a real-world situation it seems easy for them to grab a pen and fill in the paper questionnaire, or to use the words of one interviewee: *"When I have this questionnaire in front of me on paper, I tend to be the person who fills it out on paper. If I had received the questionnaire by e-mail via a link, I probably wouldn't have printed it out and filled it in, but would have submitted it online."*(see Appendix Table 3.H.4, Quote No.1).

We identified two channels where establishments stated that web or mail modes could influence their decision to participate. First, the appearance and length of a mailed questionnaire can impact the participation decision in a positive (e.g., formal and reputable) or negative (e.g., overwhelming or too long) way. Length, in particular, was reported as having a negative effect on participation in mail surveys because it is more salient than in a web survey. As one interviewee put it: *"Length is a deterrent, yes, of course. That means that if I have a twenty-page questionnaire somewhere, [...] the will to drop out suddenly increases very exponentially."* (see Appendix Table 3.H.2, Quote No.1). Second, respondents perceive responding to a web survey as less burdensome than to a mail survey in general (*"It [the web questionnaire] would go faster and would be easier, easy in terms of effort"* (see Appendix Table 3.H.2, Quote No.2)).

The biggest cited advantage of web questionnaires was the flexibility to complete the questionnaire at their convenience. This was mentioned for both mail and web modes, but was more strongly associated with the web mode: *"You can just organize it yourself. [...] Online I can say: O.k. I'll put that aside now and take it at 4:00 p.m. and work on it then."* (see Appendix Table 3.H.2, Quote No.3). For both qualitative study arms, web questionnaires were reported to be faster to complete than mail questionnaires. Respondents provided three main reasons for this. First, the return of web questionnaires does not require cumbersome postal returns: *"I think the general willingness to participate is generally higher with an online survey, because you simply save yourself the trouble of sending it back and so on."* (see Appendix Table 3.H.2, Quote No.4). Second, the internal routing of the mail questionnaire can be replaced with a brief email and other kinds of cooperation are facilitated (e.g., screen-sharing): *"But also - as I said - the internal back and forth, you're quicker at it [with web questionnaires]. And with that, there is also acceptance [for the survey request], somehow. Because anything that requires less effort within the company has great advantages in terms of getting results."* (see Appendix Table 3.H.2, Quote No.5).

Third, because using computers and web apps is part of many HR managers' regular routine, the entire response process is regarded as being quicker: *"Yes, online just goes quickly. [...] I log in, that's what I do [working with web applications] most of the time, the threshold to participate there is relatively low."* (see Appendix Table 3.H.2, Quote No.6). Moreover, the response process of a web survey is seen as easier, because it is easier to correct answers and there are no worries about unreadable handwriting: *"No, actually [online] is much better for me [...] I always doubt that you can read my handwriting then."* (see Appendix Table 3.H.2, Quote No. 7). Another cited advantage of the web questionnaire is the facilitated use of internal documents, making it easier to search, copy, and paste from internal management systems. In addition, web surveys are seen as more modern and more sustainable than mail surveys. Nicely summarized by the following statement: *"Especially with the sustainability mindset that is overtaking us all, online is the most efficient, cost-effective, and easiest method."* (see Appendix Table 3.H.2, Quote No.8)".

Regarding the advantages of mail surveys, some respondents of the short interviews noted that having a paper questionnaire on the desk has a reminding effect and could thereby increase the likelihood to participate. Other reported advantages of mail surveys were that establishments get an easy overview of all questions before starting the answering process and could discuss the questionnaire in a team meeting more easily. Some respondents also stated the advantage of writing notes on a paper questionnaire and considering their answers based on those notes: *"I'm actually also more of a haptic person. I have to be able to take notes all the time, assess questions and answers, and think things through."* (see Appendix Table 3.H.3, Quote No.1). Establishments also appreciate that the mail survey can be copied and filed in their records for future reference: *"In addition, I can make a copy of it - and I often do this [...] - and file it in our correspondence. [...] I know that I can't do that with an online survey."* (see Appendix Table 3.H.3, Quote No.2). One cited disadvantage, common to both modes, is the burden of having to proactively contact the survey institute in the case of misunderstandings or ambiguities. Further cited advantages and disadvantages of web and mail modes from the short interviews are summarized in Table 3.2. Additional quotes from the in-depth interviews are provided in Appendix Section 3.H.3.

Table 3.2: Advantages and Disadvantages of Web and Mail Modes

Web		*Mail*	
Advantages	**Disadvantages**	**Advantages**	**Disadvantages**
• Time & local flexibility (23) • Speed (11) • Easy use of internal documents (7) • Easy handling processes (6) • Easy to enter/correct (4) • Sustainability (1)	• One-way communication prevents clarification of questions or communication of additional information (4) • Cumbersome log-in & handling processes (4) • Low memory capacity (3) • Error-proneness of answering the questionnaire (2) • Data privacy concerns (2)	• Time flexibility (12) • Easy use of internal documents (7) • High memory capacity (4) • Better distribution within the establishment (2) • Questionnaire easy to handle (2) • Comparability with previous surveys / knowledge documentation (1) • Speed (1) • More intensive engagement with questionnaire (1)	• Long processing time (9) • Cumbersome handling (8) • Demanding return (6) • Unsustainable (6) • One-way communication prevents clarification of questions or communication of additional information (6) • Does not fit so well in operating procedure (2) • Error-proneness of answering the questionnaire (1)

Notes: Number of mentions in parentheses. Establishments were asked about their mode preference and the perceived advantages and disadvantages of web, mail and telephone interviews. Telephone interviews are not in the focus of this article and hence are not displayed here.
Source: 46 qualitative interviews 2022.

3.8 Discussion

This study evaluated the impacts of an experiment comparing a concurrent mail-web mixed-mode, a sequential web-to-mail mixed-mode, a single-mode web, and a single-mode mail design on survey participation in a large-scale establishment survey. The findings are useful for survey practitioners seeking to maximize participation rates and minimize nonresponse bias and costs in voluntary establishment surveys. The main findings can be summarized as follows. The experiment did not reveal any substantial differences in response rates between the four mode designs. Similarly, the four mode designs did not show meaningful differences with respect to aggregate nonresponse bias. However, there were a few differences in subgroup participation between the mode designs. In line with the literature (Dickey & Riberas, 2007; C. Jones & Phipps, 2010; Kaiser, 2001; Thompson et al., 2015), larger establishments were more likely to participate in the single-mode web survey design than in the single-mode mail survey design. In the concurrent mixed-mode design, all establishment size classes were more likely to participate via mail, but the difference in the likelihood of participation between web and mail modes was smallest for the largest establishments. We found establishments in the agriculture/forestry and construction industries to be more likely to participate via mail in the concurrent mail-web mixed-mode design, but this result did not appear in the single-mode design comparison. Against our expectations, there was no strong evidence that establishments in the information/communication, finance/insurance, and public administration industries have stronger preference for participating via web than mail (or vice versa) in a concurrent mail-web mixed-mode or in a single-mode design.

Lastly, the cost analysis showed that push-to-web designs, such as a single-mode web and a sequential web-to-mail design can achieve substantial per-respondent cost savings of more than 50 and 25 percent, respectively, compared to a concurrent mail-web mixed-mode design. A single-mode mail design, in contrast, resulted in 19 percent higher costs per respondent than the concurrent mail-web mixed-mode design. However, we note that these cost results account for variable costs only, which are typically more pronounced in mail modes than in web modes. Future research could examine whether cost savings can be achieved when fixed costs, including software and programming the web instrument, are considered.

The accompanying qualitative study provided additional insights into how establishments weigh the pros and cons of web and mail modes when deciding whether to participate in a voluntary survey. In general, the participants preferred web over mail. While most participants did not explicitly state that mode has an impact on their willingness to participate, they did repeatedly mention that web surveys require less effort to respond compared to mail. Other key advantages of the web mode that were cited include sustainability, modernness, and facilitated handling of the questionnaire, which were important factors for the establishments. A limitation of the qualitative interviews is that they were conducted 1.5 years after the IAB-JVS mode design experiments. Thus, respondents may not have been able to recall exactly their actual response decisions and response processes. However, by presenting the participants with hypothetical mode design scenarios we were able to address some of these recall problems and obtain answers which we believe are transferable to real establishment situations.

Forgoing mail questionnaires entirely and adopting a web-only mode design, as some National Statistical Institutes have done (see 3.3.1), did not yield any negative impacts in our study. We attribute this result to several factors. First, the transformative impact of the COVID-19 pandemic on establishment practices, such as the prevalence of remote and hybrid working arrangements, has likely increased the burden associated with sharing paper questionnaires within establishments. Second, the pandemic has stimulated advances in IT infrastructure and skills among establishments and employees, potentially fostering a greater willingness among previously reluctant establishments to respond online. And lastly, ongoing improvements to web questionnaires (e.g., delegation functions) are reducing the perceived burden of responding online.

This study fills important gaps in the literature regarding the impact of self-administered mode designs on voluntary establishment survey participation. The lack of recent experimental evidence in this area is particularly notable given recent changes in Internet availability and usage by businesses (OECD, 2023), but also increased work-from-home and flexible working patterns adopted by establishments in response to (and, in many cases, continuing beyond) the COVID-19 pandemic. Thus, we believe our findings are applicable to the post-pandemic situation, though further research is needed to confirm. Our study further adds to the literature by shining light on the effectiveness of various self-administered mode designs in a general population sample of establishments, which complements previous studies that have focused on more specific establishment populations (Bremner, 2011; Downey et al., 2007; Ellis et al., 2013; Erikson, 2007; Harris-Kojetin et al., 2013; Millar et al., 2018). An additional strength of the study is the comprehensive examination of several outcomes of interest: response rates, nonresponse bias, subgroup participation, and survey costs across different mode designs, which is rare in the establishment literature. The utilization of a mixed-methods approach combining quantitative experiments with qualitative interviews is another unique feature of this study, as it allowed for an examination of the pros and cons of using web and mail modes from the establishments' perspective and thus shed light on the reasons for their participation decisions. Future methodological research might consider using a similar mixed-methods approach to analyze the drivers of establishment survey participation more generally and examine them from different perspectives.

In conclusion, the findings suggest using "push-to-web" designs for self-administered establishment surveys, implemented as either a single-mode web survey or a sequential web-to-mail mixed-mode survey. These designs can yield similar response rates and levels of nonresponse bias compared to concurrent mail-web mixed-mode designs, but with significantly lower per-respondent costs. This can also be viewed as an endorsement for the growing shift towards using web surveys as a supplement, or replacement, of mail surveys by researchers and statistical agencies.

3.9 References

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3.10 Appendix

3.A Survey Information

3.A.1 PRICSSA

Table 3.A.1: PRICSSA Item Checklist

1.1 Data collection dates	The survey was administered from September 26, 2020 to January 6, 2021.
1.2 Data collection modes	This study analyzes mode of data collection and as described in 3.5.1.2 the study compares a concurrent mail-web mixed-mode, a sequential web-to-mail mixed-mode, a single-mode web, and a single-mode mail design.
1.3 Target population	The target population for the IAB-JVS is the population of establishments with at least 1 employee contributing to social security in Germany.
1.4 Sample design	The IAB-JVS uses a stratified random sampling design with establishment size, industry, and region as stratification variables.
1.5 Survey response rate(s)	Response rates are one of the outcomes of this study and are displayed in Figure 3.2.
2.1 Missingness rates	The BHP could not be merged for 3.85 % of cases. These observations are not included in the analysis of nonresponse bias (RQ2) and (RQ3), but are part of the response rate (RQ1) and cost (RQ4) analyses.
2.2 Observation deletion	Does not apply.
2.3 Samples sizes	The sample size of all experimental groups are displayed in Figure 1 and for each model of survey participation in Tables 3.F.1 and 3.F.3.
2.4 Confidence intervals/standard errors	All figures include weighted point estimates and 95 % confidence intervals.
2.5 Weighting	All analyses were weighted with design weights, i.e., inverse of inclusion probabilities.
2.6 Variance estimation	Stratum variables were applied, and Taylor Series Linearization was used to produce design-adjusted standard errors.
2.7 Subpopulation analysis	Does not apply.
2.8 Suppression rules	Does not apply.
2.9 Software	All design-based analyses were performed using Stata's svy commands (in Stata SE, Version 17). These included svy tab for cross-tabulation, and svy logit or svy mlogit for estimation of logistic and multinominal regression models.
2.10 Singleton problem	Stata's "singleunit(centered)" option was used, which specifies that strata with a single PSU be centered at the grand mean instead of the stratum mean.
2.11 Public/restricted data	The data used in this study are available from the Research Data Centre (RDC) of the Federal Employment Agency in Germany. Restrictions apply to the availability of these data, which are not publicly available. For more information on data access, see https://fdz.iab.de/en.aspx.
2.12 Embedded experiments	Next to the analyzed experiment, we conducted an experiment on order effects of a few questions late in the questionnaire. Sensitivity checks show that this experiment did not affect the results.

3.A.2 Question wording

The following questions are used to ask about the number of employees and the number of job vacancies, which we use to define a valid unit response:

Table 3.A.2: Question Wording

<u>**Number of Employees**</u>

1. How many persons **in total were employed** in your establishment or administrative post at the end of September 2020 [, and how many were employed at the end of September 2019]?

- Employees subject to social security contributions (incl.apprentices) □
- Employees in marginal employment (mini jobbers) □
- Civil servants □
- Working proprietors and contributing family workers □
- **Total number of employees (sum of above)** □

[MORE QUESTIONS NOT RELEVANT FOR THIS STUDY]

<u>**Number of Job Vacancies**</u>

5. Are you **currently** looking for new employees?
Please do not consider . . .

. . . apprenticeships
. . . renewals of fixed-term contracts or conversions into open-ended contracts
. . . employees to be leased from temporary employment agencies
. . . publicly-funded employees such as One-Euro-Jobs

Yes □ –> Question 6 No □ –> Please continue with Question 10

6.Are you **currently** searching for employees to be hired **immediately or as soon as possible**?

Yes □ No □
If yes, **How many?**
Total □

[MORE QUESTIONS NOT RELEVANT FOR THIS STUDY]

9. In addition to the vacancies specified in Question 6, are you currently looking for employees to be hired **at a later date**?

Yes □ No □
If yes, **How many?**
Total □

[MORE QUESTIONS NOT RELEVANT FOR THIS STUDY]

3.B Variable Overview

Table 3.B.1: Variable Overview

Variable	**Bias Measure**	**Hypothesis Testing**
Research Objective	**RQ2**	**RQ3**
Establishment Characteristics		
East/West Germany	X	-
Foundation Year	X	X
Industry	X	X
Number of Employees	X	X
Employee Characteristics		
Avg. Age of Employees	X	-
Proportion of Female	X	-
Proportion of Fixed-Term	X	-
Proportion of Apprentices	X	-
Proportion of Full-Time	X	-
Proportion of Part-Time	X	-
Proportion of Germans	X	-
Proportion of Regular	X	-
Proportion of Marginal	X	-
Proportion of High-Educated	X	-
Proportion of Mid-Educated	X	-
Proportion of Low-Educated	X	-
Proportion of Unknown Educated	X	-
Quartile of Wage Distribution	X	-

3.C Summary Statistics

Table 3.C.1: Descriptive Statistics - Number of Employees, BHP 2020

	Mail-Web		Web-to-Mail		Web-Only		Mail-Only	
Number of Employees	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
1-9	26,089	70.14 %	1,757	70.20 %	1,793	69.54 %	1,804	69.73 %
10-19	21,956	14.72 %	1,496	14.64 %	1,469	15.02 %	1,472	15.16 %
20-49	26,687	9.28 %	1,830	9.20 %	1,836	9.62 %	1,841	9.29 %
≥50	30,956	5.86 %	2,129	5.96 %	2,121	5.83 %	2,102	5.82 %
Design Based Pearson χ^2:	0.985							

Table 3.C.2: Descriptive Statistics - Foundation Year, BHP 2020

	Mail-Web		Web-to-Mail		Web-Only		Mail-Only	
Foundation Year	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
70s/80s	25,184	17.48 %	1,759	18.58 %	1,737	18.01 %	1,715	16.85 %
90s	25,945	20.33 %	1,818	20.27 %	1,832	19.79 %	1,775	20.67 %
00s	25,366	24.72 %	1,729	25.82 %	1,722	26.23 %	1,736	26.16 %
10s	29,193	37.48 %	1,906	35.32 %	1,928	35.97 %	1,993	36.32 %
Design Based Pearson χ^2:	0.909							

Table 3.C.3: Descriptive Statistics - Prop. of Apprentices, BHP 2020

	Mail-Web		Web-to-Mail		Web-Only		Mail-Only	
Prop. of Apprentices	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
0.00	67,064	80.75 %	4,542	80.48 %	4,545	80.97 %	4,515	80.26 %
0.01-100	38,624	19.25 %	2,670	19.52 %	2,674	19.03 %	2,704	19.74 %
Design Based Pearson χ^2:	0.922							

Table 3.C.4: Descriptive Statistics - Prop. of Female Employees, BHP 2020

	Mail-Web		Web-to-Mail		Web-Only		Mail-Only	
Prop. of Female Employees	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
0.00 - 18.18	26,748	24.33 %	1,855	25.01 %	1,789	22.98 %	1,834	26.43 %
18.19 - 40.97	26,111	17.42 %	1,733	17.49 %	1,772	17.12 %	1,812	16.69 %
40.98 - 67.12	26,376	20.05 %	1,858	19.36 %	1,843	21.41 %	1,767	19.13 %
>67.13	26,453	38.20 %	1,766	38.14 %	1,815	38.49 %	1,806	37.75 %
Design Based Pearson χ^2:	0.614							

Table 3.C.5: Descriptive Statistics - Prop. of Fixed-Term Contracts, BHP 2020

	Mail-Web		Web-to-Mail		Web-Only		Mail-Only	
Prop. of Fixed-Term Contracts	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
0.00	35,050	63.62 %	2,332	62.03 %	2,394	63.00 %	2,449	63.09 %
0.01 - 15.99	32,664	12.64 %	2,297	12.38 %	2,249	13.57 %	2,233	12.02 %
≥16.00	37,974	23.74 %	2,583	25.59 %	2,576	23.43 %	2,537	24.89 %
Design Based Pearson χ^2:	0.506							

Table 3.C.6: Descriptive Statistics - Prop. of Full-Time Contracts, BHP 2020

	Mail-Web		Web-to-Mail		Web-Only		Mail-Only	
Prop. of Full-Time Contracts	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
0.00 - 36.38	26,550	46.07 %	1,825	45.52 %	1,812	45.46 %	1,826	46.54 %
36.39 - 66.66	25,616	21.92 %	1,756	20.40 %	1,725	22.44 %	1,740	21.41 %
66.67 - 85.28	27,095	14.29 %	1,858	15.72 %	1,824	15.23 %	1,868	14.42 %
>85.29	26,427	17.72 %	1,773	18.36 %	1,858	16.87 %	1,785	17.63 %
Design Based Pearson χ^2:	0.839							

Table 3.C.7: Descriptive Statistics - Prop. of German Citizens, BHP 2020

	Mail-Web		Web-to-Mail		Web-Only		Mail-Only	
Prop. of German Citizens	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
100.00	40,994	60.66 %	2,765	60.26 %	2,842	62.62 %	2,833	60.98 %
0.00-99.99	64,694	39.34 %	4,447	39.74 %	4,377	37.38 %	4,386	39.02 %
Design Based Pearson χ^2:	0.502							

Table 3.C.8: Descriptive Statistics - Prop. of High-Educated Employees, BHP 2020

	Mail-Web		Web-to-Mail		Web-Only		Mail-Only	
Prop. of High-Educated Employees	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
0.00	29,421	55.62 %	2,015	56.49 %	2,007	54.17 %	2,013	57.13 %
0.01 - 14.99	37,911	15.17 %	2,596	15.11 %	2,582	15.44 %	2,613	15.58 %
≥15.00	38,356	29.21 %	2,601	28.40 %	2,630	30.39 %	2,593	27.29 %
Design Based Pearson χ^2:	0.490							

Table 3.C.9: Descriptive Statistics - Prop. of Low-Educated Employees, BHP 2020

	Mail-Web		Web-to-Mail		Web-Only		Mail-Only	
Prop. of Low-Educated Employees	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
0.00	33,335	55.40 %	2,253	56.45 %	2,307	55.79 %	2,293	55.98 %
0.01 - 11.99	38,042	12.65 %	2,581	12.49 %	2,559	12.63 %	2,591	12.40 %
≥12.00	34,311	31.95 %	2,378	31.06 %	2,353	31.58 %	2,335	31.62 %
Design Based Pearson χ^2:	0.990							

Table 3.C.10: Descriptive Statistics - Prop. of Mid-Educated Employees, BHP 2020

	Mail-Web		Web-to-Mail		Web-Only		Mail-Only	
Prop. of Mid-Educated Employees	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
0.00 - 50.00	29,352	32.08 %	1,985	31.07 %	1,967	30.19 %	1,990	30.11 %
50.01 - 70.58	23,256	16.02 %	1,605	15.48 %	1,637	18.48 %	1,550	15.88 %
70.59 - 84.99	26,473	16.74 %	1,777	17.02 %	1,813	15.59 %	1,827	17.33 %
>85.00	26,607	35.16 %	1,845	36.42 %	1,802	35.74 %	1,852	36.69 %
Design Based Pearson χ^2:	0.430							

Table 3.C.11: Descriptive Statistics - Prop. of Unknown-Educated Employees, BHP 2020

	Mail-Web		Web-to-Mail		Web-Only		Mail-Only	
Prop. of Unknown-Educated Employees	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
0.00	57,382	70.25 %	3,898	69.88 %	3,933	72.26 %	3,969	71.59 %
0.01-100.00	48,306	29.75 %	3,314	30.12 %	3,286	27.74 %	3,250	28.41 %
Design Based Pearson χ^2:	0.363							

Table 3.C.12: Descriptive Statistics - Avg. Age of Employees, BHP 2020

	Mail-Web		Web-to-Mail		Web-Only		Mail-Only	
Avg. Age of Employees	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
0.00-38.99	25,546	28.71 %	1,784	29.50 %	1,664	27.02 %	1,695	27.16 %
39.00-43.49	25,956	19.27 %	1,758	18.86 %	1,753	18.90 %	1,839	19.87 %
43.50-47.99	28,693	19.74 %	1,925	17.97 %	1,994	20.98 %	1,869	16.65 %
≥48.00	25,493	32.28 %	1,745	33.67 %	1,808	33.10 %	1,816	36.32 %
Design Based Pearson χ^2:	0.071							

Table 3.C.13: Descriptive Statistics - Prop. of Marginal Contracts, BHP 2020

	Mail-Web		Web-to-Mail		Web-Only		Mail-Only	
Prop. of Marginal Contracts	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
0.00	39,730	42.35 %	2,736	44.14 %	2,769	41.62 %	2,707	43.29 %
0.00-14.99	36,706	12.98 %	2,464	12.78 %	2,474	14.60 %	2,512	12.85 %
≥15.00	29,252	44.67 %	2,012	43.07 %	1,976	43.78 %	2,000	43.86 %
Design Based Pearson χ^2:	0.480							

Table 3.C.14: Descriptive Statistics - Prop. of Part-Time Contracts, BHP 2020

	Mail-Web		Web-to-Mail		Web-Only		Mail-Only	
Prop. of Part-Time Contracts	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
0.00	18,843	29.15 %	1,325	31.74 %	1,262	28.28 %	1,291	29.89 %
0.01 - 19.99	40,084	16.28 %	2,712	14.92 %	2,805	16.87 %	2,778	16.23 %
≥20.00	46,761	54.57 %	3,175	53.34 %	3,152	54.85 %	3,150	53.88 %
Design Based Pearson χ^2:	0.378							

Table 3.C.15: Descriptive Statistics - Prop. of Regular Contracts, BHP 2020

	Mail-Web		Web-to-Mail		Web-Only		Mail-Only	
Prop. of Regular Contracts	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
0.00 - 75.00	28,504	46.32 %	1,970	44.49 %	1,931	45.47 %	1,968	45.66 %
75.01 - 88.88	23,892	12.77 %	1,615	13.55 %	1,611	13.92 %	1,632	12.16 %
88.89 - 97.43	26,779	7.07 %	1,819	7.22 %	1,853	7.72 %	1,834	7.21 %
>97.44	26,513	33.84 %	1,808	34.73 %	1,824	32.89 %	1,785	34.96 %
Design Based Pearson χ^2:	0.677							

Table 3.C.16: Descriptive Statistics - Quartile of Wage Distribution, BHP 2020

	Mail-Web		Web-to-Mail		Web-Only		Mail-Only	
Quartile of Wage Distribution	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
First Quartile	16,510	18.24 %	1,112	18.18 %	1,095	16.81 %	1,086	18.01 %
Second Quartile	21,450	19.06 %	1,491	20.16 %	1,530	20.78 %	1,478	19.62 %
Third Quartile	23,033	18.70 %	1,589	19.18 %	1,525	18.55 %	1,586	19.92 %
Fourth Quartile	36,450	18.82 %	2,458	18.73 %	2,504	18.24 %	2,503	18.77 %
Missings	8,245	25.18 %	562	23.75 %	565	25.62 %	566	23.69 %
Design Based Pearson χ^2:	0.921							

Table 3.C.17: Descriptive Statistics - Federal State aggregated, BHP 2020

	Mail-Web		Web-to-Mail		Web-Only		Mail-Only	
Federal State aggregated	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
Schleswig-Holstein + Hamburg	5,443	6.29 %	359	6.03 %	347	6.54 %	404	7.21 %
Lower Saxony + Bremen	8,914	10.10 %	613	9.55 %	621	10.22 %	600	8.58 %
North Rhine-Westphalia	17,877	20.28 %	1,227	21.13 %	1,196	18.56 %	1,158	19.93 %
Hesse	6,608	7.75 %	425	7.59 %	418	6.65 %	467	8.30 %
Rhineland-Palatinate + Saarland	4,727	6.12 %	330	4.35 %	329	5.06 %	329	5.06 %
Baden-Wuerttemberg	11,930	12.96 %	839	14.53 %	892	16.04 %	816	13.38 %
Bavaria	14,835	16.44 %	1,006	16.89 %	994	17.12 %	1,028	17.66 %
Brandenburg + Berlin	12,937	7.57 %	876	7.27 %	859	6.98 %	863	7.92 %
Mecklenburg-Vorpommern	3,695	2.25 %	244	2.32 %	268	2.22 %	268	2.08 %
Saxony	9,393	5.12 %	665	5.37 %	651	5.15 %	615	4.44 %
Saxony-Anhalt	4,538	2.55 %	291	2.30 %	317	2.61 %	333	2.64 %
Thuringia	4,791	2.56 %	337	2.67 %	327	2.85 %	338	2.80 %
Design Based Pearson χ^2:	0.615							

Table 3.C.18: Descriptive Statistics - Number of Employees, BHP 2020

	Mail-Web		Web-to-Mail		Web-Only		Mail-Only	
Number of Employees	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
1-9	26,089	70.14 %	1,757	70.20 %	1,793	69.54 %	1,804	69.73 %
10-19	21,956	14.72 %	1,496	14.64 %	1,469	15.02 %	1,472	15.16 %
20-49	26,687	9.28 %	1,830	9.20 %	1,836	9.62 %	1,841	9.29 %
50-249	21,905	5.03 %	1,517	5.09 %	1,508	5.02 %	1,492	5.02 %
≥250	9,051	0.83 %	612	0.87 %	613	0.81 %	610	0.80 %
Design Based Pearson χ^2:	0.986							

Table 3.C.19: Descriptive Statistics - Industry, BHP 2020

	Mail-Web		Web-to-Mail		Web-Only		Mail-Only	
Industry	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
Agric./Manufacturing	35,078	22.67 %	2,403	22.97 %	2,383	22.52 %	2,396	22.97 %
Service	48,761	54.88 %	3,315	53.95 %	3,325	54.45 %	3,325	54.10 %
Public/Educ./Health/Arts	21,849	22.46 %	1,493	23.08 %	1,511	23.03 %	1,498	22.93 %
Design Based Pearson χ^2:	0.996							

Table 3.C.20: Descriptive Statistics - East/West Germany, BHP 2020

	Mail-Web		Web-to-Mail		Web-Only		Mail-Only	
East/West Germany	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
East Germany	35,354	20.05 %	2,413	19.93 %	2,422	19.80 %	2,417	19.88 %
West Germany	70,334	79.95 %	4,799	80.07 %	4,797	80.20 %	4,802	80.12 %
Design Based Pearson χ^2:	0.994							

Table 3.C.21: Descriptive Statistics - Industry, BHP 2020

	Mail-Web		Web-to-Mail		Web-Only		Mail-Only	
Industry	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
Agriculture / Forestry	2,800	2.72 %	190	2.72 %	193	2.69 %	186	2.65 %
Mining / Ores / Earths	1,077	0.10 %	75	0.10 %	73	0.10 %	66	0.09 %
Nutrition / Textiles / Clothing / Furniture etc.	4,963	2.46 %	339	2.47 %	340	2.52 %	340	2.50 %
Wood / Paper / Printing	3,575	0.77 %	246	0.78 %	243	0.76 %	246	0.80 %
Chemistry / Plastics / Glass / Construction Materials	4,535	0.97 %	314	0.98 %	304	0.95 %	313	0.96 %
Metals / Metal Production	4,197	1.83 %	290	1.88 %	288	1.80 %	285	1.80 %
Machines / Electronics / Vehicles	5,106	2.10 %	351	2.16 %	344	2.07 %	348	2.12 %
Energy Utilities	2,212	0.32 %	150	0.32 %	147	0.32 %	152	0.32 %
Water / Waste Management	3,212	0.44 %	219	0.46 %	220	0.45 %	223	0.46 %
Construction	3,401	10.96 %	229	11.09 %	231	10.86 %	237	11.26 %
Trade / Retail / Car-Repair	6,349	19.24 %	433	19.33 %	424	18.52 %	424	18.40 %
Transport/ Warehouses	5,263	3.76 %	357	3.84 %	360	3.76 %	353	3.69 %
Hospitality	6,441	7.04 %	442	6.93 %	440	6.98 %	436	6.90 %
Information and Communication	6,808	3.00 %	460	2.94 %	472	3.26 %	458	3.06 %
Financial Services / Insurance	5,071	2.97 %	345	2.86 %	348	2.98 %	346	3.07 %
Real Estate	3,051	3.01 %	207	2.89 %	207	2.91 %	215	3.08 %
Liberal Professions / Scientific / Technical Services	4,896	9.91 %	331	9.30 %	335	10.05 %	329	9.74 %
Other Commercial Services/ Without Temporary Employment Agencies	6,178	1.88 %	411	1.61 %	424	2.09 %	444	1.98 %
Temporary Employment Agencies	4,704	4.07 %	329	4.26 %	315	3.89 %	320	4.17 %
Public Administration	4,284	1.37 %	293	1.42 %	294	1.38 %	297	1.40 %
Education / Child Care	4,966	2.96 %	337	3.10 %	337	2.90 %	349	3.10 %
Health / Social Services	4,910	10.82 %	331	11.02 %	345	11.21 %	335	11.23 %
Art / Entertainment / Recreation	3,888	1.68 %	273	1.73 %	273	1.76 %	265	1.64 %
Other Services	3,801	5.62 %	259	5.80 %	262	5.77 %	252	5.56 %
Design Based Pearson χ^2:	1.000							

3.D Response Rate

3.D.1 Formula

$$\text{Unit Response Rate} = \frac{R}{R+NR+O} \tag{3.6}$$

where R denotes the number of respondents, NR denotes the number of nonrespondents, and O denotes the number of all other sampled cases.

3.D.2 Additional Results

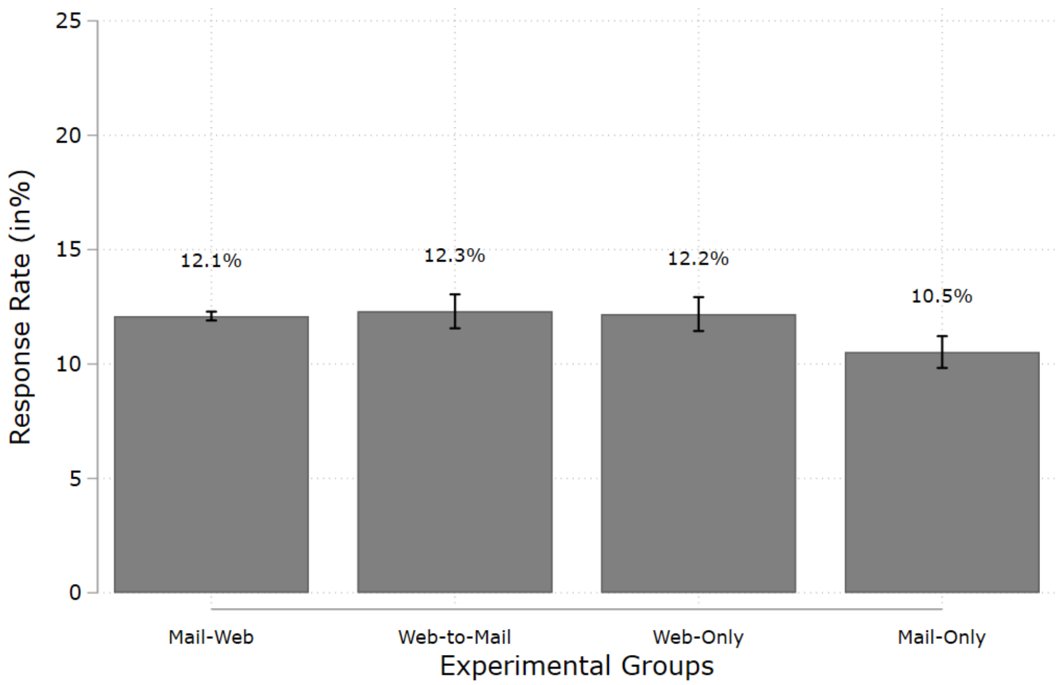


Figure 3.D.1: Response Rate (unweighted) and 95% Confidence Interval, by Mode Design. Source: IAB-JVS 2020

Table 3.D.1: Survey Response Summary Statistics, IAB-JVS 2020

	Mail-Web	Web-to-Mail	Web-Only	Mail-Only	Total
Full Sample	109,924	7,510	7,493	7,506	132,433
Post-Due-Date Reminder	99,553	6,961	6,959	6,787	120,260
Respondents	13,298	924	913	790	15,925
Web Respondents	5,305	606	913	0	6,824
Mail Respondents	7,993	318	0	790	9,101
Final Response Rate (unweighted)	12.1 (11.9 - 12.3)	12.3 (11.6 - 13.0)	12.2 (11.4 - 12.9)	10.5 (9.8 - 11.2)	12.0 (11.8 - 12.2)
Final Response Rate (weighted)	15.0 (14.5 - 15.5)	14.5 (12.5 - 16.4)	14.6 (12.6 - 16.6)	13.5 (11.6 - 15.5)	14.4 (13.5 - 15.3)
Final Web Take-Up Rate (unweighted)	4.8 (4.7 - 5.0)	8.1 (7.5 - 8.7)	12.2 (11.4 - 12.9)	0.0 (. - .)	5.2 (5.0 - 5.3)
Final Web Take-Up Rate (weighted)	4.9 (4.6 - 5.2)	7.9 (6.5 - 9.4)	14.6 (12.6 - 16.6)	0.0 (. - .)	6.9 (6.2 - 7.5)
Final Mail Take-Up Rate (unweighted)	7.3 (7.1 - 7.4)	4.2 (3.8 - 4.7)	0.0 (. - .)	10.5 (9.8 - 11.2)	6.9 (6.7 - 7.0)
Final Mail Take-Up Rate (weighted)	10.1 (9.7 - 10.6)	6.5 (5.1 - 7.9)	0.0 (. - .)	13.5 (11.6 - 15.5)	7.5 (6.9 - 8.2)

Notes: Confidence Intervals in Parentheses

3.E Nonresponse Bias

3.E.1 Average Absolute Nonresponse Bias

Table 3.E.1: Average Absolute Nonresponse Bias Estimates and 95 % Confidence Interval by Experimental Group, All Administrative Variables BHP 2020

Experimental Group	Estimate	Upper Bound	Lower Bound
Mail-Web (conc. MM)	2.561	3.348	1.774
Web-to-Mail (seq. MM)	2.265	2.978	1.553
Web-Only	2.203	3.085	1.321
Mail-Only	2.554	3.513	1.595

Table 3.E.2: Average Absolute Nonresponse Bias Estimates and 95% Confidence Interval by Experimental Group, Establishment Characteristics BHP 2020

Experimental Group	Estimate	Upper Bound	Lower Bound
Mail-Web (conc. MM)	2.707	3.967	1.448
Web-to-Mail (seq. MM)	2.631	3.989	1.273
Web-Only	1.396	2.632	0.160
Mail-Only	3.166	4.556	1.776

Table 3.E.3: Average Absolute Nonresponse Bias Estimates and 95% Confidence Interval by Experimental Group, Employee Characteristics BHP 2020

Experimental Group	Estimate	Upper Bound	Lower Bound
Mail-Web (conc. MM)	2.521	3.420	1.621
Web-to-Mail (seq. MM)	2.163	3.001	1.326
Web-Only	2.428	3.474	1.381
Mail-Only	2.383	3.550	1.217

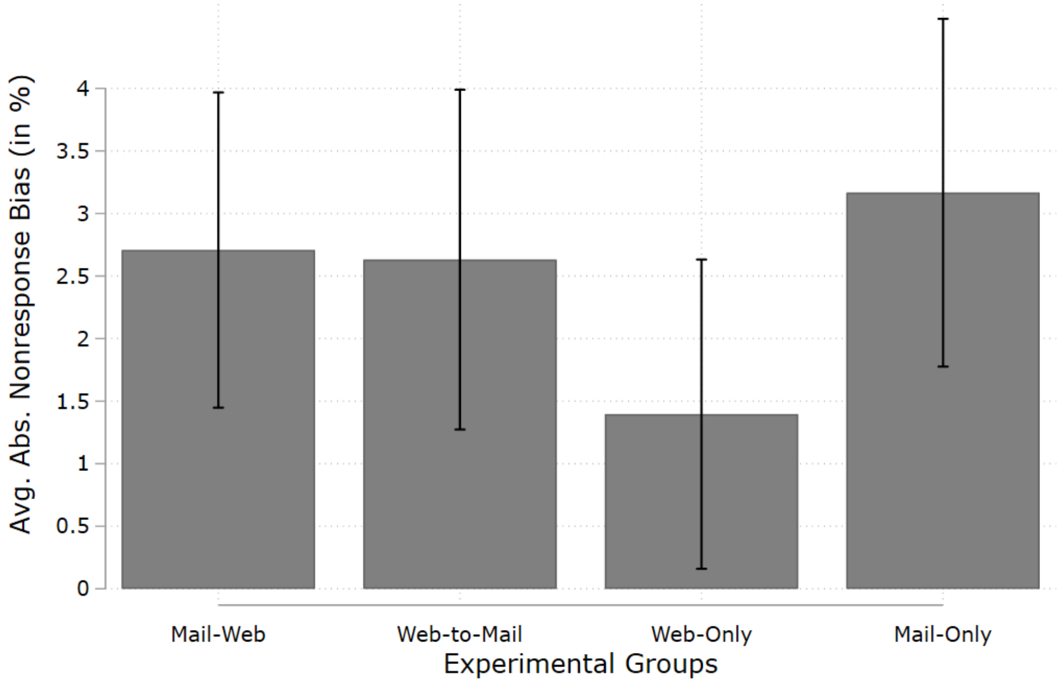


Figure 3.E.1: Average Absolute Nonresponse Bias Estimates and 95% Confidence Interval by Experimental Group, Establishment Characteristics BHP 2020

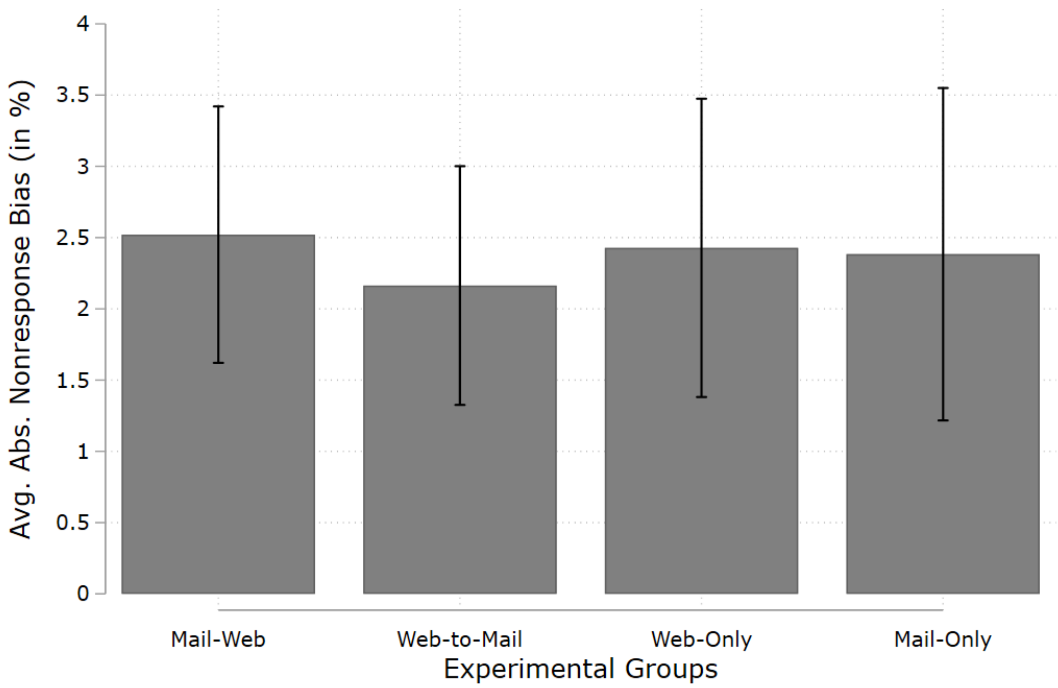


Figure 3.E.2: Average Absolute Nonresponse Bias Estimates and 95% Confidence Interval by Experimental Group, Employee Characteristics BHP

3.E.2 Median Absolute Nonresponse Biases

Table 3.E.4: Median Absolute Nonresponse Bias Estimates and 95% Confidence Interval by Experimental Group, All Administrative Variables BHP 2020

Experimental Group	Estimate	Upper Bound	Lower Bound
Mail-Web (conc. MM)	2.063	2.829	1.297
Web-to-Mail (seq. MM)	1.491	2.344	0.639
Web-Only	1.763	2.694	0.832
Mail-Only	2.282	3.287	1.277

Table 3.E.5: Median Absolute Nonresponse Bias Estimates and 95% Confidence Interval by Experimental Group, Establishment Characteristics BHP 2020

Experimental Group	Estimate	Upper Bound	Lower Bound
Mail-Web (conc. MM)	2.136	3.355	0.917
Web-to-Mail (seq. MM)	1.576	3.095	0.057
Web-Only	1.449	2.778	0.121
Mail-Only	2.181	3.594	0.768

Table 3.E.6: Median Absolute Nonresponse Bias Estimates and 95 % Confidence Interval by Experimental Group, Employee Characteristics BHP 2020

Experimental Group	Estimate	Upper Bound	Lower Bound
Mail-Web (conc. MM)	2.068	2.961	1.175
Web-to-Mail (seq. MM)	1.491	2.497	0.486
Web-Only	2.256	3.405	1.107
Mail-Only	2.313	3.537	1.090

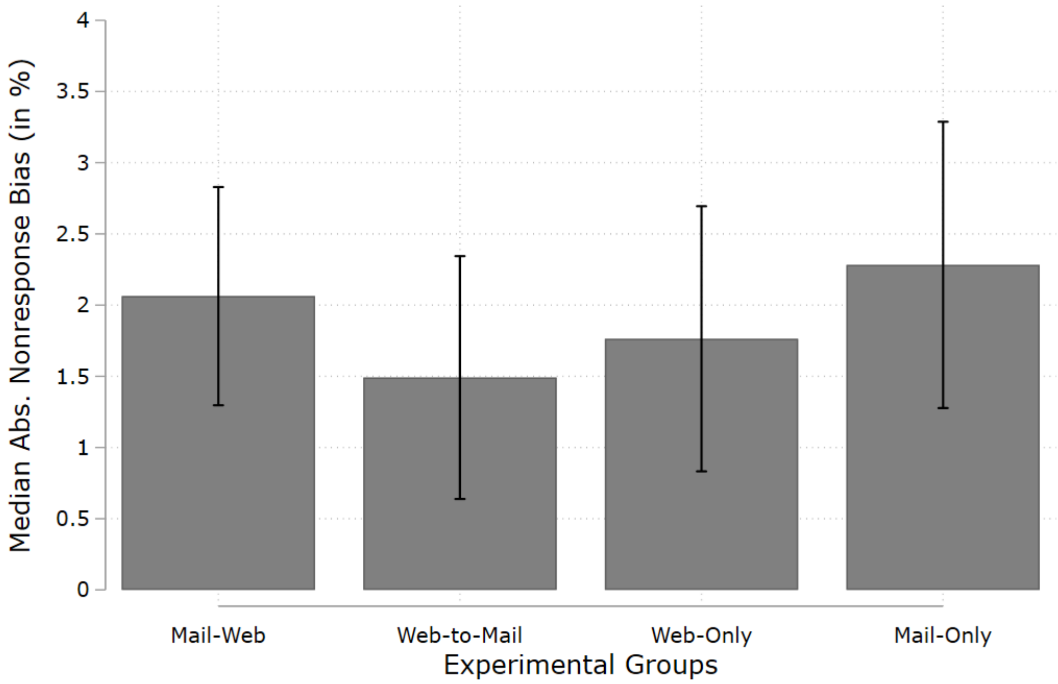
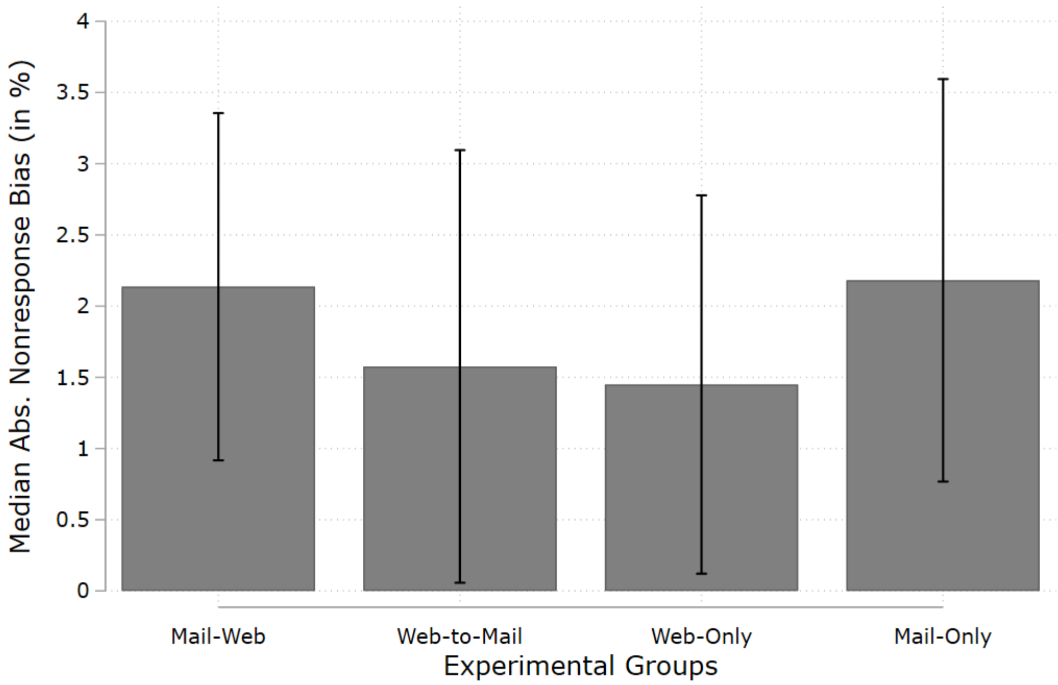


Figure 3.E.3: Median Absolute Nonresponse Bias Estimates and 95% Confidence Interval, by Mode Design, for All BHP Administrative Variables.



Notes: Estimate for the lower bound of the confidence interval of the Web-to-Mail bottom-coded to zero.

Figure 3.E.4: Median Absolute Nonresponse Bias Estimates and 95% Confidence Interval, by Mode Design, for Establishment Characteristics BHP Administrative Variables.

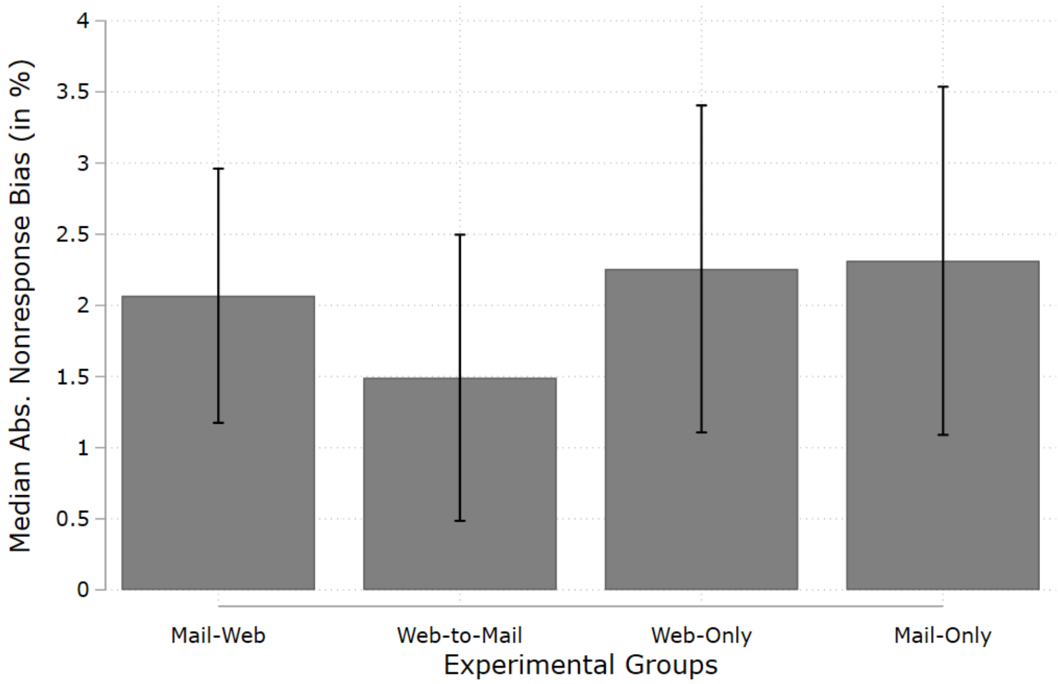


Figure 3.E.5: Median Absolute Nonresponse Bias Estimates and 95% Confidence Interval, by Mode Design, for Employee Characteristics BHP Administrative Variables.

3.E.3 Individual Nonresponse Biases

Table 3.E.7: Nonresponse Bias Estimates and 95% Confidence Interval of East/West Germany by Experimental Group, IAB-JVS 2020

	Mail-Web	Web-to-Mail	Web-Only	Mail-Only
East Germany (Ref.: West Germany)				
Estimate	0.000	1.205	-2.510	-0.449
Upper Bound	4.183	5.894	1.608	4.359
Lower Bound	-4.182	-3.483	-6.628	-5.257

Table 3.E.8: Nonresponse Bias Estimates and 95% Confidence Interval of Industry by Experimental Group, IAB-JVS 2020

	Mail-Web	Web-to-Mail	Web-Only	Mail-Only
Agric./Manufacturing				
Estimate	2.885	1.346	1.393	1.981
Upper Bound	8.233	6.757	6.536	7.686
Lower Bound	-2.464	-4.066	-3.751	-3.725
Service				
Estimate	-5.315	-7.943	-1.793	-2.080
Upper Bound	0.892	-1.117	5.137	5.182
Lower Bound	-11.521	-14.768	-8.723	-9.342
Public/Educ./Health/Arts				
Estimate	2.430	6.597	0.400	0.099
Upper Bound	8.053	12.681	6.246	6.237
Lower Bound	-3.192	0.513	-5.446	-6.039

Table 3.E.9: Nonresponse Bias Estimates and 95% Confidence Interval of Number of Employees by Experimental Group, IAB-JVS 2020

	Mail-Web	Web-to-Mail	Web-Only	Mail-Only
1-9				
Estimate	2.673	3.402	2.532	7.253
Upper Bound	7.314	7.644	7.296	11.791
Lower Bound	-1.968	-0.841	-2.232	2.714
10-19				
Estimate	0.074	-1.787	-1.506	-2.877
Upper Bound	4.081	1.527	2.127	0.897
Lower Bound	-3.933	-5.102	-5.138	-6.651
20-49				
Estimate	-1.037	-0.665	0.569	-1.905
Upper Bound	0.616	1.056	2.720	-0.259
Lower Bound	-2.691	-2.386	-1.581	-3.552
≥50				
Estimate	-1.709	-0.950	-1.595	-2.470
Upper Bound	-0.838	0.128	-0.626	-1.579
Lower Bound	-2.581	-2.027	-2.564	-3.361

Table 3.E.10: Nonresponse Bias Estimates and 95% Confidence Interval of Foundation Year by Experimental Group, IAB-JVS 2020

	Mail-Web	Web-to-Mail	Web-Only	Mail-Only
70s/80s				
Estimate	2.063	1.365	0.938	-0.321
Upper Bound	6.966	6.354	5.572	4.622
Lower Bound	-2.840	-3.624	-3.696	-5.264
90s				
Estimate	1.995	2.474	-1.763	7.155
Upper Bound	7.394	7.903	2.901	13.501
Lower Bound	-3.404	-2.955	-6.427	0.809
00s				
Estimate	-1.133	-2.757	1.288	2.282
Upper Bound	4.504	2.971	7.530	8.537
Lower Bound	-6.769	-8.485	-4.953	-3.973
10s				
Estimate	-2.925	-1.083	-0.463	-9.116
Upper Bound	3.579	5.542	6.456	-2.729
Lower Bound	-9.429	-7.708	-7.382	-15.503

Table 3.E.11: Nonresponse Bias Estimates and 95% Confidence Interval of Quartile of Wage Distribution by Experimental Group, IAB-JVS 2020

	Mail-Web	Web-to-Mail	Web-Only	Mail-Only
First Quartile				
Estimate	-0.945	-2.191	-1.625	-1.916
Upper Bound	3.853	3.057	3.866	3.333
Lower Bound	-5.742	-7.440	-7.116	-7.165
Second Quartile				
Estimate	0.990	4.880	0.847	-2.313
Upper Bound	6.202	11.035	6.224	2.699
Lower Bound	-4.223	-1.276	-4.529	-7.326
Third Quartile				
Estimate	1.209	1.138	5.080	1.802
Upper Bound	6.382	6.207	10.525	8.066
Lower Bound	-3.965	-3.932	-0.366	-4.463
Fourth Quartile				
Estimate	-1.309	-0.460	-4.529	-0.186
Upper Bound	2.985	3.998	-0.652	5.338
Lower Bound	-5.603	-4.918	-8.407	-5.711
Missings				
Estimate	0.055	-3.366	0.227	2.614
Upper Bound	5.989	2.393	6.727	9.008
Lower Bound	-5.878	-9.125	-6.273	-3.780

Table 3.E.12: Nonresponse Bias Estimates and 95% Confidence Interval of Avg. Age of Employees by Experimental Group, IAB-JVS 2020

	Mail-Web	Web-to-Mail	Web-Only	Mail-Only
0.00-38.99				
Estimate	-1.971	-5.144	-2.715	3.106
Upper Bound	4.168	0.931	3.497	9.850
Lower Bound	-8.111	-11.219	-8.927	-3.638
39.00-43.49				
Estimate	-1.337	0.245	-2.779	-0.874
Upper Bound	3.299	5.082	1.850	4.724
Lower Bound	-5.972	-4.592	-7.409	-6.472
43.50-47.99				
Estimate	0.795	0.669	2.206	-0.223
Upper Bound	6.065	6.119	8.136	4.874
Lower Bound	-4.475	-4.781	-3.723	-5.320
≥48.00				
Estimate	2.513	4.230	3.288	-2.009
Upper Bound	8.879	10.921	9.997	5.038
Lower Bound	-3.853	-2.460	-3.420	-9.056

Table 3.E.13: Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of Female Employees by Experimental Group, IAB-JVS 2020

	Mail-Web	Web-to-Mail	Web-Only	Mail-Only
0.00 - 18.18				
Estimate	-0.664	-4.374	-0.736	-3.877
Upper Bound	5.124	0.267	4.570	1.848
Lower Bound	-6.451	-9.015	-6.042	-9.602
18.19 - 40.97				
Estimate	0.506	2.861	0.426	3.254
Upper Bound	4.982	8.475	5.449	8.822
Lower Bound	-3.971	-2.753	-4.597	-2.314
40.98 - 67.12				
Estimate	-0.443	1.751	-3.314	0.267
Upper Bound	4.778	6.668	1.847	5.907
Lower Bound	-5.664	-3.166	-8.476	-5.374
>67.13				
Estimate	0.601	-0.238	3.624	0.357
Upper Bound	7.084	6.411	10.691	7.073
Lower Bound	-5.883	-6.886	-3.442	-6.360

Table 3.E.14: Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of Fixed-Term Contracts by Experimental Group, IAB-JVS 2020

	Mail-Web	Web-to-Mail	Web-Only	Mail-Only
0.00				
Estimate	2.820	1.837	4.355	-2.255
Upper Bound	8.605	7.572	10.540	4.500
Lower Bound	-2.965	-3.898	-1.830	-9.009
0.01 - 15.99				
Estimate	-0.565	-0.164	-1.792	-1.156
Upper Bound	2.708	2.639	1.793	2.605
Lower Bound	-3.839	-2.968	-5.376	-4.918
≥16.00				
Estimate	-2.255	-1.673	-2.564	3.411
Upper Bound	2.632	3.513	2.565	9.723
Lower Bound	-7.142	-6.859	-7.692	-2.902

Table 3.E.15: Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of Apprentices by Experimental Group, IAB-JVS 2020

	Mail-Web	Web-to-Mail	Web-Only	Mail-Only
0.00 (Ref.: 0.01-100)				
Estimate	0.509	-0.724	-0.482	-2.428
Upper Bound	5.043	4.285	3.938	3.364
Lower Bound	-4.024	-5.733	-4.902	-8.220

Table 3.E.16: Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of Full-Time Contracts by Experimental Group, IAB-JVS 2020

	Mail-Web	Web-to-Mail	Web-Only	Mail-Only
0.00 - 36.38				
Estimate	-1.256	-2.586	-2.929	3.209
Upper Bound	5.313	3.906	4.236	10.179
Lower Bound	-7.825	-9.079	-10.094	-3.762
36.39 - 66.66				
Estimate	2.209	-2.490	3.793	2.383
Upper Bound	7.712	1.954	9.602	8.471
Lower Bound	-3.295	-6.934	-2.017	-3.704
66.67 - 85.28				
Estimate	0.481	3.994	0.806	-1.803
Upper Bound	4.584	8.763	5.245	2.428
Lower Bound	-3.622	-0.774	-3.633	-6.034
>85.29				
Estimate	-1.433	1.082	-1.669	-3.789
Upper Bound	3.371	6.417	3.311	0.713
Lower Bound	-6.237	-4.253	-6.650	-8.291

Table 3.E.17: Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of Part-Time Contracts by Experimental Group, IAB-JVS 2020

	Mail-Web	Web-to-Mail	Web-Only	Mail-Only
0.00				
Estimate	0.848	0.893	1.060	-0.470
Upper Bound	7.193	7.406	7.849	6.198
Lower Bound	-5.497	-5.620	-5.730	-7.139
0.01 - 19.99				
Estimate	-0.531	-0.423	-1.511	-1.580
Upper Bound	3.216	2.578	2.445	2.255
Lower Bound	-4.278	-3.424	-5.466	-5.414
≥20.00				
Estimate	-0.317	-0.470	0.451	2.050
Upper Bound	6.372	5.979	7.326	8.912
Lower Bound	-7.006	-6.919	-6.424	-4.812

Table 3.E.18: Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of German Citizens by Experimental Group, IAB-JVS 2020

	Mail-Web	Web-to-Mail	Web-Only	Mail-Only
100.00 (Ref.: 0.00-99.99)				
Estimate	3.882	2.858	3.827	3.989
Upper Bound	10.038	8.861	9.901	10.508
Lower Bound	-2.274	-3.146	-2.247	-2.530

Table 3.E.19: Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of Regular Contracts by Experimental Group, IAB-JVS 2020

	Mail-Web	Web-to-Mail	Web-Only	Mail-Only
0.00 - 75.00				
Estimate	0.959	-2.933	-1.705	5.048
Upper Bound	7.971	4.127	5.239	11.992
Lower Bound	-6.054	-9.993	-8.650	-1.897
75.01 - 88.88				
Estimate	0.555	3.565	-0.706	0.625
Upper Bound	4.397	8.360	3.096	5.161
Lower Bound	-3.288	-1.231	-4.508	-3.912
88.89 - 97.43				
Estimate	-0.848	0.002	-0.298	-1.024
Upper Bound	0.726	1.785	1.954	0.627
Lower Bound	-2.422	-1.781	-2.551	-2.675
>97.44				
Estimate	-0.665	-0.633	2.710	-4.648
Upper Bound	5.961	6.098	9.384	1.987
Lower Bound	-7.291	-7.364	-3.964	-11.284

Table 3.E.20: Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of Marginal Contracts by Experimental Group, IAB-JVS 2020

	Mail-Web	Web-to-Mail	Web-Only	Mail-Only
0.00				
Estimate	-0.833	-1.491	4.592	-2.388
Upper Bound	6.241	5.223	11.630	4.620
Lower Bound	-7.907	-8.206	-2.447	-9.396
0.00-14.99				
Estimate	-0.181	0.574	0.940	-1.199
Upper Bound	2.784	3.535	4.772	2.042
Lower Bound	-3.146	-2.387	-2.893	-4.440
≥15.00				
Estimate	1.014	0.917	-5.531	3.587
Upper Bound	8.096	7.935	1.321	10.682
Lower Bound	-6.068	-6.101	-12.384	-3.507

Table 3.E.21: Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of High-Educated Employees by Experimental Group, IAB-JVS 2020

	Mail-Web	Web-to-Mail	Web-Only	Mail-Only
0.00				
Estimate	0.015	-5.301	-1.428	-3.660
Upper Bound	6.299	1.232	5.531	3.583
Lower Bound	-6.269	-11.835	-8.386	-10.903
0.01 - 14.99				
Estimate	-1.846	-1.283	-2.256	-2.745
Upper Bound	1.217	1.986	1.171	0.848
Lower Bound	-4.908	-4.552	-5.683	-6.338
≥15.00				
Estimate	1.831	6.584	3.684	6.406
Upper Bound	7.815	12.799	9.992	13.138
Lower Bound	-4.154	0.370	-2.625	-0.327

Table 3.E.22: Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of Mid-Educated Employees by Experimental Group, IAB-JVS 2020

	Mail-Web	Web-to-Mail	Web-Only	Mail-Only
0.00 - 50.00				
Estimate	-1.808	-3.141	-2.488	5.407
Upper Bound	4.294	2.219	4.006	12.373
Lower Bound	-7.910	-8.500	-8.981	-1.559
50.01 - 70.58				
Estimate	-1.386	0.490	-0.608	1.141
Upper Bound	2.998	5.254	4.673	6.870
Lower Bound	-5.769	-4.274	-5.889	-4.588
70.59 - 84.99				
Estimate	0.612	1.701	1.737	-5.419
Upper Bound	5.248	7.142	6.073	-1.464
Lower Bound	-4.024	-3.741	-2.599	-9.373
>85.00				
Estimate	2.581	0.950	1.358	-1.129
Upper Bound	9.116	7.853	8.539	5.960
Lower Bound	-3.953	-5.952	-5.822	-8.218

Table 3.E.23: Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of Low-Educated Employees by Experimental Group, IAB-JVS 2020

	Mail-Web	Web-to-Mail	Web-Only	Mail-Only
0.00				
Estimate	4.412	0.415	4.329	3.307
Upper Bound	10.571	7.108	10.900	10.236
Lower Bound	-1.748	-6.279	-2.241	-3.623
0.01 - 11.99				
Estimate	-1.164	0.810	2.334	-3.157
Upper Bound	1.480	3.775	5.682	-0.998
Lower Bound	-3.809	-2.156	-1.013	-5.315
≥12.00				
Estimate	-3.248	-1.224	-6.663	-0.150
Upper Bound	2.623	5.099	-0.731	6.862
Lower Bound	-9.118	-7.547	-12.596	-7.162

Table 3.E.24: Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of Unknown-Educated Employees by Experimental Group, IAB-JVS 2020

	Mail-Web	Web-to-Mail	Web-Only	Mail-Only
0.00 (Ref.: 0.01-100.00)				
Estimate	3.645	10.271	4.394	0.125
Upper Bound	9.304	14.603	9.299	6.442
Lower Bound	-2.015	5.938	-0.511	-6.191

3.F Survey Participation

Table 3.F.1: Results of Logistic Regression on Response in the Single-Mode Designs

	Survey Participation Model	
DV: Response to the Survey		
Industry (Ref.: Manufacturing)	ref.	
Agriculture/Forestry	1.689	(0.607)
Mining/Energy/Waste	0.720	(0.160)
Construction	0.985	(0.325)
Trade/Car-Repair	0.712	(0.224)
Transportation/Storage	1.649	(0.421)
Information/Communication	0.704	(0.214)
Finance/Insurance	0.929	(0.299)
Business-Related Services	1.140	(0.262)
Other Services	0.932	(0.184)
Public Administration	0.813	(0.227)
Web	1.174	(0.335)
Industry (Ref.: Manufacturing) × Web	ref.	
Agriculture/Forestry × Web	0.393	(0.215)
Mining/Energy/Waste × Web	1.043	(0.322)
Construction × Web	0.937	(0.410)
Trade/Car-Repair × Web	1.051	(0.450)
Transportation/Storage × Web	0.548	(0.204)
Information/Communication × Web	0.679	(0.297)
Finance/Insurance × Web	0.280*	(0.160)
Business-Related Services × Web	0.883	(0.280)
Other Services × Web	0.921	(0.243)
Public Administration × Web	1.161	(0.418)
Number of Employees (Ref.: 1-9)	ref.	
10-19	0.691	(0.153)
20-49	0.666**	(0.101)
50-249	0.470***	(0.081)
≥250	0.228***	(0.053)
Number of Employees (Ref.: 1-9) × Web	ref.	
10-19 × Web	1.194	(0.354)
20-49 × Web	1.494	(0.319)
50-249 × Web	1.496	(0.344)
≥250 × Web	1.012	(0.331)
Decade of Foundation (Ref.: 70s/80s)	ref.	
90s	1.309	(0.345)
00s	1.003	(0.267)
10s	0.634	(0.168)
Decade of Foundation (Ref.: 70s/80s) × Web	ref.	
90s × Web	0.621	(0.215)
00s × Web	0.958	(0.339)
10s × Web	1.425	(0.498)
Constant	0.206***	(0.044)
Observations	14,438	
Goodness-of-Fit Test	Prob > F	0.9173

Exponentiated coefficients; Standard errors in parentheses; * p<0.05, ** p<0.01, *** p<0.001

Table 3.F.2: Predicted Probabilities and First Differences based on Multinominal Regression on Participation in the Single-Mode Designs

	Pr(Response)	SE	P-Value	First Difference	SE	P-Value
Industry						
Agriculture/Forestry, Mail	0.213	(0.058)	0.000	0.213-0.122 = 0.091	0.071	0.201
Agriculture/Forestry, Web	0.122	(0.042)	0.004			
Mining/Energy/Waste, Mail	0.103	(0.018)	0.000	0.103-0.136 = -0.032	0.028	0.249
Mining/Energy/Waste, Web	0.136	(0.022)	0.000			
Manufacturing, Mail	0.138	(0.015)	0.000	0.138-0.173 = -0.035	0.022	0.113
Manufacturing, Web	0.173	(0.016)	0.000			
Construction, Mail	0.136	(0.036)	0.000	0.136-0.162 = -0.025	0.051	0.619
Construction, Web	0.162	(0.036)	0.000			
Trade/Car-Repair, Mail	0.102	(0.027)	0.000	0.102-0.135 = -0.033	0.042	0.437
Trade/Car-Repair, Web	0.135	(0.032)	0.000			
Transportation/Storage, Mail	0.209	(0.037)	0.000	0.209-0.159 = 0.050	0.049	0.311
Transportation/Storage, Web	0.159	(0.033)	0.000			
Information/Communication, Mail	0.101	(0.025)	0.000	0.101-0.091 = 0.011	0.035	0.761
Information/Communication, Web	0.091	(0.024)	0.000			
Finance/Insurance, Mail	0.129	(0.034)	0.000	0.129-0.051 = 0.078	0.041	0.056
Finance/Insurance, Web	0.051	(0.022)	0.022			
Business-Related Services, Mail	0.154	(0.025)	0.000	0.154-0.174 = -0.019	0.037	0.600
Business-Related Services, Web	0.174	(0.027)	0.000			
Other Services, Mail	0.130	(0.018)	0.000	0.130-0.152 = -0.022	0.026	0.390
Other Services, Web	0.152	(0.018)	0.000			
Public Administration, Mail	0.115	(0.027)	0.000	0.115-0.165 = -0.050	0.039	0.209
Public Administration, Web	0.165	(0.029)	0.000			
Number of Employees						
1-9 Employees, Mail	0.150	(0.014)	0.000	0.150-0.155 = -0.005	0.020	0.799
1-9 Employees, Web	0.155	(0.014)	0.000			
10-19 Employees, Mail	0.109	(0.018)	0.000	0.109-0.132 = -0.023	0.026	0.380
10-19 Employees, Web	0.132	(0.018)	0.000			
20-49 Employees, Mail	0.105	(0.011)	0.000	0.105-0.154 = -0.049	0.018	0.005
20-49 Employees, Web	0.154	(0.014)	0.000			
50-249 Employees, Mail	0.077	(0.010)	0.000	0.077-0.114 = -0.038	0.016	0.017
50-249 Employees, Web	0.114	(0.012)	0.000			
≥250 Employees, Mail	0.039	(0.008)	0.000	0.039-0.041 = -0.002	0.012	0.864
≥250 Employees, Web	0.041	(0.008)	0.000			

Table 3.F.3: Results of Multinominal Logistic Regression on Response in the Concurrent Mail-Web Mixed-Mode

	Web Response	Paper Response
Industry (Ref.: Manufacturing)	ref.	ref.
Agriculture/Forestry	1.040	1.242*
	(0.168)	(0.135)
Mining/Energy/Waste	0.926	0.730***
	(0.075)	(0.051)
Construction	0.915	1.189
	(0.119)	(0.105)
Trade/Car-Repair	0.635***	0.732***
	(0.079)	(0.069)
Transportation/Storage	0.808	0.980
	(0.090)	(0.083)
Information/Communication	1.264*	0.581***
	(0.121)	(0.056)
Finance/Insurance	0.938	0.648***
	(0.121)	(0.072)
Business-Related Services	1.061	1.007
	(0.092)	(0.071)
Other Services	0.847*	1.066
	(0.064)	(0.061)
Public Administration	1.456***	0.790**
	(0.119)	(0.064)
Number of Employees (Ref.:1-9)	ref.	ref.
10-19	0.986	0.932
	(0.077)	(0.061)
20-49	1.023	0.690***
	(0.065)	(0.034)
50-249	0.910	0.532***
	(0.058)	(0.029)
≥250	0.378***	0.229***
	(0.033)	(0.020)
Decade of Foundation (Ref.: 70s/80s)	ref.	ref.
90s	0.843	0.990
	(0.086)	(0.079)
00s	0.735**	0.825*
	(0.076)	(0.066)
10s	0.819*	0.717***
	(0.080)	(0.056)
Constant	0.081***	0.164***
	(0.006)	(0.011)
Observations	105,688	
Goodness-of-Fit Test Prob > F	0.000	0.000

Exponentiated coefficients; Standard errors in parentheses; * p<0.05, ** p<0.01, *** p<0.001

Table 3.F.4: Predicted Probabilities and First Differences based on Logistic Regression on Participation in the Concurrent Mail-Web Mixed-Mode Designs

	Pr(Response)	SE	P-Value	First Difference	SE	P-Value
Industry						
Agriculture/Forestry, Mail	0.128	(0.012)	0.000	0.128-0.057 = 0.071	0.015	0.000
Agriculture/Forestry, Web	0.057	(0.008)	0.000			
Mining/Energy/Waste, Mail	0.080	(0.004)	0.000	0.080-0.054 = 0.026	0.006	0.000
Mining/Energy/Waste, Web	0.054	(0.004)	0.000			
Manufacturing, Mail	0.106	(0.003)	0.000	0.106-0.056 = 0.050	0.004	0.000
Manufacturing, Web	0.056	(0.002)	0.000			
Construction, Mail	0.124	(0.009)	0.000	0.124-0.050 = 0.073	0.011	0.000
Construction, Web	0.050	(0.006)	0.000			
Trade/Car-Repair, Mail	0.081	(0.007)	0.000	0.081-0.037 = 0.044	0.008	0.000
Trade/Car-Repair, Web	0.037	(0.004)	0.000			
Transportation/Storage, Mail	0.105	(0.007)	0.000	0.105-0.046 = 0.059	0.009	0.000
Transportation/Storage, Web	0.046	(0.005)	0.000			
Information/Communication, Mail	0.063	(0.005)	0.000	0.063-0.073 = -0.010	0.008	0.226
Information/Communication, Web	0.073	(0.006)	0.000			
Finance/Insurance, Mail	0.071	(0.007)	0.000	0.071-0.055 = 0.017	0.010	0.088
Finance/Insurance, Web	0.055	(0.006)	0.000			
Business-Related Services, Mail	0.106	(0.006)	0.000	0.106-0.059 = 0.047	0.007	0.000
Business-Related Services, Web	0.059	(0.004)	0.000			
Other Services, Mail	0.113	(0.004)	0.000	0.113-0.047 = 0.065	0.006	0.000
Other Services, Web	0.047	(0.003)	0.000			
Public Administration, Mail	0.083	(0.006)	0.000	0.083-0.081 = 0.002	0.008	0.822
Public Administration, Web	0.081	(0.006)	0.000			
Number of Employees						
1-9 Employees, Mail	0.110	(0.003)	0.000	0.110-0.050 = 0.060	0.004	0.000
1-9 Employees, Web	0.050	(0.002)	0.000			
10-19 Employees, Mail	0.103	(0.005)	0.000	0.103-0.050 = 0.054	0.006	0.000
10-19 Employees, Web	0.050	(0.003)	0.000			
20-49 Employees, Mail	0.078	(0.003)	0.000	0.078-0.053 = 0.026	0.004	0.000
20-49 Employees, Web	0.053	(0.002)	0.000			
50-249 Employees, Mail	0.062	(0.003)	0.000	0.062-0.048 = 0.014	0.003	0.000
50-249 Employees, Web	0.048	(0.002)	0.000			
≥250 Employees, Mail	0.028	(0.002)	0.000	0.028-0.021 = 0.007	0.003	0.012
≥250 Employees, Web	0.021	(0.002)	0.000			

3.G Costs

Table 3.G.1: Mode related costs that could not be quantified in this paper

Web	**Mail**
Unique Costs for Web and Mail	
– Developing or acquisition of web survey program	– Designing the layout of the mail questionnaire
– Programming the web questionnaire	– Review of the mail questionnaire
– Testing the web questionnaire	– Coordination of printage and mailing
	– Programming the data entry software
	– Testing the data entry software
	– Training the data entry personnel
	– Disposal of completed questionnaires
Similar Costs for Web and Mail	
– Question development	– Question development
– Conducting pretests	– Conducting pretests
– Data privacy management	– Data privacy management
– Field management	– Field management
– Data processing	– Data processing
– Scientific personnel	– Scientific personnel

Table 3.G.2: Detailed Survey Costs by Experimental Group

	Mail-Web	Web-to-Mail	Only-Web	Only-Mail
Invitations	109,924	7,510	7,493	7,506
Post-Due-Date Reminder	99,553	6,961	6,959	6,787
Mail Respondents	7,993	318	0	790
Web Respondents	5,305	606	913	0
Postage Invitation	170,382.20 €	6,008.00 €	5,994.40 €	11,634.30 €
Print Invitation	21,984.80 €	600.80 €	599.44 €	1,501.20 €
Postage Post-Due-Date Reminder	154,307.15 €	10,789.55 €	5,566.20 €	10,519.85 €
Print Post-Due-Date Reminder	19,910.60 €	1,392.20 €	567.72 €	1,357.40 €
Re-Postage Mail	12,389.15 €	492.90 €	0.00 €	1,224.50 €
Data Entry Mail	15,861.11 €	631.03 €	0.00 €	1,567.66 €
Data Entry Web	0.00 €	0.00 €	0.00 €	0.00 €
Total Costs	*394,835.01 €*	*19,914.48 €*	*12,717.76 €*	*27,804.91 €*
Costs per Sampeld Unit	*3.59 €*	*2.65 €*	*1.70 €*	*3.70 €*
Costs per Respondent Unit	*29.69 €*	*21.55 €*	*13.93 €*	*35.20 €*

Notes: Postage Mail Package: 1.55 €; Postage Web Package: 0.80 €; Print Mail Package: 0.20 €; Print Web Package: 0.08 €; Re-Postage Mail Respondent: 1.55 €; Data Entry Mail Respondent: 1.98 €; Data Entry Web Respondent: 0.00 €;

3.H Qualitative Interviews

3.H.1 Short Interviews

The quantitative survey was later followed by short structured interviews conducted with responding establishments from the four experimental groups. The short structured interviews were designed to collect data about the mode preferences of establishments and the perceived advantages and disadvantages of the different mode designs. All interviews were recruited and conducted by interviewers from the Institute for Employment Research, who are experienced and trained to conduct such short structured interviews. The interviews were designed as a routine questionnaire pretest and conducted via telephone. At the end of this pretest, interviewers asked about the mode preferences of these establishments and their perceived advantages and disadvantages of web, mail, and telephone modes. As the focus of this article is on self-administered modes, respondents' answers about the telephone mode are not considered further. By asking the mode questions at the end of the interview, respondents were familiar with the type of questions asked in the IAB-JVS and could better answer the questions about mode. To analyze these interviews, we used an inductive approach to interpret and cluster the advantages and disadvantages into thematic categories.

3.H.2 In-Depth Interviews

To understand the impact of mode on response processes and the decision to participate, we conducted an additional twelve in-depth semi-structured interviews with establishments that were allocated to each of the four mode design experimental groups from the 2020 IAB-JVS. The interviewers of the short interviews carried out the recruiting for the in-depth interviews. Seven in-depth interviews were recruited based on the short interviews, where respondents were asked if they would participate in an additional interview about response processes. The other five in-depth interviews, mostly with nonrespondents, were recruited without a previous short interview. One or two human resource representatives or managers participated in each interview. All interviews were conducted via video or telephone, recorded, and fully transcribed with the participants' consent.

Table 3.H.1: Sample Characteristics for Short and In-Depth Qualitative Interviews

Characteristics	Short Interviews	In-Depth Interviews
Interview Mode		
– Telephone	46	3
– Video Telephone	0	9
2020 IAB-JVS-Experience		
– Respondents	46	8
– Nonrespondents	0	4
Experimental Group		
– Conc. Mixed-Mode (Mail-Web)	14	4
– Seq. Mixed-Mode (Web-to-Mail)	9	5
– Web	11	3
– Mail	12	4
Establishment Size		
– < 50 Employees	20	3
– 50-249 Employees	10	5
– ≥ 250 Employees	16	4
Industry		
– Agriculture/Production	23	5
– Service	15	3
– Public Administration/Health/Education	8	4
Region		
– East Germany	13	6
– West Germany	33	6
N	46	12

We coded the interviews using qualitative content analysis (Mayring, 2022) with the coding program MAXQDA (VERBI Software, 2021). In the first step, we coded an interview inductively in the research team. This was done independently in the first step to ensure the validity of the coding. After the first coding, the codes and codings were compared, discussed, and subsequently, a code tree was created, which served for the coding of the remaining interviews. Trained colleagues carried out the coding of the 12 in-depth interviews and we, the authors, validated these codings in a second coding run. In a further step, the interviews were interpreted hermeneutically in their entirety in relation to the research question in the team in order to reconstruct the respective case in its entirety (Kurt & Herbrik, 2014; Ronald, 2004; Soeffner, 1989). In a further step, we compared the thematic codes with each other to obtain answers to the mode preferences, their reasons, and the different response processes. All quotes listed were translated into English by the authors.

3.H.3 Quotes

Table 3.H.2: Quotes from the In-Depth Qualitative Interviews in Favor of Web

Number	*Keywords*	*Quote*	*Interview Partner*
Quote No.			
1	Effort; Overwhelming	Length is a deterrent, yes, of course. That means that if I have a twenty-page questionnaire somewhere, or if I suddenly find on the last page of the structural survey that I first have to enter forty employees, then you can of course imagine that the will to drop out suddenly increases very exponentially.	*Tax Consultant, Establishment with less than 50 employees*
2	Effort	Well, that it [the web questionnaire] would be faster and easier, easy in terms of effort...	*Owner, Establishment with less than 50 employees*
3	Flexibility	You can just organize it yourself. (...) Online I can say: O.k. I'll put that aside now and take it at 4:00 p.m. and work on it then.	*Establishment with more than 250 employees*
4	No Postal Return	So I think the general willingness to participate is generally higher with an online survey, because you simply save yourself the trouble of sending it back and so on.	*Tax Consultant, Establishment with less than 50 employees*
5	Internal Routing	But also - as I said - the internal back and forth, you're quicker at it [with web questionnaires]. And with that, there is also acceptance somewhere. Because anything that requires less effort within the company has great advantages in terms of getting results. So I can well imagine that in many companies something like this simply goes by the wayside because people don't feel like - in quotation marks - answering a paper questionnaire.	*HR-Manager, Establishment with more than 250 employees*
6	Faster; Less Deterrent	Yes, online just goes quickly. I say once, if I ... I log in, that's what I do [working with web applications] most of the time, the threshold to participate there is relatively low.	*Administrative employee, Establishment with less than 50 employees*

7	Faster; Handwriting Issues	No, actually [online] is much better for me than if I really still had to do it on paper or something, if you got a questionnaire by mail now, because first of all it's much faster online, secondly I always doubt that you can read my handwriting then.	*HR-Manager, Establishment with 50-249 employees*
8	Sustainability; Cost-Efficiency; Easier to handle	As I said [..] especially with the sustainability mindset that is overtaking us all, online is the most efficient, cost-effective and easiest method, also for you to evaluate.	*HR-Manager, Establishment more than 250 employees*
9	Easier to Handle; Modern	I think online access to enter my data makes more sense, it's easier to handle, you type in the data, and somewhere I think it's a bit more up-to-date than a paper version.	*HR-Manager, Establishment more than 250 employees*
10	Effort	The decisive thing is what impression I have, what effort the whole thing has, that's the decisive thing for me, yes. And if there, let's say, a thick letter comes (laughs), a pile, then I would put that aside, that's relatively easy [...]	*Owner, Establishment with less than 50 employees*
11	Modern	Yes, and it's [web questionnaire] more modern. In the end, I would also say that it is unusual - in quotation marks - for surveys to still be conducted on paper.	*HR-Manager, Establishment with more than 250 employees*
12	Easier to handle; Sustainable	Yes, first of all it [web questionnaire] has the advantage that you don't have a piece of paper lying around somewhere, but you have an access point that you open and enter the data, so I think that's a clean solution and paperless, of course, that makes a lot of sense, yes. But that's ... it's relatively easy to create, I think, such an online solution. So I think it makes sense that the less paper we have on the table here, (laughs) the better it is, I think, yes.	*HR-Manager, Establishment with more than 250 employees*
13	Less cumbersome	And accordingly, a click process like this is certainly more pleasant.	*Tax Consultant, Establishment with less than 50 employees*
14	Less cumbersome	then I would rather do it online than by mail, that's too cumbersome for me, yes, then I would have to send off another letter here [...] that's too much for me (laughs)	*Owner, Establishment with less than 50 employees*
15	Internal routine; Internal routing	Yes, that is our basic corporate strategy, as little paper as possible, everything online (...) So we've digitized most of the processes and move very little paper back and forth	*Manager, Establishment with 50-249 employees*

16	Internal routine; Costs	Well, you just change the medium. If you have paper, well, I don't think it's comfortable for you or for us. If I were in your shoes, I would try to generate a data pot, so to speak, that everybody feeds into. But if you are sending out papers, first of all, you have to do that with postage, that costs money. You have to print. You have to mail it out. Somebody has to sit down to do it. These are all steps that I would save if I were you	*HR-Manager, Establishment with more than 250 employees*

Table 3.H.3: Quotes from the In-Depth Qualitative Interviews in Favor of Mail

Number	*Keywords*	*Quote*	*Interview Partner*
Quote No.			
1	Personal Preference	I'm actually also more of a haptic person. I have to be able to take notes all the time, assess questions and answers, and think things through.	*HR-Manager, Establishment with more than 250 employees*
2	Documentation	In addition, I can make a copy of it - and I often do this, for example - and file it in our correspondence. And then I know that I can't do that with an online survey.	*Administrative employee, Establishment with less than 50 employees*
3	Documentation	The only advantage [of mail questionnaires] might actually have been, if I am not in the establishment and there are queries about the whole thing, then of course the colleagues can look and say: What did the <name of the interviewee> tick or give for information? Of course, these things are actually sent out in the online process. And if you hadn't had me today and had asked my colleague, she wouldn't have known at all: What did he tick? - or whatever. So this search is still better in paper form, of course, if you keep it. But good.	*HR-Manager, Establishment with 50-249 employees*
4	Personal Preference	I would probably even opt for the mail variant if it was a checkbox variant or if there was little text to fill in. I'm still, well, probably a bit old school in that respect. I like to write very much (laughs) and so that wouldn't bother me now.	*Administrative employee, Establishment with less than 50 employees*
5	Reminder	And what's more, I find that if I have something on paper lying here, then I can definitely put it aside when the phone rings or if some other appointment comes up, and I still have it lying here afterwards and I know, okay, this is still pending. And then I might finish it the next day. And with an online survey, it's more like, yes, then the phone rings, I'm in an appointment, and the next day it's forgotten - there's still a tab open, but it's also just relatively quickly closed and forgotten - that I then actually have it on my mind sooner when it's here on my desk.	*HR-Manager, Establishment with more than 250 employees*

6	Overview; Control	With a paper survey, I could have skimmed over the last questions relatively quickly. You often can't do that with an online survey. You are forwarded from question to question. When you notice in an online survey: There's another question, there's another question, and now there's suddenly something completely different - that's what you can do in a paper questionnaire, which you have in your hand, and then you realize: Aha, we're sticking to the topic. Yes? Or the questions become more difficult at the back, become more critical, become more extensive. I've noticed this very often in online surveys: people supposedly say it's quick, it's easy, and then it becomes more and more difficult towards the end. There are more and more answer options, there are more and more text fields set. And that's something I actually like less in online questions. So a certain structure would have to remain.	*HR-Manager, Establishment with more than 250 employees*

Table 3.H.4: Quotes from the In-Depth Qualitative Interviews discussing Additional Aspects

Number	*Keywords*	*Quote*	*Interview Partner*
Quote No.			
1	Mode	When I have this questionnaire in front of me on paper, I tend to be the person who fills it out on paper. If I had received the questionnaire by e-mail via a link, I probably wouldn't have printed it out and filled it in, but would have submitted it online. But if it's already in front of me and printed out, then I'm someone who quickly picks up a pen and prefers to fill it in manually.	*HR-Manager, Establishment with more than 250 employees*
2	Every possible way of return	I would actually scan it [mail questionnaire] and email it back. So we have the option, of course, I could put it in an envelope here. I would then take it back to the post office where it came from. Then it would be stamped there and mailed back. But I would actually scan it and email it because that's just quicker, and I know it arrived then.	*HR-Manager, Establishment with more than 250 employees*
3	Upload from Internal Systems	What we evaluate for this are basically from our payroll program, where the payroll is created, [...], there are a variety of programs, [...] they are web-based, they all look similar, and we pull out data, actually in Excel form, so pivot tables we use for this or just in CSV format, to then upload them elsewhere.	*HR-Manager, Establishment more than 250 employees*
4	Upload from Internal Systems	I think that makes sense, of course, if you can just somehow pull up or upload data in CSV form.	*HR-Manager, Establishment with more than 250 employees*
5	Overview of questionnaire	It would be good if I could look at all the questions once when I log in, I don't know if that works for you. Some questionnaires are like this, you have to fill out this one first before you get to the next page. I don't know if that's the case with you. But if you can look across once, what do they want, that would be important.	*Manager, Establishment with 50-249 employees*

Literature for Appendix

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3.H.4 Semi-Structured Interview Guide of In-Depth Interviews

We used the following interview guide for the in-depth interviews. The interview guide is divided into modules, with each interviewee being asked the main questions. Where possible and necessary, follow-up questions were posed. However, in none of the interviews were all of the questions from the interview guide asked. The interview guide also includes some modules that are not the subject of this paper.

Interview Guide:

Module 1: Introduction, Thank you:

Hello, my name is NN and this is XX. We are researcher at the Institute for Employment Research, the research department of the Federal Employment Agency. As you know from our cover letter and contact with our colleagues, we are currently conducting an evaluation study at the IAB to evaluate the IAB survey "IAB Job Vacancy Survey". We want to emphasize at this point that this research project is independent of the Federal Employment Agency. The interviews we conduct will be treated as strictly confidential and the research results will only be published in anonymous form, i.e., it will not be possible to draw conclusions about establishments and individuals.

Project information
As already mentioned, the subject of the study is the evaluation of the IAB Job Vacancy Survey, one of our establishment surveys. The aim is to find out more about the processes, participation and response to establishment surveys in order to improve the survey. To do this, we conduct interviews with establishment to examine their experiences with establishment surveys. A central role in our conversation will be the method of data collection, i.e., the question of whether it is a web survey, a mail survey or something similar. Our conversation with you helps us to better understand the processes of participating and answering surveys from a scientific perspective in order tailor the survey more closely to the needs of the establishments. For this reason, we would like to thank you again for allowing us to speak to you today.

Information about the interview and the course of the interview
Our interview will be a so-called open interview. Open means that although there are specific topic blocks that are important to us, we will not pre-structure the content of the interview much, as happens, for example, in standardized interviews using questionnaires. Since you are the expert, we will start with a general question and ask you to tell us everything that comes to your mind and is important to you. We will ask more detailed questions only afterwards.
We would like to record the conversation and, with your consent, transcribe it later in order to include it in the evaluation as part of the accompanying research. You will receive a consent form for this purpose. After transcription and evaluation, the recording will be deleted.
The interview content and information will be treated as strictly confidential and will not be passed on internally or to third parties except for transcription. For the communication and publication of results, we will make the information unrecognizable in accordance with existing data protection regulations so that no conclusions can be drawn about individual people or establishments. In publications, we will therefore use general statements where necessary and alienate passages that may allow conclusions to be drawn about people.
o Duration: approx. 30-45 minutes (based on the actual interview, not the preliminary and follow-up discussions); this depends on the exact course of the conversation

o The questions are kept open and we are interested in your personal experiences and assessments, so there are no wrong answers
o We now start recording.

Module 2 – Personal details of interview partner

<table>
<tr><td colspan="2">Then let’s start the interview. First, I'd like you to introduce yourself. Please describe your training and your current field of activity in the establishment.</td></tr>
<tr><td>Please tell me more about your activities in the establishment?
What are your tasks in the establishment?
In which department do you work in the establishment? And for which fields of activity is your department responsible?
How long have you been working in this field of activity, including before you started working here?</td><td><u>Horizon of expectation:</u>
Professional background
Day-to-day tasks</td></tr>
</table>

Module 3 – General experience with surveys

<table>
<tr><td colspan="2">Let’s now turn to establishment surveys: In general, what experience with establishment surveys has your establishment already had?</td></tr>
<tr><td colspan="2">For example, can you remember if you were invited to participate in any of the following surveys? (e.g., surveys like the Structure of Earnings Survey, surveys by the Federal or State Statistical Office, ifo institute, surveys by the Chamber of Industry and Commerce or employers’ associations, university surveys, BeCovid, IAB Job Vacancy Survey, IAB BeCovid, IAB Establishment Panel)</td></tr>
<tr><td>Can you say approximately how many survey invitations you receive?
If yes, which surveys are you invited to and how did you deal with them?
What form of survey is it? Are there any differences in the coordination process?
We know that establishments in particular are quite often invited to participate in several surveys a year - how do you decide which ones to participate in and which ones not?
Is the handling of survey invitations regulated? Are there official rules or informal agreements regarding participation in surveys? If so, what are they?
What distinction do you make between surveys conducted by government organizations and other organizations?
How do you choose which surveys to take part in?
Are the survey invitations recorded centrally?
Do you have an established process for participating in web surveys? How should we imagine this?
How do I have to imagine the coordination process for participation in concrete terms?
With whom do you coordinate the decision to participate?</td><td><u>Horizon of expectation:</u>
Experience with surveys
General rules for participating in surveys
Selection criteria from various surveys
Internal coordination process for participation</td></tr>
</table>

• Is the decision to participate a matter for the boss? • What was the decision-making process like for you at the time?	

Module 4: Participation process in the fourth quarter of the IAB-JVS

[Questions were adapted to the experimental group the establishment was part of.]

Can you remember your participation in the IAB Job Vacancy Survey? **In the fourth quarter of 2020, you received an invitation letter to participate in the web survey "IAB Job Vacancy Survey" and then took part in the web survey. In the IAB Job Vacancy Survey, your establishment answered questions about job vacancies and recruitment processes. Can you explain to us step-by-step how this invitation letter and request were handled in your establishment? Please start your description at the time you received the invitation letter and end it when you sent the questionnaire.** **[If no or little recollection of the specific survey: Presentation of the survey charateristics (voluntary, from Federal Employment Agency, etc.)].**	
<u>If no memory of IAB Job Vacancy Survey:</u> **Ok, in this case I would like to discuss a fictitious scenario with you.** **Imagine that the Institute for Employment Research together with the Federal Employment Agency send you a letter asking you to participate in a web survey for establishments. The data is needed for official statistics. Participation is voluntary and the survey is conducted online. Can you explain to us step-by-step how this request would be handled in your establishment? Please start your description at the time you received the invitation letter and end it when you sent the questionnaire.**	
<u>Questions about the process in general:</u> • Who receives the invitation letter? • Who opens the invitation letter? • Who reads the invitation letter first? • To whom is the invitation letter forwarded? • Has anything changed about the processes as a result of the covid pandemic?	<u>Horizon of expectation:</u> • Path of participation materials in the establishment • Standardization of the response process
<u>Questions about the decision to participate</u> • What was the process of deciding at the time that you would participate in the IAB Job Vacancy Survey? • Which people were involved in the decision? • Is all important information quickly apparent on the invitation letter?	<u>Horizon of expectation:</u> • Persons involved in the participation decision • Context of the participation decision
<u>Questions about answering the questionnaire</u> • **(As you know) the questionnaire contains questions about number of staff, recruitment processes and**	<u>Horizon of expectation:</u> • People involved in answering the questionnaire

employment trends. If you couldn't answer the answers off the top of your head, how did you proceed? • Who is involved in answering the questions? • What positions do these people hold? • Do you sometimes ask colleagues for advice? • How can I specifically imagine these inquiries with colleagues? Do you ask colleagues in your office room or do you call other colleagues? • Do you let colleagues look at the questionnaire? • How do you then forward the login information? • What documents do you use to answer the questionnaire? • Do you estimate some numbers?	• Use of sources • Cognitive processes when answering questions

<u>**Questions about the mode:**</u>
• Do the advantages and disadvantages also play a role for you?
• Can you explain this with your own experience or example?
• **How challenging is it for you to participate in web surveys? Are there any difficulties or concerns?**
• Would it help you to know the mail questionnaire in advance?
• To what extent do you have data protection concerns and if so, what are they?
• Do you have the necessary equipment to participate in web surveys?
  o Computer
  o Internet connection
  o <u>Etc.</u>
	<u>Horizon of expectation:</u>
	• Problems with web surveys
	• Advantages of web surveys
	• Disadvantages of web surveys
	• Influence of the mode on the decision to participate

Module 5: Mode in the participation process

[Questions were adapted to the experimental group the establishment was part of.]

We have now talked in detail about participating in a web survey. Now please imagine that we had contacted you and asked you to participate in the same survey, only this time it was conducted using a mail questionnaire. What would have changed compared to the process just described?	
<u>Questions about the mode:</u> • **What would be the process of sending back the questionnaire? Please also describe who is submitting the questionnaire to the post office.** • **How challenging is it for you to take part in web surveys? Are there any difficulties or concerns?** • How might the mail questionnaire affect your decision-making processes? Do you recall any of mail surveys?	<u>Horizon of expectation:</u> • Problems with mail surveys • Advantages of mail surveys

o Length of the questionnaire o Appearance • Do you have data protection concerns about mail surveys? • If several people are involved in answering the questionnaire, how is the questionnaire forwarded?	• Disadvantages of mail surveys • Influence of the mode on the decision to participate

Please imagine again that we have contacted you with a request to take part in the same survey, only this time you can decide whether you take part by mail or web. Which mode would you choose?	
<u>Questions about the mode:</u> • How would you decide whether to participate using the mail questionnaire or the web questionnaire? • **What factors play a role in this?** • **What advantages do web or mail surveys have for you as a respondent?**	<u>Horizon of expectation:</u> • Reasons for choosing one of the modes

Module 6: Participation processes in follow-up quarters (depending on time budget, shorter or longer) [NOT ANALYZED IN THIS PAPER]

[Questions were adapted to the experimental group the establishment was part of.]

Do you still remember your participation in the follow-up telephone survey of the IAB Job Vacancy Survey, in which we asked for the latest figures for the current quarter? **After your participation in the fourth quarter of 2020, we contacted you by telephone in the first quarter of 2021 to ask for a few pieces of information for that quarter. This involved a few questions about vacancies, working hours and number of employees.** **Can you please tell us your impression of the follow-up telephone survey?** **[If no or little recollection of the specific survey: Presentation of the survey (voluntary, from Federal Employment Agency, etc.)].**	
Perhaps you can imagine the scenario: **You participated in our survey a few months ago. Now we contact you by phone and ask for the latest data on vacancies, working hours and number of employees for the current quarter. A colleague of ours would call you unannounced and ask for an update on the information you provided in the web survey. The interview would last about 5 minutes.** **What do you think of this type of follow-up survey? Please tell us your thoughts on this.**	
<u>Questions about the process in general:</u> • Who answers the calls? • Do you make an appointment for the short interview?	<u>Horizon of expectation:</u> • Procedure of the telephone interviews

• What would you say to the following statement? "I answer the questions quickly to get the interview over with." • Are there any experiences you have had that support this perception? If so, what are they?	
Questions about the phone contact: • **How did you perceive the personal telephone contact compared to the mail or web correspondence?** • What role does your impression of the interviewer play in your decision to participate?	
Questions about the decision to participate • What are the coordination processes for the renewed participation decision? • What role does the timing of the call play? • **How do you perceive not being able to determine the time of the interview?**	Horizon of expectation: • Context of the participation decision • Persons involved
Questions about the mode: • What has been your experience with telephone surveys in general? • Do you have any data protection concerns about telephone surveys? • Do the advantages and disadvantages also play a role for you?	Horizon of expectation: • Problems of telephone surveys • Advantages of telephone surveys

Module 7: Effect of the mode change

[Questions were adapted to the experimental group the establishment was part of.]

Please imagine that we had conducted the follow-up survey as a web survey instead of a telephone survey. You would have received another invitation letter with the login information for the web questionnaire. What would that have been like for you?	
Questions about the mode: • What do you think about the survey always being conducted in the same way, i.e., always web and no change to a telephone survey? • Do you base your assessment on your own experience with establishment surveys?	Horizon of expectation: • Advantages of a unified mode • Disadvantages of a unified mode • Influence of the mode on the participation decision

Module 8: Mode preference

Finally, we would like to ask you about your preference. Which type of survey, i.e., web, mail or telephone, is most suitable for you? Could you please also explain the reasons for your decision.	
Questions about the mode: • How does your wish differ between the short follow-up surveys and the comparatively long initial survey? • What advantages and disadvantages do you see in a telephone survey in general and specifically for follow-up surveys? • Do you have data protection concerns about telephone surveys?	Horizon of expectation: • Mode preference • Reasons for mode preference

Module 9 – Information about the establishment

Finally, we have a small question section that revolves around your establishment and the human resource management of your establishment. Can you tell us what the core business of your establishment is?	
• How is your establishment structured? To what extent are there different branches or a parent establishment? • Do you know what type of establishment, e.g., stock corporation or Ltd, your establishment is? • Which supporting organization does your facility/administrative office have? • What role does data play in your core business? Can you tell us a little more about this?	Horizon of expectation: • Establishment characteristics • Data affinity of the establishment

Module 10 – Information about documentation of personnel

The IAB Job Vacancy Survey deals with personnel and hiring data. We are therefore interested in how you handle personnel and hiring data. Can you give us a little insight into how you manage this data?	
• To what extent are your personnel administration and hiring processes digitalized? • How are personnel data stored and managed at your establishment? • What software do you use? • Which tasks are performed by external service providers? • **What types of personnel reporting/personnel documentation do you prepare for management or other levels?** • **How do you keep track of your employment statistics?** • To what extent is this reporting/documentation digitalized and standardized?	Horizon of expectation: • Data affinity • Digitalization • Reporting

- **Module 11: Concluding Remarks**

Thank you very much for this interview! You gave us some valuable suggestions.
Are there any additions or aspects from your side that we didn't address today?
Do you have any questions?
Finally, we would like to ask you to give us your written consent to transcribe this conversation and to evaluate it as part of the accompanying research.
Giving an outlook: Further course of the study, time horizon of the publication of results

- **Stimulating the conversation**

To keep the conversation going, the following stimuli can be used and adapted. In principle, the interviewer links the first sentence to a statement made by the interviewee and then follows with a question.	
<u>Questions about details</u> • You have often emphasized point X. This seems important to you. Can you elaborate on that? • I have to ask again: This project you have worked on, what exactly is it about? • Earlier you talked about the X ("problems with computers in surveys"). Can you say more about this? • How would you describe the decision to participate?	<u>Horizon of expectation:</u> • Getting the conversation partner to talk
<u>Filling in the blanks</u> • You only spoke briefly about receiving the letter and then got right to answering it. What happened in between? • You said that the letter passed through several hands. Who had the letter in their hands?	<u>Horizon of expectation:</u> • Getting the conversation partner to talk
<u>Completing interrupted passages</u> • Earlier, you briefly alluded to XY. How exactly did this go? • You said that you get a lot of requests. Who are you getting these requests from?	<u>Horizon of expectation:</u> • Getting the conversation partner to talk

Chapter 4

Effects of Replacing Telephone with Web, Mail, and Mixed-Mode Data Collection in an Establishment Follow-Up Survey[1]

4.1 Abstract, Keywords, Acknowledgements

Abstract: Due to rising data collection costs, there is growing pressure to move away from traditional interviewer-administered mode designs in favor of fully self-administered mode designs in ongoing panel surveys, including large-scale establishment panels. However, the consequences of moving to a fully self-administered mode design on follow-up and cumulative participation in ongoing establishment panel surveys are largely unknown. To address this research gap, we report the results of a follow-up mode design experiment conducted in the second wave of the 2020 IAB-Job Vacancy Survey, an ongoing panel study in Germany. The experiment builds on a previously-reported mode design experiment conducted in the first wave survey, where establishments were randomized to four self-administered mode designs (concurrent mail-web mixed-mode, sequential web-to-mail mixed-mode, single-mode web, and single-mode mail). In the second wave (i.e., follow-up) survey, reported here, respondents from the first wave were further randomly allocated to 1) a continuation of the same self-administered mode design from the first wave, or 2) a single-mode telephone design. The results show that the continuation of self-administration leads to higher response rates (both follow-up and cumulative) for the single-mode mail and concurrent mail-web mixed-mode designs and comparable response rates for the single-mode web and sequential web-to-mail mixed-mode designs, compared to the telephone follow-up design. Using extensive administrative data, we do not find evidence that forgoing telephone follow-ups adversely affects nonresponse bias or subgroup participation compared to continuing with self-administration in the follow-up wave. Potential cost savings (of up to 67%) were evidenced when replacing the telephone mode with a self-administered

[1]This paper is joint work with Joseph W. Sakshaug, Stefan Zins, and Claudia Globisch and is in preparation for a submission to Survey Research Methods.

follow-up mode design. In-depth qualitative interviews revealed that establishments prefer a constant mode design across waves due to the familiarity and routine of the response process.

Keywords: Nonresponse; Data Collection; Self-Administered Modes; CATI

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4.2 Introduction

Establishment panel surveys are a vital tool for measuring the economic activity of businesses and organizations over time. By repeatedly collecting data from the same units, they allow for the measurement of dynamic changes and trends within and across business sectors. However, the quality of panel survey data are threatened by attrition, decreasing response rates, and rising data collection costs (e.g., König et al., 2021; Küfner et al., 2022b; U.S. Bureau of Labor Statistics, 2023a), which puts pressure on survey agencies to develop more efficient data collection strategies, including greater use of self-administered modes (e.g., web). Most establishment surveys around the world use self-administered mode designs as opposed to more traditional interviewer-administered modes, such as computer-assisted telephone interviewing (CATI) or computer-assisted personal interviewing (CAPI) (e.g., Haraldsen, 2013b; Memobust, 2014; Nicholls II et al., 2000; U.S. Bureau of Labor Statistics, 2023a). Nonetheless, interviewer-administered modes are still used in many voluntary establishment panel surveys, as interviewers are well-suited to motivate respondents to continue participating in follow-up interviews (Haraldsen, 2013b). For example, the voluntary Job Openings and Labor Turnover Survey in the U.S., which is designed as a panel study, uses CATI for approximately the first five waves of data collection to establish a reporting routine before establishments can decide whether they want to participate via web, e-mail, or continue with CATI (BLS Handbook of Methods: U.S. Bureau of Labor Statistics, 2023). The voluntary Establishment Panel run by the Institute for Employment Research (IAB) in Germany makes extensive use of both CAPI and CATI modes for nonresponse follow-ups after an initial invitation to web, resulting in more than the half of all responses collected by interviewers (Bächmann et al., 2023). The voluntary IAB-Job Vacancy Survey (IAB-JVS) in Germany is another ongoing panel study, which annually recruits a new cohort using a concurrent mail-web mixed-mode design and conducts three CATI follow-up interviews in the first, second, and third quarters of the following year (Bossler et al., 2020).

In the case of the IAB-JVS, declining response rates and rising data collection costs recently prompted the survey team to experiment with four alternative self-administered mode designs (concurrent mail-web mixed-mode, sequential web-to-mail mixed-mode, single-mode web, single-mode mail) in the first panel wave and replacing the CATI mode with self-administration in the follow-up waves, with an eye towards making the panel fully self-administered in the future. The results of the experiments conducted in the first panel wave of the 2020 survey, reported in Küfner et al. (2024), showed that neither response rates nor nonresponse bias substantially differed between the four self-administered mode designs. Further, the results indicated a large potential for cost-savings (up to 50% per respondent) when utilizing a sequential web-to-mail or a single-mode web design compared to the concurrent mail-web mixed-mode design that is currently used in the IAB-JVS. The motivation to build on this prior work and experiment with replacing the CATI mode with self-administration in the second panel wave is based on addressing the current decline in CATI response rates (Küfner et al., 2022a), reducing costs, and minimizing the risk of longitudinal measurement mode effects (Cernat & Sakshaug, 2021). Additionally, maintaining self-administration across all panel waves has the potential to streamline survey organizational processes and allow more flexibility in the development of the survey design. However, forgoing telephone follow-ups may also come with potential risks. For instance, the absence of interviewers could actually have a negative impact on response rates in the follow-up waves. In addition, the risk of nonresponse bias may increase if self-administered follow-ups are less effective at motivating certain types of establishments to continue participating in the panel compared to interviewer-administered follow-ups. With the COVID-19 pandemic reshaping business practices and fostering an era of remote work and reliance on online tools, there's a growing need to identify the most effective modes (or mode designs) for maximizing establishment panel survey participation in this new business environment.

The empirical literature offers limited guidance in evaluating the potential benefits and risks associated with replacing interviewer-administered follow-ups with self-administered ones in establishment panel surveys. Furthermore, the literature mainly focuses on response rates, leaving the effects on nonresponse bias and costs unquantified (for an exception, see Gleiser et al. (2022)). To address this research gap, we present results from the aforementioned follow-up mode design experiment conducted in the second wave of the 2020 IAB-JVS panel survey, building on the first wave experiment. Specifically, we compare the effects of using CATI follow-ups versus following up with the same self-administered mode design used in the first wave. In addition to evaluating both follow-up and cumulative response rates over both waves, we also examine nonresponse bias and predictors of follow-up and cumulative survey participation by exploiting a large-scale administrative database containing detailed information on establishment and aggregate employee characteristics. Further, we present results from a cost analysis to quantify the cost implications of the different mode design combinations. Lastly, post-survey qualitative interviews were conducted with establishments to acquire insights into their perceptions of CATI and self-administered modes and their preferences for continuing with the same self-administered mode design or switching to an interviewer-led mode design from one panel wave to the next.

In summary, this article pursues the following five research questions:

1. *RQ1: To what extent do follow-up and cumulative response rates differ between a continuation of a self-administered mode design and a switch to a CATI mode design in the follow-up wave of an establishment panel survey?*

2. *RQ2: Do follow-up and cumulative nonresponse biases differ between a continuation of a self-administered mode design and a switch to a CATI mode design in the follow-up wave of an establishment panel survey?*

3. *RQ3: Are some establishment subgroups more (or less) likely to participate in the follow-up wave conducted under a continuation of a self-administered mode design or a switch to a CATI mode design in the follow-up wave of an establishment panel survey? Do subgroup patterns of cumulative participation in both waves of the panel vary between the different mode design sequences?*

4. *RQ4: To what extent does a continuation of a self-administered mode design affect both follow-up and cumulative survey costs compared to a switch to a CATI mode design in the follow-up wave of an establishment panel survey?*

5. *RQ5: What do establishments perceive to be the advantages and disadvantages of web, mail, and CATI mode designs, and switching from one mode design to another between waves of a panel survey?*

The remainder of this article is structured as follows. Section 4.3 provides an overview of self- and interviewer-administered modes in establishment surveys and summarizes the literature on mode design changes between panel waves. The experimental design, the data sources used, and the analytic strategy are described in Section 4.4. Section 4.5 presents the results of the mode design experiments. Section 4.6 reports insights from both short structured and in-depth qualitative interviews with establishments. Lastly, Section 4.7 provides a summary of the key findings and implications for survey practice.

4.3 Background

4.3.1 Self-Administered and Interviewer-Administered Mode Designs in Establishment Surveys

Mail and web modes (incl. electronic data interchange) are the primary modes of data collection used in establishment surveys with other self-administered modes (e.g., fax, touchtone data entry) and interviewer-administered modes (e.g., CAPI, CATI) used to a lesser extent (e.g., Buiten et al., 2018; Haraldsen, 2013b; Memobust, 2014; Robertson & Hatch-Maxfield, 2012). All of these modes can be deployed as part of a single-mode design, in which all establishments are offered only one mode of data collection, or a mixed-mode design, in which multiple modes are deployed to collect data from establishments. A further distinction can be made between concurrent mixed-mode designs, in which multiple modes are offered simultaneously and the establishment can choose which one they use, and sequential mixed-mode designs, in which data collection starts with one mode in the first phase of fieldwork and additional modes are deployed to remaining nonrespondents in the subsequent fieldwork phases. Mixed-mode designs can comprise a mix of either self-administered or interviewer-administered modes, or a combination of both mode types. For example, a common sequential mixed-mode design is to use a self-administered starting mode, such as web, and follow-up remaining nonrespondents with an interviewer-administered mode, such as CATI (De Leeuw, 2005, 2018). In addition to mixing modes within one wave of a survey, one can also mix modes or mode designs across multiple waves of a panel survey. For instance, a survey might use a face-to-face design in the first wave and introduce a web design in subsequent waves. The present study focuses on the impact of mixing modes between waves by examining the effect of switching from a self-administered mode design in the first wave to a CATI mode design in the follow-up wave, compared to using a constant self-administered mode design in both waves.

The popularity of self-administered modes is driven by at least four factors. First, establishment surveys collect extensive data on quantities and facts, which respondents may not be able to recall on the spot in the presence of an interviewer. To provide this data, establishments often must check their records, balance sheets, or internal documentation systems. With self-administered modes, respondents can take their time to search for this information and verify the correct response. Second, self-administered questionnaires are easier to share among colleagues within an establishment who could contribute to answering the questions (e.g., Haraldsen, 2013b, 2023; Küfner et al., 2024; Memobust, 2014). Third, self-administered modes, especially web and mail, facilitate the use of matrix and grid tables (Moore & Wojan, 2016), which are often used in establishment surveys. Administering a two-dimensional matrix in interviewer-administered modes, especially CATI, could be very demanding for the interviewer and respondent (Haraldsen, 2013b), especially when the items involve disaggregated numbers and arithmetic sums. And fourth, self-administered modes are associated with lower survey costs compared to interviewer-administered modes (e.g., Haraldsen, 2013b; Memobust, 2014; Moore & Wojan, 2016; Rosen & O'Connell, 1997). Further, web questionnaires offer additional features and capabilities, including automated filtering, prompts on item nonresponse, and preloading of available data, which may improve data quality and facilitate the response process (e.g., Couper, 2008; Moore & Wojan, 2016).

Although interviewer-administered modes are less common in establishment surveys, they possess certain advantages. Most dominantly, interviewer-administered modes enable a two-way communication that allows respondents to ask questions to clarify vague or ambiguous questions. Moreover, interviewers can motivate establishments to take part in the survey and thus influence the decision to participate, which could ultimately lead to higher response rates (e.g., Haraldsen, 2013b, 2023; Memobust, 2014). As a consequence, CATI and CAPI modes are primarily employed for specific types of surveys and contact screening. This is evident in the European Company Survey (Ipsos, 2020), where direct conversation is used to identify the most knowledgeable respondent within a company and assess the eligibility of the company. In establishment panel surveys, establishments face a high burden of participation due to repeated survey requests. The likelihood of panel participation in such cases could benefit from a trust-based relationship between the establishment and the interviewer, who actively encourages and motivates the establishment to continue participating in subsequent survey waves. Additionally, interviewers are extensively used for nonresponse follow-ups. For example, the Australian Bureau of Statistics (2023) regularly deploys interviewers, who play a key role in persuading reluctant establishments to participate. The main disadvantages of interviewer-administered modes are that they are more expensive than self-administered survey modes, less timely, and less suitable for high frequency data collection (e.g., Haraldsen, 2013b; Memobust, 2014; Moore & Wojan, 2016; Rosen & O'Connell, 1997).

4.3.2 Transitioning from Interviewer-Administration to Self-Administration in Establishment Panel Surveys

The AAPOR Task Force Report by Olson, Smyth, Horwitz, Keeter, Lesser, Marken, et al. (2021) offers a comprehensive overview of surveys shifting from CATI to self-administered data collection. Although the report acknowledges the dearth of evidence specific to establishment surveys (both cross-sectional and panel), it outlines two important motivations relevant to the implementation of self-administered modes in establishment surveys: lower survey costs and increased data quality. As previously outlined, CATI is known to entail higher costs than self-administered modes. Therefore, it is common to transition from CATI to self-administered modes in order to reduce expenses and increase cost efficiencies. With respect to data quality, the aim is to maintain (or increase) response rates that have been steadily declining in CATI surveys over time (e.g., Küfner et al., 2022a; Olson, Smyth, Horwitz, Keeter, Lesser, Marken, et al., 2021) without exacerbating nonresponse bias. Specific to establishment surveys, meta-analyses are lacking which examine whether the general trend of decreasing response rates (e.g., König et al., 2021; Küfner et al., 2022b; U.S. Bureau of Labor Statistics, 2023a) is more pronounced in self-administered or interviewer-administered modes.

For panel surveys, changing the mode design between waves comes with certain risks. As it is key for panel surveys to minimize panel attrition over the waves, changing the mode design could backfire if panel respondents prefer the previous mode design over the new one (see for example Jäckle et al., 2015). Thus, altering the mode design between waves of a panel study could lead to an increased risk of nonresponse or attrition and associated selection biases in subsequent waves of data collection.

4.3.3 Empirical Evidence on Replacing Interviewer-Administered with Self-Administered Modes in Establishment Surveys

Limited research exists comparing interviewer and self-administered modes on participation in establishment surveys, both in a cross-sectional (DesRoches et al., 2007; Gleiser et al., 2022; Moore & Wojan, 2016; Zuckerbraun et al., 2013) and a panel setting (Ellguth & Kohaut, 2014). For instance, Moore and Wojan (2016) run an experimental pilot in the cross-sectional U.S. Rural Establishment Innovation Survey in 2014 comparing five sequential mixed-mode designs with varying order of mail, web, and CATI modes (two mail-first, one web-first, and two CATI-first), additionally varying incentives (no incentive, 2$, 4$), e-mail reminders (yes/no), the use of priority mail (none, once, twice), and the use of refusal aversion questionnaires (yes/no). The two mail-first, the web-first, and the CATI-first designs using incentives had similar response rates (about 30%), but the CATI-first design without incentives and priority mailing had a significantly lower response rate of 19%. Surprisingly, both CATI-first designs had significantly lower shares of CATI responses (up to 17%) compared to the web (up to 58%) and mail (up to 35%) follow-up responses. This implies that even when offering CATI as the first mode of data collection, the majority of respondents seem to prefer the mail and web follow-up mode.

Within the 2018 cross-sectional refreshment sample of the voluntary German IAB-Establishment Panel, Gleiser et al. (2022) conducted an experimental comparison between a face-to-face mode design and a sequential web-to-face-to-face mixed-mode design. Both designs included a "mop-up" phase with self-administered paper questionnaires offered to all remaining nonrespondents. The results show similar response rates (22.14% and 21.14%, respectively) and (aggregate) levels of nonresponse bias between both mode designs, and about 14% cost savings per respondent in the web-first design, which yielded fewer face-to-face contact attempts (Gleiser et al., 2022).

Ellguth and Kohaut (2014) investigated the possibility of switching the mode design of the IAB-

Establishment Panel from face-to-face paper & pencil interviews with the option of paper self-completion to computer-assisted personal interviews with the option of self-completion of web questionnaires by asking panelists about their ability and willingness to participate online. While 95% of panel respondents indicated that they have internet access and are able to participate online, only 38% expressed a willingness to do so. The main barrier cited was security concerns about data transfer.

Additional research has found limited effects of using telephone calls to prompt establishments that broke off a web survey to complete the web questionnaire compared to not using them within a cross-sectional establishment survey (Zuckerbraun et al., 2013), and a lower likelihood of establishments without employees participating via web than CATI within the single wave of a panel survey (DesRoches et al., 2007).

4.3.4 Research Gaps

While there are several studies that examine introducing self-administered modes or mixed-mode designs in follow-up waves of household panel surveys (e.g., Allum et al., 2018; Bianchi et al., 2017; Jäckle et al., 2015), such studies are limited in the establishment survey literature (e.g., DesRoches et al., 2007; Ellguth & Kohaut, 2014; Gleiser et al., 2022; Zuckerbraun et al., 2013). The reviewed literature points to a lack of experimental evidence on the impact of changing or continuing the same mode design in the follow-up waves of establishment panel surveys, as well as a limited understanding of the effects of various mode design sequences over multiple panel waves, particularly when starting with a self-administered mode design in the first wave. Moreover, there is an absence of evidence on the effects of various mode design combinations in panel surveys with respect to nonresponse bias, subgroup participation, and costs. Qualitative data on establishments' perceptions of continuing or changing the mode design from self-administration to interviewer-administration in follow-up waves and its impact on their response processes is also missing from the literature.

A better understanding of these issues would inform survey organizations and broaden their consideration of alternative mode designs in establishment panel surveys. This includes providing reference estimates for impacts on response rates, nonresponse bias, and costs. Additionally, subgroup analyses would help identify those establishments that are more (or less) likely to participate in follow-up waves of a panel study under different mode designs. Finally, collecting qualitative insights from establishments on their mode design preferences and response processes in panel studies could help to inform survey designs that mitigate or remedy the disadvantages of the different mode designs.

Although establishment surveys primarily collect factual data, which should be less prone to measurement mode effects, changing the mode design in an ongoing panel survey comes with the risk of confounding true change and measurement mode effects, which could compromise estimates of change and trends over time (Cernat & Sakshaug, 2021; Smith & Yung, 2019). While we acknowledge the importance of investigating such risks in panel surveys, this article focuses solely on participation and selection effects and we leave the topic of measurement mode effects to future research.

4.4 Data and Methods

4.4.1 Data

4.4.1.1 IAB Job Vacancy Survey

The IAB Job Vacancy Survey (IAB-JVS) is a voluntary establishment survey covering all establishments with at least one employee contributing to social security in Germany (Bossler et al., 2020). The IAB-JVS collects extensive data on job vacancies, recruiting processes, and job flows, such as hires and layoffs. It serves as the official data source for the number of job vacancies in Germany and these results are reported to Eurostat on behalf of Germany. It is designed as a four-wave panel survey with the first wave starting in the fourth quarter of each year followed by three quarterly follow-ups conducted in the following year. Since 2002, the IAB-JVS has used a concurrent mail-web mixed-mode design in which paper invitation letters are sent to a cross-sectional sample of establishments in the first panel wave along with a copy of the paper questionnaire and an optional web link to complete the survey online. Since 2006, the three follow-up panel waves have been conducted via single-mode CATI. The follow-up panel waves are designed to be very short (3-5 minutes, on average, depending on the quarter), collecting updated information about the quarter-specific number and structure of employees, vacancies, and the average number of hours per employee on working time accounts. The sample is drawn from the population of all establishments in Germany with at least one employee who is subject to social insurance contributions. Establishments that have indicated they do not wish to be contacted for surveys are excluded from the sampling frame. The IAB-JVS uses a stratified sample design with region, establishment size, and industry as stratification variables. All data used in this study are available from the Research Data Centre (RDC) of the Federal Employment Agency in Germany. Restrictions apply to the availability of these data, which are not publicly available. For more information on data access, see https://fdz.iab.de/en.aspx.

4.4.1.2 Experimental Design

The second panel wave experiment analyzed in this article builds on a preceding large-scale mode design experiment conducted in the first panel wave (i.e., the fourth quarter) of the 2020 IAB-JVS, in which four self-administered mode designs were compared: concurrent mail-web mixed-mode, sequential web-to-mail mixed-mode, single-mode web, and single-mode mail (Küfner et al., 2024). The rationale for the mode experiment in the first wave was to examine the potential for cost savings with the single-mode web and sequential web-to-mail mixed-mode designs (i.e., the push-to-web designs), while also evaluating their impact on various aspects of survey participation compared to concurrent mail-web mixed-mode and single-mode mail designs. Because of the importance of the survey for official statistics and substantive research, the decision to adopt a new mode design – despite its known advantages (see section 4.3.1 and 4.3.2) – was only to be made on the basis of empirical evidence from these experiments. The sample size in the first wave experiments was 132,433 establishments and the entire field period lasted from the 26th of September 2020 to the 6th of January 2021.

The first wave experiment showed no statistically significant difference between the experimental groups in terms of response rates and aggregate nonresponse bias. Larger establishments were more likely to participate via web than mail in the single-mode designs. In addition, the web-to-mail and single-mode web designs indicated the highest potential for cost-savings. See Küfner et al., 2024 for complete details of this experiment and outcomes.

Building on this previous experiment, a follow-up survey experiment was conducted in the second panel wave, i.e., the first quarter of 2021, which is illustrated in Figure 4.1. Specifically, respondents within each of the four mode designs of the first panel wave (fourth quarter of 2020) were randomly subdivided into two experimental mode design groups for the follow-up panel wave – 1) a mode design continuation group that continued the same self-administered mode design that was randomly assigned to establishments in the first wave, and 2) a mode design switch group that switched the mode design to single-mode CATI (i.e., the standard IAB-JVS follow-up mode design). This random split was carried out by applying systematic random sampling after sorting the sampling frame by establishment size and industry. Analogous to the first wave experiment, the rationale behind the follow-up wave experiment was to investigate potential cost savings and the implications of replacing interviewers with self-administration on continued survey participation.

A total of 15,890 establishments were fielded in the follow-up wave experiment. The field period of the follow-up wave started on the 9th of January 2021 and ended 31st of March 2021. All establishments received an advance letter multiple days prior to the follow-up wave thanking them for participating in the first wave and informing them about the upcoming follow-up survey. As in the first panel wave, all self-administered mode designs in the follow-up panel wave included postal invitation letters and one post-due-date reminder letter[2]. Following completion of the first wave questionnaire, participants were asked to provide details of a designated contact person and their corresponding telephone number. This designated contact person served as the recipient for all mailed correspondence in the follow-up wave, with a parallel arrangement for directing telephone contacts in the CATI mode design. If the telephone number used in the CATI mode design turned out to be invalid, alternative telephone numbers were obtained through extensive Internet research or from data available at the

[2]This paper encompasses all experimental groups in which a post-due-date reminder was used in the first wave. Additional experimental groups in which a pre-due-date reminder was tested are not considered in this paper.

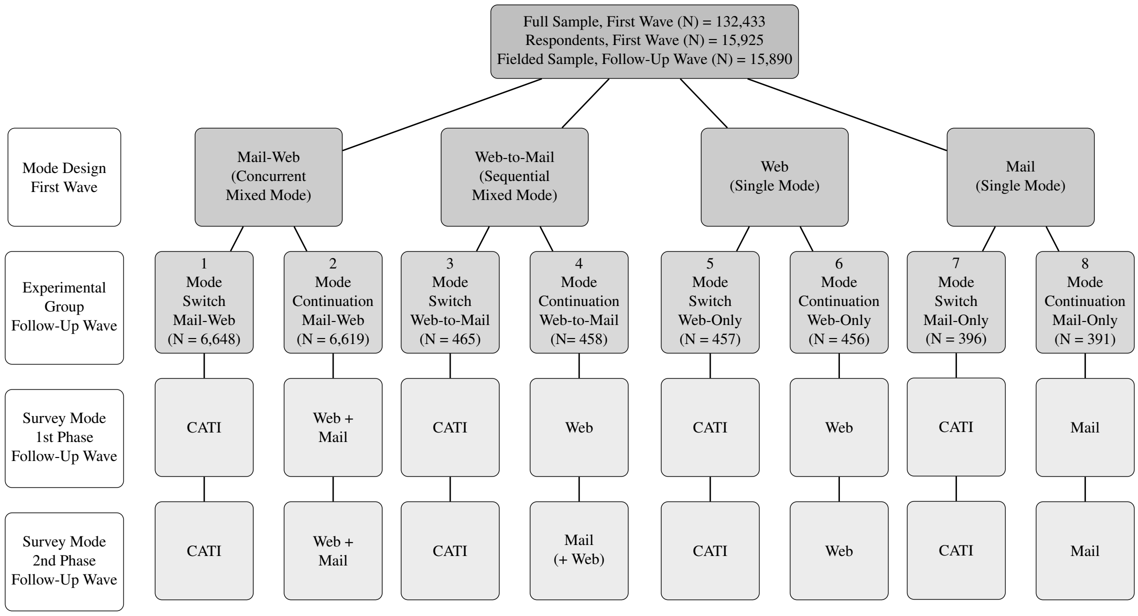


Figure 4.1: Experimental Design

German Federal Employment Agency (Bundesagentur für Arbeit). We note that due to administrative reasons, all mode design groups were fielded in two tranches, resulting in a 37 day longer field period for observations in the first tranche than for those in the second tranche. In the Appendix Section 4.B.1, we provide more details on the reasons for using separate tranches and dates of invitations and reminders of both tranches as well as additional sensitivity checks, which show that our results are robust to the impact of the tranches.

4.4.1.3 Establishment History Panel

The Establishment History Panel (BHP) is an administrative data source, which we use to analyze nonresponse bias (RQ2) and predictors of survey participation (RQ3). The BHP contains detailed establishment and employee characteristics for all establishments in Germany with at least one employee (Ganzer et al., 2022). These characteristics are expected to be correlated with important variables collected in the IAB-JVS, including the number of job vacancies and share of hired employees on fixed-term contracts. These correlations make the BHP well-suited for analyzing nonresponse bias in the IAB-JVS. By using a unique establishment identifier the IAB-JVS response indicator can be directly linked to the 2020 BHP, resulting in a dataset with detailed information for both respondents and nonrespondents. Exceptions are for establishments that ceased to exist between the reference date for the BHP generation (30th of June) and the IAB-JVS sampling (31st of December of the previous year). These non-linked cases account for 3.85% of the IAB-JVS sample. These establishments are excluded from the analysis of nonresponse bias (RQ2) and predictors of survey participation (RQ3), but are included in the response rate (RQ1) and cost analyses (RQ4). The Appendix Section 4.A contains the full list of BHP variables used in the analysis and descriptive statistics of each for the fielded sample and each experimental group.

4.4.2 Empirical Strategy

4.4.2.1 Response Rates

For each wave of data collection, we define a completed interview (or response) for an establishment that answers two key survey items: the number of job vacancies and the number of employees. Both items are necessary to meet the reporting requirements of Eurostat. In addition, all self-administered interview data has to be actively submitted, either by mailing the paper questionnaire back to the survey institute or by clicking the submit button in the web survey. For CATI interviews, the same two items have to be answered and all questions have to be read out loud to be considered a complete interview.

Response rates are computed using the AAPOR Response Rate 1 definition (American Association for Public Opinion Research, 2023). This response rate is seen as the minimum response rate as it is simply the ratio of the number of respondents to the fielded sample. Response rates are reported separately for the follow-up wave and cumulatively for both panel waves (Q4/2020 and Q1/2021). As shown in equation 4.1, the follow-up response rate relates the respondents of the follow-up wave to the fielded sample of this wave.

$$\text{Follow-Up Response Rate}_{fup,exp} = \frac{R_{fup,exp}}{N_{fup,exp}} \tag{4.1}$$

where $R_{fup,exp}$ denotes the number of respondents in the follow-up wave in the experimental group *exp* and $N_{fup,exp}$ is the number establishments fielded in the follow-up wave *fup* in the respective experimental group *exp*.

To enable inference to the population, we use nonresponse weights to estimate the follow-up response rate. These nonresponse weights account for nonresponse in the first panel wave by estimating response propensities separately for each experimental group using the standard IAB-JVS auxiliary variables, namely, establishment size, region, industry, wage of employees, and age of employees (see Brenzel et al., 2016). The inverse of the response propensities is then multiplied by the inverse of the inclusion probability, i.e., design weights. To account for the systematic random split of respondents into the mode design switch and continuation groups, we then multiply the weights by two and finally add an adjustment factor to scale the weights to the population total.

Cumulative response rates are calculated by relating respondents who participated in both waves to the fielded sample of the first wave.

$$\text{Cum. Response Rate}_{cum,exp} = \frac{R_{cum,exp}}{N_{fir,exp}} \tag{4.2}$$

where $R_{cum,exp}$ denotes the number of respondents that participated in the first and follow-up wave in the experimental group *exp* and $N_{fir,exp}$ is the number of establishments fielded in the first panel wave *fir* in the respective experimental group *exp*.

For the estimation of cumulative response rates, we only apply design weights as the reference group is the full sample of the first panel wave. Hence, we don't consider nonresponse in the first wave. Similar to the nonresponse weights, we multiply the design weights by two to compensate for the systematic random split within the first wave experimental groups and scale the weights afterward to the population total. Stratification is accounted for in all standard error estimations.

4.4.2.2 Nonresponse Bias

To evaluate the effects of the mode designs and mode design combinations on nonresponse bias (RQ2), we compute follow-up and cumulative nonresponse bias estimates for various establishment and employee characteristics from the BHP. Nonresponse bias is defined as the difference between the estimate of interest for respondents and the corresponding estimate of interest for the fielded sample, which are proportions for the categorized BHP variables. Hence, nonresponse bias in the follow-up panel wave is defined as:

$$\text{Follow-Up}\,\widehat{\text{NR Bias}}_{fup,exp,k} = \hat{Y}_{fup,exp,k,r,p} - \hat{Y}_{fup,exp,k,n,p} \tag{4.3}$$

where $\hat{Y}_{fup,exp,k,r,p}$ denotes the estimator for the k^{th} statistic of interest in the follow-up wave for the respective experimental group *exp* based on the respondents (r) using design and nonresponse weights (p) and estimator $\hat{Y}_{fup,exp,k,n,p}$ is analogously defined for the fielded sample (n) (see Equations 4.11 and 4.12 in the Appendix 4.C for definitions of $\hat{Y}_{fup,exp,k,r,p}$ and $\hat{Y}_{fup,exp,k,n,p}$, respectively).

Analogous to the response rate analysis, we apply different sets of weights for the nonresponse bias analysis. To isolate the effect of mode design on nonresponse bias in the follow-up panel wave, we use nonresponse weights to account for selectivity of response in the first panel wave.

In order to estimate the cumulative nonresponse bias of the different mode design combinations and enable the decomposition of the impacts of the first and follow-up panel waves, we estimate the nonresponse bias of the first and follow-up panel waves separately and apply only design weights. The cumulative nonresponse bias is then calculated as the sum of the design-weighted nonresponse biases of the first and follow-up panel waves for each statistic of interest. This approach enables us to identify whether the mode designs of the follow-up wave offset or reinforce the nonresponse bias of the first panel wave. The cumulative nonresponse bias of the first and follow-up panel waves for the k^{th} statistic of interest is then estimated by:

$$\text{Cum. }\widehat{\text{NR Bias}}_{cum,exp,k} = (\hat{Y}_{fir,exp,k,r,d} - \hat{Y}_{fir,exp,k,n,d}) + (\hat{Y}_{fup,exp,k,r,d} - \hat{Y}_{fup,exp,k,n,d}) \tag{4.4}$$

where $\hat{Y}_{w,exp,k,r,d}$ denotes the estimator for the k^{th} statistic of interest in the first ($w = fir$) or follow-up panel ($w = fup$) wave for the respective experimental group *exp* based on the respondents (r) using design weights (d) and estimator $\hat{Y}_{w,exp,k,n,d}$ is analogously defined for the fielded sample (n) (see Equations 4.13 and 4.14 for definitions of $\hat{Y}_{w,exp,k,r,d}$ and $\hat{Y}_{w,exp,k,n,d}$ in the Appendix Section 4.C).

For summary comparisons, we also compute absolute nonresponse biases and average absolute nonresponse biases for the follow-up panel wave. Absolute nonresponse bias is defined as the absolute value of the nonresponse bias, as shown in the following equation:

$$\text{Abs. Follow-}\widehat{\text{Up NR}}\text{ Bias}_{fup,exp,k} = \left|\text{Follow-Up }\widehat{\text{NR B}}\text{ias}_{fup,exp,k}\right| \tag{4.5}$$

Average absolute nonresponse bias is defined as the average nonresponse bias across all statistics of interest, as shown in the equation below:

$$\text{Avg. Abs. Foll}\widehat{\text{ow-Up}}\text{ NR Bias}_{fup,exp} = \frac{\sum_{k=1}^{K} \text{Abs. Follow-}\widehat{\text{Up NR}}\text{ Bias}_{fup,exp,k}}{K} \tag{4.6}$$

with K being the total number of statistics of interest considered.

Analogously, we compute absolute and average absolute cumulative nonresponse bias estimates across both panel waves using the following formula:

$$\text{Abs. Cum. }\widehat{\text{NR B}}\text{ias}_{cum,exp,k} = \left|\text{Cum. N}\widehat{\text{R Bias}}_{cum,exp,k}\right| \tag{4.7}$$

$$\text{Avg. Abs. C}\widehat{\text{um. N}}\text{R Bias}_{cum,exp} = \frac{\sum_{k=1}^{K} \text{Abs. Cum. }\widehat{\text{NR B}}\text{ias}_{cum,exp,k}}{K} \tag{4.8}$$

with K being the total number of statistics of interest considered.

To obtain an aggregate measure of nonresponse bias across a range of individual variables, we compute the average absolute nonresponse bias separately for three groups of BHP administrative variables: establishment characteristics, employee characteristics, and all BHP variables (see Table 4.A.20 of the Appendix for a comprehensive overview).

The concurrent mail-web mixed-mode groups have a disproportionately large sample size compared to other groups; hence, we apply a repeated downsampling approach to ensure comparable sample sizes to the other mode design groups (around 7,500 in the first wave and 450 in the follow-up wave) are used for this analysis, thereby avoiding any potential sample size effects on the bias results. This approach also allows for the computation of confidence intervals for the average absolute bias estimates in this mode design group. For the other experimental groups, we estimate confidence intervals using standard errors estimated by a bootstrap method based on 500 replicates and normal-approximated quantiles.

4.4.2.3 Predictors of Survey Participation

To better understand the factors that influence survey participation in the follow-up panel wave, we fitted logistic regression models based on all establishments fielded in the follow-up wave separately for each mode design used in the first wave. This analysis sheds light on which establishments are more (or less) likely to participate in the follow-up wave under the mode design continuation or switch scenarios. Using establishment characteristics and their interactions with the experimental indicator (also included as main effects) as explanatory variables, we modeled survey participation (1 = response in the follow-up wave; 0 = nonresponse in the follow-up wave) and estimated predicted probabilities of response for different establishment characteristics with the covariates fixed at their global means. For evaluating differences in predicted probabilities between the mode design continuation and switch designs, the results of a Wald test are displayed (see Mize, 2019). The following formula shows the logistic regression model used to predict the participation probabilities:

$$Pr(R_{fup,exp,i} = 1) = \frac{1}{1 + e^{(-(\alpha + \beta \mathbf{x}^{\top}_{fup,exp,i} + \zeta [\mathbf{x}_{fup,exp,i} \mathbf{m}_{fup,exp,i}]^{\top}))}} \tag{4.9}$$

where $Pr(.)$ is the probability function of $R_{fup,exp,i}$, the response indicator for the i^{th} establishment ($R_{fup,exp,i} = 1$ = response in the follow-up wave, $R_{fup,exp,i} = 0$ = nonresponse in the follow-up wave) in the respective experimental group *exp*, $\mathbf{x}_{fup,exp,i}$ is a vector of independent variables (establishment characteristics and the experimental mode design indicator), β the corresponding vector of coefficients, $[\mathbf{x}_{fup,exp,i} \mathbf{m}_{fup,exp,i}]$ is a vector of establishment characteristics interacting with the experimental mode design indicator, ζ is the corresponding vector of coefficients, and α the intercept.

We estimate further logistic regression models to identify predictors of cumulative survey participation separately for each mode design combination across the first and follow-up waves. As in the regressions analyzing the follow-up wave, establishment characteristics are used as explanatory variables (without interaction terms). The larger sample size enables us to use a more detailed industry aggregation. For these regressions, the dependent variable, survey participation, is defined as 1 if an establishment participated in both waves and 0 if it did not participate in the first or the follow-up panel waves. Using these survey participation models, we estimate response probabilities for various establishment characteristics with the covariates fixed at their global means. The following formula is applied to predict the probabilities of cumulative survey participation:

$$Pr(R_{cum,exp,i} = 1) = \frac{1}{1 + \mathrm{e}^{(-\alpha + \beta \mathbf{x}_{cum,exp,i}^{\top})}} \tag{4.10}$$

where $Pr(.)$ is the probability function of $R_{cum,exp,i}$, the response indicator for the i^{th} establishment (R_k = 1 = response in the first and follow-up wave, R_k = 0 = nonresponse in the first or follow-up wave) in the exp^{th} experimental group, $\mathbf{x}_{cum,exp,i}$ is a vector of independent variables (establishment characteristics), β the corresponding vector of coefficients, and α the intercept.

Analyses of the follow-up panel wave account for inclusion probabilities and nonresponse in the first panel wave. The cumulative regressions are estimated using design weights. All computations consider the stratification variables and were conducted using Stata 17 (StataCorp, 2021).

4.4.2.4 Survey Costs

The fourth research question focuses on the survey costs incurred during the follow-up panel wave and separately for both panel waves. Unfortunately, we are unable to disclose the actual costs due to contractual obligations. Instead, we report relative costs by comparing the costs of different mode designs relative to each other. A fixed price per CATI respondent was agreed upon with the survey institute, which includes multiple call attempts, unsuccessful contacts, supervision, among other aspects. For the self-administered mode designs, the price includes postage, printing, envelopes, and the handling of the survey by the institute, including data entry, programming the web questionnaire, etc. Due to constraints of the contract with the survey institute for the first panel wave, it is not feasible to assign costs separately for each mode design. To overcome this limitation, we utilize the costs for web and mail responses in the follow-up wave and adjust them based on the length of the questionnaire. In doing so, we assume that the costs related to web and mail responses are closely tied to the questionnaire's length, including factors such as more data entry, more programming requirements for a longer questionnaire, and additional data processing. Since this approach ignores fixed costs that are unrelated to the size of the questionnaire, this analysis can be considered more as an upper bound of the costs for the first panel wave. Additionally, we account for costs of printing and postage for invitations and reminders that originate from a separate contract and can be clearly assigned to the mode designs. To compare costs per respondent, we divide the total costs by the number of respondents and then relate these costs to the fixed price per CATI respondent for the follow-up wave and to the current IAB-JVS standard design (first wave: mail-web; follow-up wave: CATI) for both waves.

4.5 Results

4.5.1 Response Rates

For all the following analyses, we first compare the effects of the mode design continuation and switch groups on survey participation in the follow-up wave for each of the mode design groups of the first panel wave. This is followed by comparing the effects of the mode design combinations over both panel waves on cumulative survey participation. Figure 4.2 presents the nonresponse-adjusted response rates for each experimental group in the follow-up panel wave (Q1/2021), whereas Figure 4.3 shows the design-weighted cumulative response rates over both survey waves (Q4/2020 and Q1/2021). Appendix Section 4.B provides a tabular version of these response rates, including absolute numbers of responses and unweighted results.

4.5.1.1 Follow-Up Participation

The results show that for each self-administered mode design implemented in the first wave, continuing with the same mode design in the follow-up wave leads to similar, or higher, response rates compared to switching to a CATI follow-up design. Specifically, the concurrent mail-web and single-mode mail designs exhibit significantly higher response rates in the follow-up wave under a mode design continuation than a mode design switch to CATI, with rates of 72.4% versus 58.7% and 76.9% versus 52.0%, respectively. For the sequential web-to-mail and single-mode web designs, the difference in follow-up response rates between continuing with these mode designs or switching to a CATI mode design is not statistically significant (52.4% versus 59.8% and 57.9% versus 64.8%, respectively). Additional sensitivity checks (see Appendix Section 4.B) show this pattern is consistent for both tranches and whether or not the establishment provides a contact name in the first panel wave. Overall, these findings suggest that continuing with the same self-administered mode design in the follow-up wave leads to similar, or higher, response rates compared to changing to a CATI mode design.

4.5.1.2 Cumulative Participation

Examination of continued participation over the first two waves indicates that using the same self-administered mode design in both waves results in significantly higher cumulative response rates for the concurrent mail-web mixed-mode (10.8% vs. 8.8%) and mail-only designs (11.1% vs. 6.7%) compared to using these mode designs in the first wave and switching to a CATI design in the follow-up wave. The corresponding differences between a mode design continuation and switch in the web-

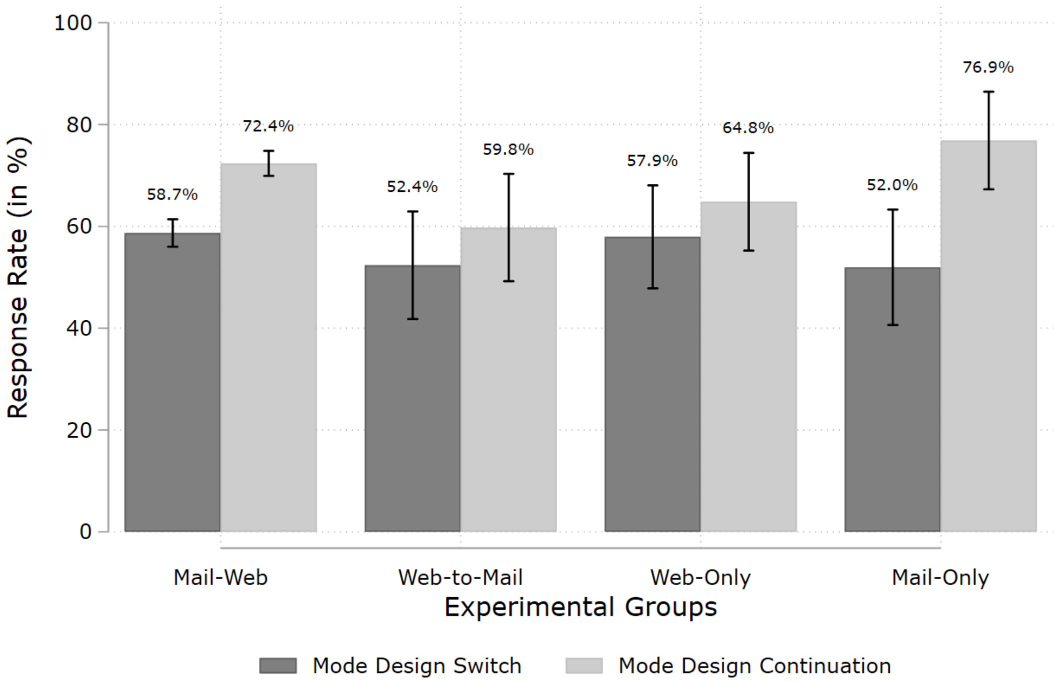


Figure 4.2: Follow-Up Response Rates (Nonresponse-Adjusted) and 95% Confidence Interval by Experimental Group, IAB-JVS 2021/Q1

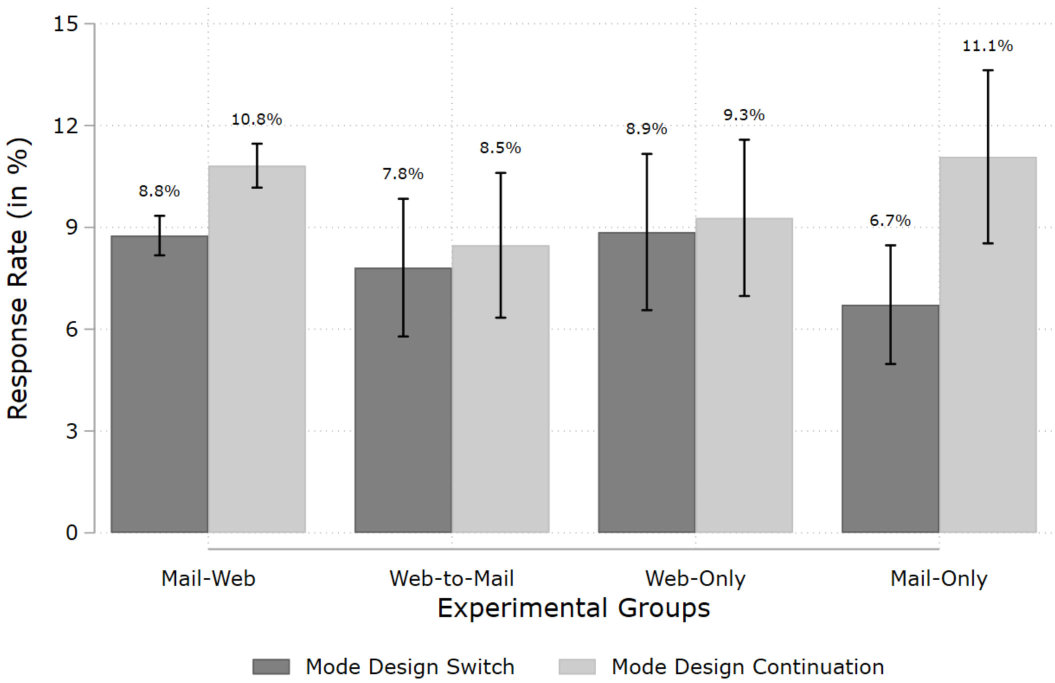


Figure 4.3: Cumulative Response Rates (Design-Weighted) by Experimental Group, IAB-JVS 2020/Q4 - 2021/Q1

to-mail (8.5% vs. 7.8%) and single-mode web groups (9.3% vs. 8.9%) are not statistically significant, although the results marginally favor the mode design continuation. Across all four self-administered mode designs in the first wave with a mode design continuation in the follow-up wave, the cumulative response rates are similar and exhibit no significant differences.

4.5.2 Nonresponse Bias

Figure 4.4 depicts the average absolute nonresponse bias over all BHP administrative variables for the follow-up wave, while Figure 4.5 presents the cumulative average absolute nonresponse bias across both the first and follow-up panel waves. For supplementary information, including tables and figures displaying the average absolute nonresponse bias for subgroups of establishment and employee characteristics, please refer to Appendix Section 4.C. Additionally, Appendix Sections 4.C.3 (follow-up wave) and 4.C.4 (cumulative waves) provide tables of estimated nonresponse biases for individual variables.

4.5.2.1 Follow-Up Participation

The pattern of average absolute nonresponse bias in the follow-up wave mostly reflects the response rate patterns observed earlier. Switching to a CATI design in the follow-up wave exhibits slightly larger nonresponse biases in this wave, on average, compared to continuing the same self-administered mode design from the first wave. This is true for all of the self-administered mode designs considered. However, none of these differences is statistically significant. Overall, the average nonresponse bias estimates are not very large and always below 4.2% for every mode design.

Large and statistically significant estimates of nonresponse bias are observed for some individual variables in the follow-up wave. For example, establishments with 20-49 employees are overrepresented among respondents in the CATI follow-up group when a single-mode mail design was used in the first wave (4.2%-points). Further, establishments in the service industry are underrepresented in the web-to-mail continuation group by 8.7%-points and establishments founded in the 2000s by 11.2%-points in the CATI follow-up group when a web-to-mail design was used in the first wave. In terms of employee characteristics, large nonresponse biases are evident in the single-mode web continuation group, where establishments without apprentices are underrepresented among respondents by 6.5%-points. The smallest proportion of regular employees is underrepresented by 15.6%-points in the CATI follow-up group when a web-to-mail design was used in the first wave.

4.5.2.2 Cumulative Participation

When looking at the cumulative participation perspective, we observe that all experimental groups display nearly identical average nonresponse biases at approximately 4%-points (with the web-to-mail continuation group slightly higher at 5.6%-points) and there are no statistically significant differences between them. Similar patterns are observed when considering subgroup analyses based on establishment and employee characteristics, as well as when examining the median nonresponse bias across different variables (see Appendix Section 4.C).

Regarding the individual nonresponse bias estimates, it becomes evident how cumulative nonresponse bias can be disentangled into wave-specific nonresponse biases that either align or diverge in direction. For instance, the service industry category exhibits a significant and substantial cumulative nonresponse bias of -15.6%-points in the continuation of the web-to-mail design. This bias is influenced by effects from both the first wave (-7.7%-points) and the follow-up wave (-7.9%-points). On the other hand, establishments with the lowest proportion of employees on full-time contracts display a comparably large and statistically significant nonresponse bias of -12.0%-points in the follow-up wave for a CATI switch design, which is partially offset by the nonresponse bias estimate in the first panel wave under a single-mode mail design (2.3%-points), resulting in a statistically insignificant cumulative nonresponse bias of -9.6%-points. Within the single-mode mail design of the first wave and switching to CATI in the follow-up wave leads to virtually no cumulative nonresponse bias (0.6%-points) for establishments with 1-9 employees compared with an overrepresentation of these establishments in the continuation group of the single-mode mail design (11.8%-points). Furthermore, it can be seen that establishments founded in the 2010/20s are statistically significantly

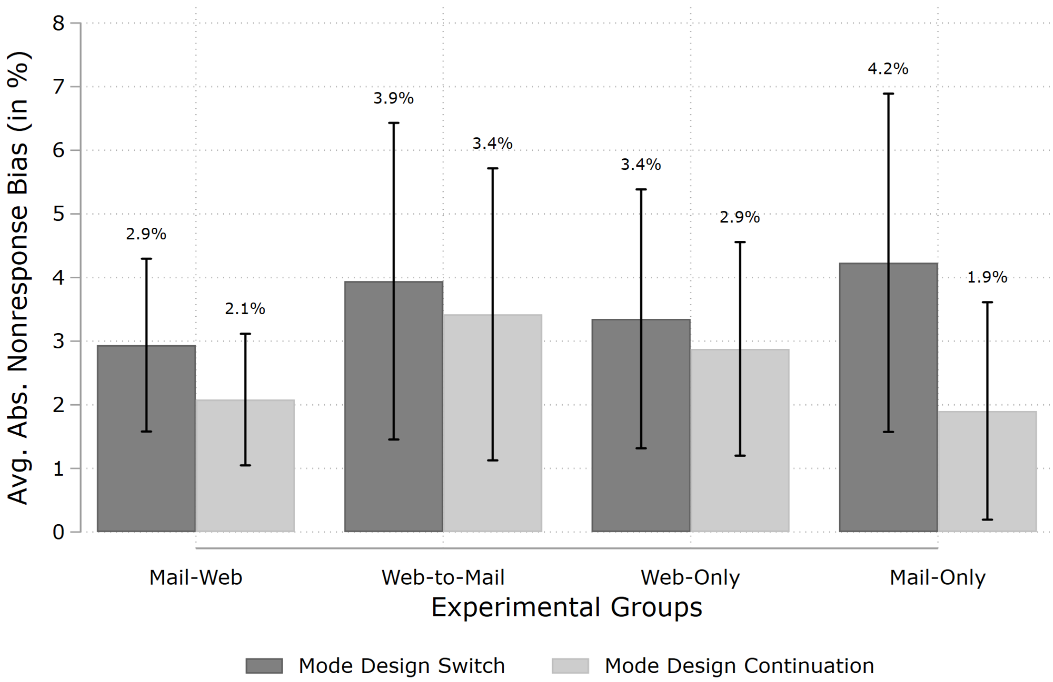


Figure 4.4: Average Absolute Nonresponse Bias for the Follow-Up Wave (Nonresponse-Adjusted) by Experimental Group, All Variables BHP 2020

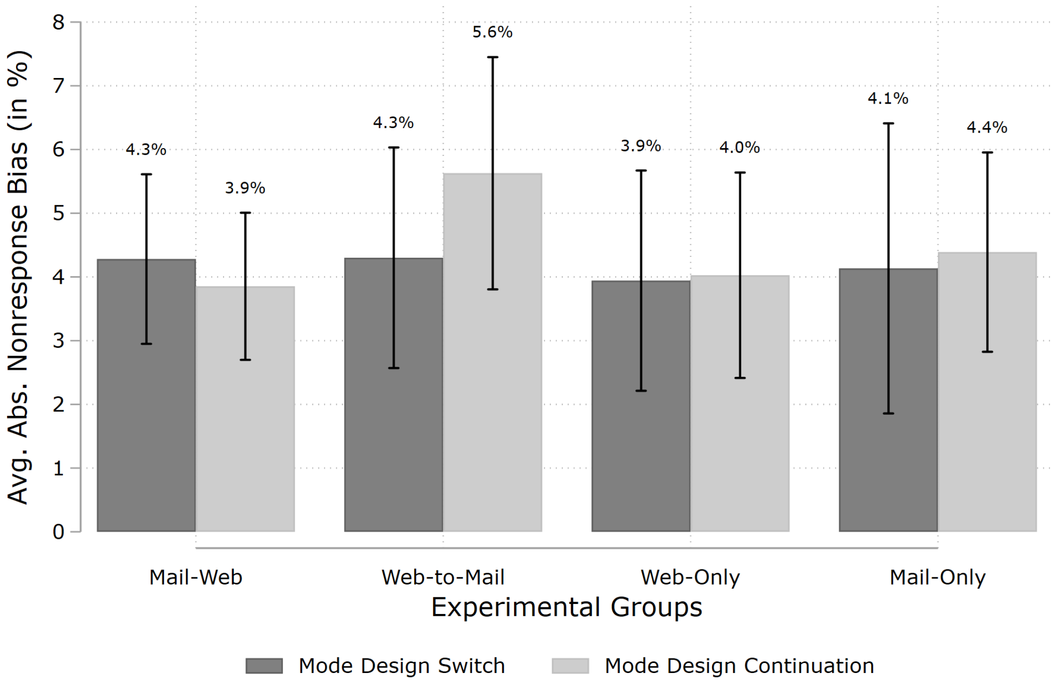


Figure 4.5: Average Absolute Nonresponse Bias Cumulative for Both Waves (Design-Weighted) by Experimental Group, All Variables BHP 2020

underrepresented in the single-mode web continuation group by 14.9%-points, but are not statistically underrepresented in the single-mode web design who were switched to CATI in the follow-up wave (-2.0%-points). Establishments without highly-educated employees are statistically significantly underrepresented among respondents in the web-to-mail continuation group (-16.8%-points), but insignificantly overrepresented in the web-to-mail group that was switched to CATI in the following wave (5.1%-points).

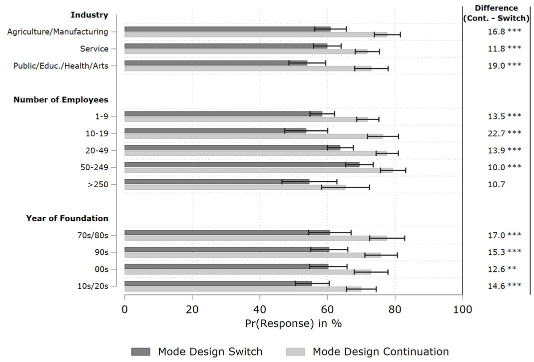
To sum up the nonresponse bias analysis, the findings indicate that using self-administration in both waves does not have a negative effect on average follow-up and cumulative nonresponse bias compared to switching to a CATI design in the follow-up wave. Furthermore, all self-administered mode designs yield similar levels of average follow-up and cumulative nonresponse bias. However, when analyzing biases for individual variables, several differences between the mode designs and also variations between the two waves were observed.

4.5.3 Predictors of Survey Participation

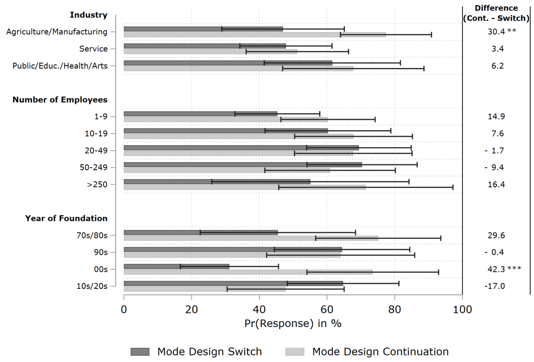
4.5.3.1 Follow-Up Participation

Figure 4.6 shows the predicted probabilities of follow-up survey participation for the mode design continuation and switch groups, presented separately by the mode design used in the first wave.

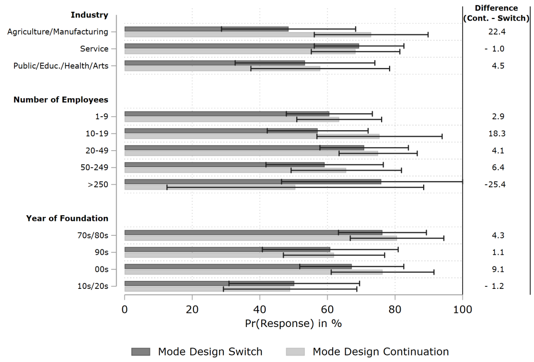
For establishments in the concurrent mail-web mixed-mode design of the first wave (see Figure



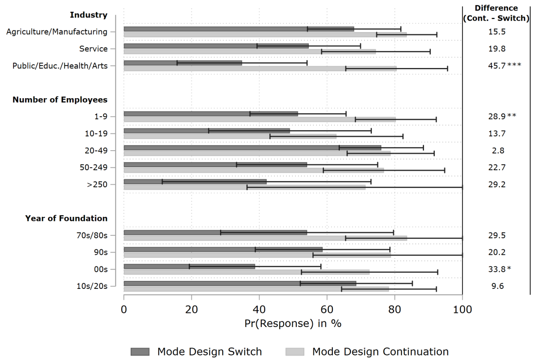
(a) Mail-Web Mixed-Mode



(b) Web-to-Mail Mixed-Mode



(c) Single-Mode Web



(d) Single-Mode Mail

Figure 4.6: Predicted Probabilities and 95% Confidence Intervals of Follow-Up Survey Participation in the Mode Design Continuation and Mode Design Switch Groups by First Wave Mode Design, IAB-JVS 2021/Q1

4.6a), it is evident that all establishment characteristics (industry, number of employees, and year of foundation) are associated with a higher likelihood of response (by at least 10%-points) in the second wave when they are followed up using the same self-administered mode design as opposed to a switch to the CATI design. These differences are statistically significant for each characteristic with the exception of establishments with more than 250 employees. Establishments with 10-19 employees exhibit the most substantial difference of 22.7%-points between the mode design continuation and switch groups.

For those in the sequential web-to-mail mixed-mode design of the first wave (see Figure 4.6b), establishments in agriculture/manufacturing have a 30.4%-points higher predicted response probability in the follow-up wave under the continuation design than the CATI switch design. The other significant effect is observed for establishments founded in 2000s, which have a 42.3%-points higher response probability in the continuation design. All other establishment characteristics do not differ significantly in their response probabilities between the continuation and switch designs.

For the single-mode web design of the first wave (see Figure 4.6c), there are no statistically significant differences in the follow-up response probabilities between the mode design continuation and switch groups.

Lastly, for the single-mode mail design of the first wave (see Figure 4.6d), establishments in the public/education/health/arts industry have a statistically significant 45.7%-points higher response probability in the follow-up wave under the continuation design than the switch design. Similarly, establishments with 1-9 employees show a 28.9%-points significantly higher response probability under the continuation design than the switch design. Additionally, the continuation design outperforms the switch design by 33.8%-points for establishments founded in the 2000s.

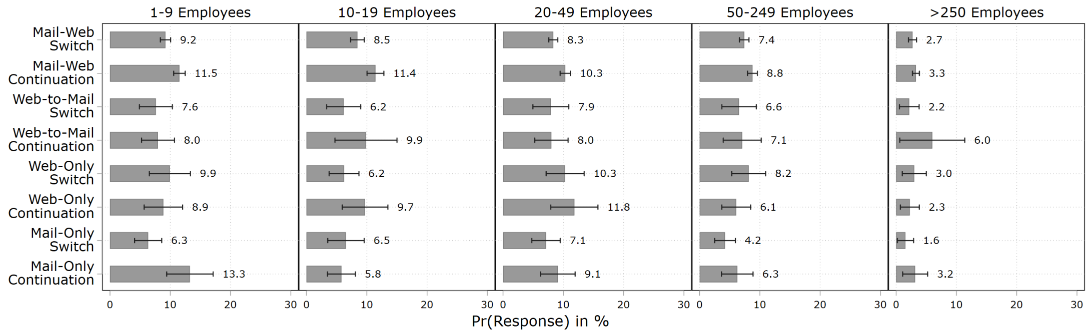
In summary, none of the comparisons indicate an adverse effect of replacing the CATI mode design with a continuation of the self-administered mode design on participation in the follow-up wave. The mode design continuation group consistently outperforms (or performs similarly to) the mode design switch group in terms of estimated response probabilities for all establishment characteristics.

4.5.3.2 Cumulative Participation

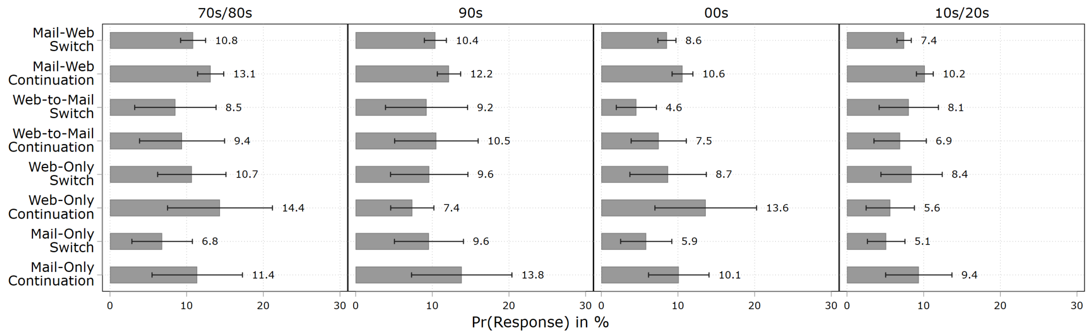
Figure 4.7 shows the predicted response probabilities for cumulative participation in both waves by different establishment characteristics. The results are presented separately by the eight mode design combinations over the two waves. Overall, the results indicate that response patterns are comparable across all eight mode design combinations. The predicted response probabilities are similar with mostly overlapping confidence intervals for each establishment characteristic across the mode combinations. The results also hold when comparing the average marginal effects based on the same logistic regression models 4.D.6.

In summary, the analysis of both follow-up and cumulative panel participation shows that replacing CATI in the follow-up wave with a continuation of self-administration from the first wave results in higher (or similar) response probabilities across all establishment characteristics. Thus, we find no negative effects of forgoing interviewer-administered follow-ups on panel participation.

(a) Industry



(b) Number of Employees



(c) Decade of Foundation

Figure 4.7: Predicted Probabilities and 95% Confidence Intervals of Cumulative Survey Participation in the Mode Design Continuation and Mode Design Switch Groups by First Wave Mode Design, IAB-JVS 2020/Q4 - 2021/Q1

4.5.4 Survey Costs

4.5.4.1 Follow-Up Costs

Figure 4.8 presents empirical evidence regarding the cost structure associated with data collection in the follow-up panel wave, specifically comparing the costs of switching to the CATI mode design to that of continuing with the alternative self-administered mode designs.

The findings indicate that all self-administered mode designs are associated with lower costs than CATI on a per-respondent basis. Among the self-administered mode designs used in the follow-up wave, the single-mode mail design is the most expensive, with costs per respondent reaching 80% of the costs associated with CATI. This is due to the relatively high costs linked to each contact attempt and data entry required for this mode design. The concurrent mail-web mixed-mode design is the second-most expensive design (66% of CATI costs). The higher costs of this mode design are attributable to the expenses incurred for postage and printing, although these are partially offset by the lower data entry costs associated with this mode design. The sequential web-to-mail mixed-mode design and the single-mode web design, which have higher numbers of web respondents and less expensive mailings, are the least expensive mode designs, with costs per respondent reaching 46% and 33% of the costs associated with CATI, respectively. These findings underscore the potential cost savings associated with self-administered mode designs, particularly those that utilize a push-to-web design, in the context of establishment surveys. Moreover, if the follow-up questionnaire were

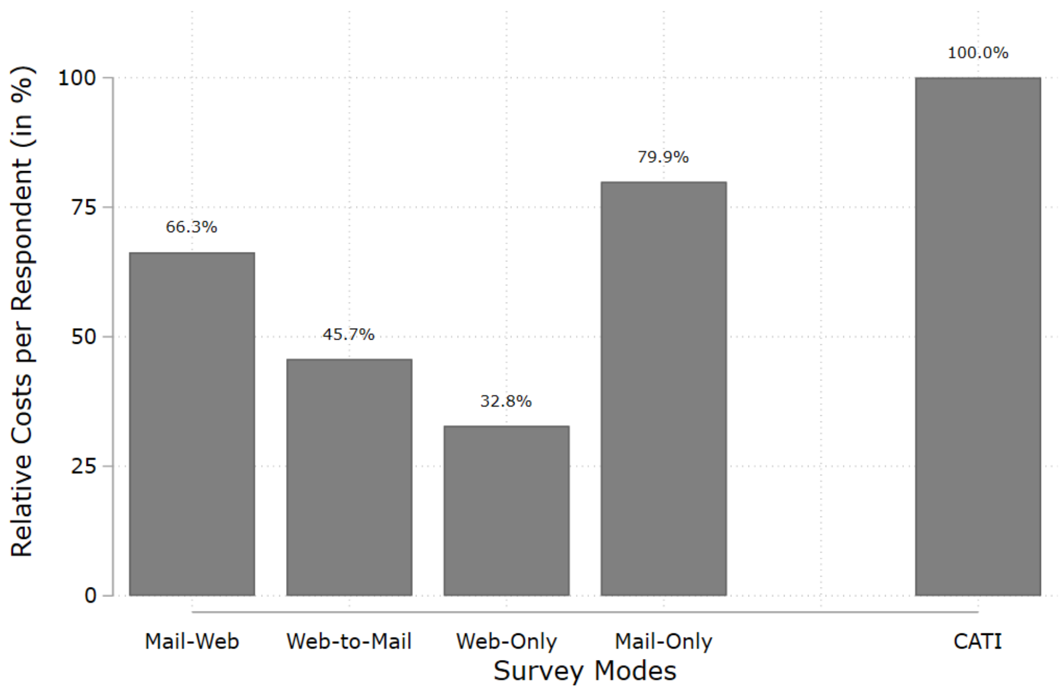


Figure 4.8: Relative Follow-Up Survey Costs per Respondent and Mode Design Compared to CATI Mode Design, IAB-JVS 2021/Q1

to be even longer, the cost advantage of these self-administered mode designs would be even more pronounced.

4.5.4.2 Cumulative Costs

Figure 4.9 depicts the cost structure associated with the mode design combinations used across both panel waves. It presents the relative costs of the different mode design combinations relative to the standard mode design combination used in the IAB-JVS (first wave: mail-web, follow-up wave: CATI).

The analysis shows that the costs of the first panel wave dominate the costs of the follow-up panel wave since the follow-up mode design does not alter the cost ranking of the mode design combinations of both panel waves. Among the different designs, the single-mode mail design used in the first panel wave exhibits the highest relative per-respondent costs for both the mode design switch and continuation groups (switch: 128%, continuation: 125%) relative to the standard mode design combination used in the IAB-JVS. This is followed by the mode design combination commencing with the current standard of the IAB-JVS first wave (switch: 100%, continuation: 95%). Cost savings are observed for designs employing a sequential web-to-mail design (switch: 75%, continuation: 67%) and a single-mode web design in the first panel wave (switch: 46%, continuation: 37%). The dominance of the cumulative costs associated with the first panel wave can be attributed to the utilization

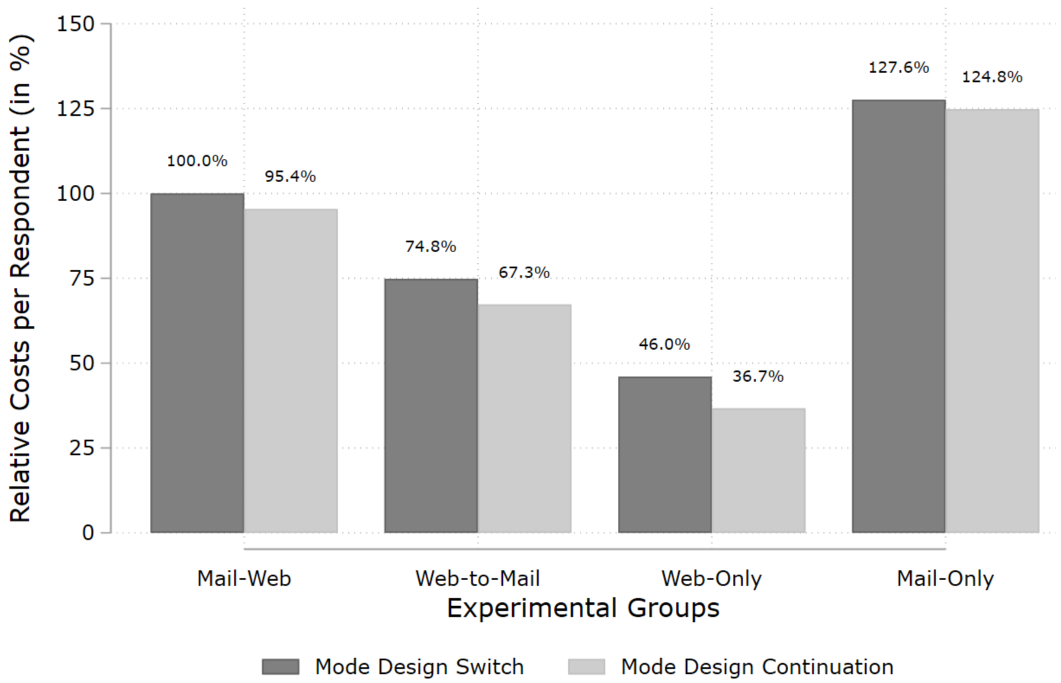


Figure 4.9: Relative Cumulative Survey Costs per Respondent and Mode Design Combination Compared to the Current IAB-JVS Mode Design Combination (First Wave: Mail-Web, Follow-Up Wave: CATI), IAB-JVS 2020/Q4 - 2021/Q1

of a substantially longer questionnaire and a larger number of contacted establishments necessary to achieve the desired number of respondents required to meet Eurostat precision targets.

To conclude, replacing the CATI follow-ups with a continuation of self-administered mode designs results in small cumulative cost savings over both waves, ranging from 3%-points (single-mode mail in the first wave) to 9%-points (single-mode web in the first wave). The potential cumulative cost savings would be greater if the follow-up wave used a longer questionnaire.

4.6 Qualitative Insights

In order to gather further insights into the perceptions of web, mail, and CATI modes and to assess the effects of switching mode designs between the starting wave and the follow-up wave on survey participation processes, a total of 46 short structured interviews and 8 in-depth semi-structured interviews were conducted with respondents of both panel waves of the experiment. The following analysis focuses specifically on perceptions around the CATI mode itself and the current IAB-JVS mode design of switching respondents from self-administration to CATI in the follow-up waves. A more comprehensive qualitative analysis of web and mail modes can be found in Küfner et al. (2024).

As part of the routine pretest for the IAB-JVS, short structured interviews were conducted with respondents from the first wave. These interviews aimed to gather data on establishments' mode preferences and their perceived advantages and disadvantages of web, mail, and CATI modes. Ensuring a representative sample, participating establishments were balanced across experimental groups, establishment sizes, industries, and regions (see Appendix Table 4.E.1). The interviews, conducted via telephone between February and May 2022, targeted human resources representatives and managers responsible for responding to the IAB-JVS. All interviews were executed by trained interviewers from the IAB, with expertise in short structured interviews.

To gain a comprehensive understanding of establishments' perceptions of web, mail, and CATI modes and to explore their attitudes and preferences towards changing to a CATI mode design in the follow-up waves, we additionally conducted 8 in-depth semi-structured interviews with respondents of the first and the follow-up panel waves. These participating establishments were selected to represent each experimental group, establishment size class, industry, and region. Recruitment was carried out by the interviewers of the short structured interviews. We used a semi-structured interview guide (see Appendix Section 4.E.3) and the interviews lasted between 31 and 55 minutes. Each interview was attended by one or two representatives or managers from the human resources department. The interviews were conducted either through video or telephone and were recorded with the participants' consent. Additional methodological details regarding the short structured and in-depth interviews can be found in Appendix Section 4.E.

When asked about their impression of switching mode designs from self-administration to CATI compared to responding in a constant self-administered mode design across two survey waves, respondents strongly preferred keeping the self-administered mode design constant. Most dominantly, respondents explained that a mode design switch would lead to deviating response processes. In the case of a mode design switch to CATI in the follow-up wave, the internal participation process established in the first wave cannot be replicated in the same way: *"Then [i.e., using a self-administered survey mode in the first panel wave] you already know what you have to prepare, and then it [answering in the follow-up wave] goes quickly."* (See Appendix Table 4.E.5, No. 1). Another respondent emphasized the advantage of keeping the data collection procedure constant: *"It also makes sense that you structure it [i.e., collect data] the same way [...] this uniformity is [...] overall a bit more reasonable."* (See Appendix Table 4.E.5, No. 2). Another aspect is that a constant mode design and recruitment strategy increases the probability of being recognized as a follow-up to a previous survey: *"That [a constant mode] makes it easier. You have a recognition value and you know that it's not that extensive that you can integrate it well [into your workday] ."* (See Appendix Table 4.E.5, No. 3). This perception as a follow-up survey is of essential importance for panel surveys, since respondents then link the follow-up wave with the first survey wave and hence do not have to be convinced again of the seriousness and importance of their participation.

Next to the mode design switch element, interviewees talked mostly about the advantages and disadvantages of the CATI mode itself. The most highlighted advantage mentioned during the short interviews was that additional clarification for unclear questions could be provided in telephone interviews. A respondent in the in-depth interviews paraphrased it saying: *"One can also ask questions [...]. You can communicate with each other much better."* (see Appendix Table 4.E.3, No. 1). A CATI mode design, according to some establishments, is linked to less mental burden. Both the preparation for the interview and the actual interview are structured by the interviewer and are not the responsibility of the establishment. In particular, this is true for scheduled interviews: *"It would be for me already better that one says [...] at that time I call and then we do it [the interview]. So otherwise [in the case of self-administered modes] it can be that it is lost to me, then I push it further and further out."* (see Appendix Table 4.E.3, No. 2). Some respondents mentioned that they like to talk to people personally and hence enjoy this aspect of telephone interviewing: *"In terms of personal exchange, it has a different character, because HR managers thrive on talking to people."* (see Appendix Table 4.E.3, No. 3). Related to that, establishments saw an advantage in telephone interviews that they can provide additional information to explain their particular situations, which might help to be seen as a more fruitful contribution: *"Don't you need more info? Or: I would like to give you more info, for example, about this job vacancy. And I'm probably way too boxed in there [when answering self-administered surveys]."* (see Appendix Table 4.E.3, No. 4).

Interestingly, other establishments perceived CATI and especially telephone calls without an appointment as an interruption in their day-to-day business and, thus, as a very burdensome way of being interviewed. One respondent stated: *"I would find it good if something like this [telephone interview] is announced to me. Otherwise it [without appointment] costs [...] each side time."* (see Appendix Table 4.E.4, No. 1). Another reported disadvantage of CATI is that respondents have less time to prepare answers to factual or detailed questions (e.g., checking internal systems), when the questions are not available in advance. In contrast, establishments believe that CATI surveys are a good way to grasp data about rough estimations, trends, or opinions. One respondent expressed it in the following way: *"When they [the survey institute] say: O.k. We recorded the following situation at that time [previous wave interview]. Is the trend consistent, worse, better? You can do that by phone, you don't need precise numbers. If [...]][the survey institute asks if] I have 520 to 530 to 540 [job vacancies], I need to look that up. And then it makes sense to go online."* (See Appendix Table 4.E.4, No. 2). Moreover, some respondents reported privacy concerns when interviewed by telephone: *"We do not provide information by telephone without further notice."* (See Appendix Table 4.E.4, No. 3) or that the interviewer cannot prove legitimacy, which could also lead to refusals: *"On the phone, anyone can tell you that they are any institution."* (See Appendix Table 4.E.4, No. 4). One respondent also stated that he got so many advertising calls that he often tries to decline requests by phone: *"So that's sometimes the crux of this unexpectedness [i.e., unannounced calls] because you're always [...] suspecting something else. [...] That's the defense reflex first."* (See Appendix Table 4.E.4, No. 5). In the in-depth qualitative interviews, some respondents stated additional disadvantages that weren't mentioned during the short interviews. For example, CATI comes with a higher degree of unpredictability as respondents can only control to a limited extent the date and the duration of the interview and do not know the questionnaire in advance. This uncertainty is recognized as a burden of the CATI mode.

In summary, respondents in both the short structured and in-depth interviews perceived more disadvantages of a switch to a CATI mode design in the follow-up waves or the use of the CATI mode in general than when using a constant self-administered mode design in an establishment panel. These disadvantages reflect a higher burden of participation, for example, when established response routines have to be changed because of a change to the mode design from one wave to the next. A summary of the advantages and disadvantages of web, mail, and CATI modes based on the short structured interviews is provided in Appendix Table 4.E.2.

4.7 Conclusion

This study addressed important research gaps related to continuing with the same mode design versus introducing a new mode design in the follow-up wave of establishment panel surveys. Specifically, we analyzed the effects of replacing a CATI mode design in the follow-up wave of a panel with the continuation of a self-administered mode design used in the first panel wave. While previous studies have examined replacing (or supplementing) interviewer-administered modes with self-administered modes in ongoing household panels (e.g., Allum et al., 2018; Bianchi et al., 2017; Jäckle et al., 2015), there is only limited evidence on such changes in establishment panel surveys (e.g., DesRoches et al., 2007; Ellguth & Kohaut, 2014; Gleiser et al., 2022; Moore & Wojan, 2016; Zuckerbraun et al., 2013). This research gap includes the lack of experimental evidence on continuing or altering the mode design on response rates, nonresponse bias, subgroup participation, and survey costs. Given the recent shift to work-from-home and flexible working arrangements in response to the COVID-19 pandemic and their potential negative effects on CATI survey participation (Küfner et al., 2022a), it was especially important to systematically explore the effects of replacing CATI with self-administered data collection techniques.

To address these gaps, we analyzed an experiment comparing a mode design continuation of various self-administered mode designs with a switch to a CATI mode design in the follow-up wave of the IAB-JVS. The first panel wave started with four experimental mode design groups: a concurrent mail-web mixed-mode, a sequential web-to-mail mixed-mode, a single-mode web, and a single-mode mail design. The continuation of these self-administered mode designs yielded higher (for the mail-web and the single-mode mail groups) or similar (for the web-to-mail and single-mode web groups) response rates compared to switching to the CATI mode design in the follow-up wave. The continuation of self-administration also performed slightly better than the switch to the CATI mode design in terms of cumulative response rates over both waves. This was especially pronounced for the single-mode mail and concurrent mail-web designs, perhaps due to the short (one-page) follow-up questionnaire that was clearly visible to establishments that received the paper version. The results showed no significant differences in cumulative response rates between all mode designs that used a continuation of self-administration. Moreover, all experimental groups displayed similar average nonresponse biases in the follow-up panel wave and cumulatively over both panel waves, with no statistically significant differences. Nevertheless, significant variations in individual nonresponse bias estimates were identified among the different designs.

The results of the survey participation models showed that replacing the CATI follow-ups with a continuation of self-administration leads to higher (or similar) predicted response propensities concerning industry, establishment size, and decade of establishment foundation in the follow-up wave. There were no meaningful differences between the eight mode design combinations with respect to cumulative response propensities across both waves.

Lastly, the cost analysis illustrated that the continuation of a self-administered mode design could result in cost savings compared to switching to a CATI design in the follow-up wave. The single-mode web and web-to-mail designs demonstrated the greatest potential for relative cost savings, with 33% and 46% of the CATI costs per respondent, respectively. Meanwhile, the mail-web and single-mode mail designs also achieved cost savings but to a lesser extent (66% and 80% of the CATI costs). The cumulative costs for both panel waves combined were dominated by the costs associated with the first panel wave, since the recruitment and data collection costs are much higher for the more comprehensive first wave. Hence, the cumulative costs are less for the single-mode web design (37%-46% of the standard IAB-JVS design costs) and the sequential web-to-mail design (67%-75% of the standard IAB-JVS design costs) than the standard IAB-JVS design (first wave: mail-web, second wave: CATI) and the single-mode mail design (125%-128% of the standard IAB-JVS design costs). The potential savings in cumulative costs ranged only from 3%-points (single-mode mail) to 9%-points (single-mode web) when replacing the CATI mode design with a continuation of self-administration in the follow-up wave.

To gain deeper insights into the perceptions of the CATI mode and shifting from it to self-administration in the proceeding waves, qualitative interviews were performed with previous survey respondents. The qualitative study revealed that changing from a self-administered mode design in the first wave to a CATI mode design in the follow-up wave imposes additional burdens on respondents. This is attributed to the inability to replicate established response processes used in the first wave and the lower likelihood of recognizing the survey as a follow-up to the previous one under a different mode design. Regarding the use of the CATI mode itself, interviewees highlighted certain advantages, such as the opportunity to clarify unclear questions (see also Haraldsen, 2013b). But respondents also identified disadvantages of the CATI mode, including perceptions of it being burdensome and interrupting their daily business. Privacy and legitimacy concerns with the CATI mode were also reported. Consistent with prior research (e.g., Haraldsen, 2013b; Memobust, 2014), respondents remarked that CATI is less suitable for answering factual questions that require checking internal record systems.

A notable strength of this study is the comprehensive examination of different survey outcomes, including response rates (both follow-up and cumulative), nonresponse bias, subgroup participation, and survey costs. Moreover, this study uniquely combines quantitative experiments and qualitative interviews to examine the advantages and disadvantages of carrying out interviewer-administered follow-ups versus employing a fully self-administered panel design from establishments' perspectives, which yields additional insights into establishments' perceptions of alternative mode designs. Additionally, the results of the survey participation models can be used to identify possible auxiliary variables (e.g., number of employees) for nonresponse correction models or for adaptive designs that tailor their recruitment strategies to maximize the uptake of different modes.

We note some study limitations and possibilities for future research. First, like much of the previous research, this study relies on a single case study to evaluate the effects of altering the mode design in an ongoing panel survey. The observed effects might be different in other establishment panels with more detailed follow-up interviews or a longer time interval between waves (e.g., annually). In addition, it is important to emphasize again that the different mode designs may also affect measurement error and the validity of the survey results; hence, this aspect should be considered in future work.

In summary, these findings suggest that replacing a CATI mode design in the second wave of an establishment panel survey with a continuation of the same self-administered mode design used in the first wave results in higher (or comparable) response rates. On average, we do not observe any negative effects of this approach on nonresponse bias or subgroup participation. Although the concurrent mail-web mixed-mode and single-mode mail designs tended to yield better response rates in the follow-up wave, both push-to-web designs yielded the most significant cost savings. These results are encouraging for survey researchers who are considering abolishing interviewer-administration in their establishment panels in favor of a fully self-administered design.

4.8 References

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4.9 Appendix

4.A Variable Overview and Descriptive Statistics

4.A.1 Descriptive Statistics

Table 4.A.1: Descriptive Statistics - Number of Employees, BHP 2020

	Mail-Web Switch		Mail-Web Cont.		Web-to-Mail Switch		Web-to-Mail Cont.		Web-Only Switch		Web-Only Cont.		Mail-Only Switch		Mail-Only Cont.	
Number of Employees	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
1-9	1,891	69.84 %	1,874	70.63 %	128	71.10 %	123	67.11 %	121	72.13 %	116	65.03 %	118	62.25 %	122	72.41 %
10-19	1,536	15.17 %	1,495	14.35 %	93	12.46 %	111	16.19 %	99	12.59 %	102	18.21 %	88	21.65 %	84	12.84 %
20-49	1,704	9.14 %	1,729	9.26 %	130	10.50 %	119	9.87 %	123	8.66 %	144	10.75 %	104	9.43 %	107	9.49 %
≥50	1,401	5.84 %	1,407	5.76 %	102	5.94 %	97	6.83 %	103	6.62 %	89	6.01 %	78	6.68 %	71	5.26 %
Design Based Pearson χ^2:	0.555															

Table 4.A.2: Descriptive Statistics - East/West Germany, BHP 2020

	Mail-Web Switch		Mail-Web Cont.		Web-to-Mail Switch		Web-to-Mail Cont.		Web-Only Switch		Web-Only Cont.		Mail-Only Switch		Mail-Only Cont.	
East/West Germany	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
East Germany	2,044	20.40 %	2,025	20.06 %	153	21.83 %	152	21.79 %	140	17.51 %	144	21.61 %	131	19.14 %	129	20.96 %
West Germany	4,488	79.60 %	4,480	79.94 %	300	78.17 %	298	78.21 %	306	82.49 %	307	78.39 %	257	80.86 %	255	79.04 %
Design Based Pearson χ^2:	0.967															

Table 4.A.3: Descriptive Statistics - Industry, BHP 2020

	Mail-Web Switch		Mail-Web Cont.		Web-to-Mail Switch		Web-to-Mail Cont.		Web-Only Switch		Web-Only Cont.		Mail-Only Switch		Mail-Only Cont.	
Industry	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
Agric./Manufacturing	2,538	23.09 %	2,515	22.84 %	175	23.54 %	172	24.66 %	181	24.52 %	179	21.49 %	146	24.65 %	141	20.80 %
Service	2,612	53.27 %	2,620	53.72 %	185	50.42 %	177	50.93 %	166	53.72 %	182	55.68 %	166	52.79 %	163	54.67 %
Public/Educ./Health/Arts	1,382	23.65 %	1,370	23.43 %	93	26.04 %	101	24.41 %	99	21.77 %	90	22.83 %	76	22.56 %	80	24.53 %
Design Based Pearson χ^2:	1.000															

Table 4.A.4: Descriptive Statistics - Industry, BHP 2020

	Mail-Web Switch		Mail-Web Cont.		Web-to-Mail Switch		Web-to-Mail Cont.		Web-Only Switch		Web-Only Cont.		Mail-Only Switch		Mail-Only Cont.	
Industry	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
Agriculture / Forestry	224	2.74 %	222	2.69 %	13	2.84 %	12	2.87 %	17	2.69 %	17	2.30 %	17	3.67 %	9	1.55 %
Mining / Ores / Earths	40	0.05 %	44	0.07 %	1	0.03 %	1	0.03 %	3	0.06 %	3	0.08 %	3	0.09 %	2	0.06 %
Nutrition / Textiles / Clothing / Furniture etc.	334	2.36 %	332	2.34 %	21	2.80 %	28	2.20 %	28	3.10 %	28	3.17 %	14	1.63 %	22	3.14 %
Wood / Paper / Printing	266	0.73 %	267	0.72 %	16	0.74 %	15	0.72 %	16	0.57 %	17	0.63 %	14	0.81 %	16	0.66 %
Chemistry / Plastics / Glass / Construction Materials	297	0.90 %	288	0.89 %	22	0.73 %	19	0.75 %	21	1.02 %	18	0.72 %	20	1.27 %	14	0.79 %
Metals / Metal Production	353	1.98 %	349	1.95 %	30	2.63 %	24	1.98 %	25	1.79 %	30	1.94 %	18	1.88 %	21	1.63 %
Machines / Electronics / Vehicles	395	2.37 %	388	2.36 %	31	2.25 %	29	2.51 %	22	2.08 %	22	2.05 %	21	2.69 %	24	2.77 %
Energy Utilities	100	0.29 %	97	0.28 %	5	0.26 %	10	0.56 %	6	0.33 %	6	0.29 %	4	0.23 %	3	0.19 %
Water / Waste Management	226	0.51 %	229	0.52 %	14	0.53 %	13	0.55 %	14	0.46 %	15	0.56 %	17	0.75 %	14	0.45 %
Construction	303	11.15 %	299	11.03 %	22	10.72 %	21	12.48 %	29	12.41 %	23	9.77 %	18	11.62 %	16	9.56 %
Trade / Retail / Car-Repair	293	19.16 %	301	19.09 %	18	19.44 %	22	17.26 %	20	17.18 %	25	19.00 %	13	13.19 %	21	23.93 %
Transport/ Warehouses	320	3.73 %	327	3.73 %	26	3.67 %	22	3.13 %	23	3.40 %	25	4.54 %	29	4.05 %	28	3.28 %
Hospitality	366	6.01 %	365	5.91 %	20	3.58 %	24	4.72 %	30	7.92 %	25	6.06 %	24	6.84 %	21	5.95 %
Information and Communication	374	3.01 %	364	3.02 %	23	2.36 %	20	3.69 %	17	3.05 %	21	3.46 %	19	4.15 %	20	2.55 %
Financial Services / Insurance	208	2.93 %	217	2.92 %	10	3.13 %	11	2.88 %	8	1.83 %	11	5.53 %	13	3.03 %	12	3.21 %
Real Estate	219	2.62 %	217	2.59 %	17	4.16 %	21	4.49 %	10	2.23 %	11	2.15 %	16	3.18 %	12	2.58 %
Liberal Professions / Scientific / Technical Services	318	11.07 %	315	11.19 %	28	9.88 %	17	8.75 %	23	14.03 %	25	10.34 %	21	12.67 %	20	8.27 %
Other Commercial Services/ Without Temporary Employment Agencies	273	1.61 %	242	1.28 %	25	2.01 %	18	1.33 %	19	0.90 %	19	0.54 %	19	0.79 %	16	2.11 %
Temporary Employment Agencies	241	3.13 %	272	3.98 %	18	2.20 %	22	4.69 %	16	3.18 %	20	4.06 %	12	4.90 %	13	2.77 %
Public Administration	309	1.40 %	307	1.42 %	20	1.52 %	21	1.50 %	23	1.64 %	22	1.37 %	16	1.72 %	15	1.36 %
Education / Child Care	295	2.77 %	292	2.80 %	17	1.94 %	18	2.67 %	21	2.34 %	17	2.67 %	15	2.62 %	20	2.86 %
Health / Social Services	294	11.88 %	297	11.65 %	21	16.35 %	25	13.25 %	18	8.70 %	23	12.73 %	17	11.60 %	16	12.27 %
Art / Entertainment / Recreation	183	1.30 %	181	1.34 %	12	1.45 %	16	1.66 %	16	2.13 %	14	1.75 %	18	1.98 %	14	0.70 %
Other Services	301	6.29 %	293	6.23 %	23	4.78 %	21	5.34 %	21	6.96 %	14	4.30 %	10	4.64 %	15	7.34 %
Design Based Pearson χ^2:	1.000															

Table 4.A.5: Descriptive Statistics - Federal State aggregated, BHP 2020

	Mail-Web Switch		Mail-Web Cont.		Web-to-Mail Switch		Web-to-Mail Cont.		Web-Only Switch		Web-Only Cont.		Mail-Only Switch		Mail-Only Cont.	
Federal State aggregated	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
Schleswig-Holstein + Hamburg	324	5.92 %	337	7.23 %	18	6.36 %	20	6.05 %	19	2.98 %	18	5.25 %	30	11.22 %	21	5.15 %
Lower Saxony + Bremen	570	10.10 %	598	11.78 %	45	19.24 %	42	13.31 %	43	7.66 %	52	10.67 %	24	10.17 %	39	7.53 %
North Rhine-Westphalia	997	18.77 %	1,042	17.21 %	79	9.21 %	81	19.51 %	70	19.90 %	67	12.50 %	49	15.55 %	57	18.26 %
Hesse	396	8.00 %	392	7.65 %	34	9.22 %	22	3.13 %	25	8.62 %	22	10.28 %	25	3.68 %	16	9.12 %
Rhineland-Palatinate + Saarland	306	5.36 %	280	5.24 %	15	4.13 %	14	5.24 %	22	9.46 %	17	3.44 %	14	3.22 %	14	6.79 %
Baden-Wuerttemberg	833	13.82 %	806	12.67 %	58	15.91 %	57	11.69 %	59	15.71 %	58	14.24 %	47	18.93 %	40	10.02 %
Bavaria	1,062	17.64 %	1,025	18.17 %	51	14.10 %	62	19.28 %	68	18.15 %	73	22.01 %	68	18.08 %	68	22.17 %
Brandenburg + Berlin	690	7.28 %	682	7.43 %	57	9.33 %	50	4.74 %	49	6.00 %	49	10.06 %	41	5.36 %	44	10.13 %
Mecklenburg-Vorpommern	243	2.62 %	230	2.53 %	26	3.67 %	22	4.52 %	11	1.74 %	17	1.66 %	12	1.73 %	23	4.12 %
Saxony	567	5.61 %	547	4.85 %	39	5.10 %	46	4.36 %	36	3.87 %	41	4.24 %	39	6.25 %	25	2.70 %
Saxony-Anhalt	253	2.26 %	261	2.60 %	18	2.17 %	19	3.79 %	21	2.71 %	17	4.39 %	16	1.90 %	20	1.78 %
Thuringia	291	2.62 %	305	2.65 %	13	1.55 %	15	4.38 %	23	3.19 %	20	1.26 %	23	3.90 %	17	2.23 %
Design Based Pearson χ^2:	0.508															

Table 4.A.6: Descriptive Statistics - Foundation Year, BHP 2020

	Mail-Web Switch		Mail-Web Cont.		Web-to-Mail Switch		Web-to-Mail Cont.		Web-Only Switch		Web-Only Cont.		Mail-Only Switch		Mail-Only Cont.	
Foundation Year	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
70s/80s	1,719	20.20 %	1,741	18.85 %	118	19.91 %	118	17.97 %	120	16.28 %	123	20.55 %	94	17.86 %	95	17.19 %
90s	1,725	23.07 %	1,692	21.09 %	121	21.10 %	125	24.51 %	117	20.02 %	120	17.35 %	125	27.67 %	113	28.37 %
00s	1,494	22.66 %	1,492	24.23 %	111	28.30 %	104	19.95 %	104	24.03 %	109	29.90 %	85	33.09 %	95	26.47 %
10s	1,594	34.07 %	1,580	35.83 %	103	30.69 %	103	37.56 %	105	39.67 %	99	32.20 %	84	21.38 %	81	27.96 %
Design Based Pearson χ^2:	0.450															

Table 4.A.7: Descriptive Statistics - Avg. Age of Employees, BHP 2020

	Mail-Web Switch		Mail-Web Cont.		Web-to-Mail Switch		Web-to-Mail Cont.		Web-Only Switch		Web-Only Cont.		Mail-Only Switch		Mail-Only Cont.	
Avg. Age of Employees	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
0.00-38.99	1,411	28.19 %	1,408	28.69 %	96	26.16 %	98	29.45 %	107	29.23 %	86	23.51 %	81	31.04 %	89	25.71 %
39.00-43.49	1,524	19.56 %	1,521	19.10 %	103	14.98 %	109	24.88 %	112	19.56 %	107	21.69 %	89	20.33 %	87	17.37 %
43.50-47.99	1,766	19.63 %	1,801	20.16 %	116	15.65 %	117	18.95 %	118	22.15 %	129	19.46 %	105	15.13 %	95	16.94 %
≥48.00	1,831	32.62 %	1,775	32.05 %	138	43.21 %	126	26.72 %	109	29.06 %	129	35.34 %	113	33.51 %	113	39.98 %
Design Based Pearson χ^2:	0.772															

Table 4.A.8: Descriptive Statistics - Prop. of Apprentices, BHP 2020

	Mail-Web Switch		Mail-Web Cont.		Web-to-Mail Switch		Web-to-Mail Cont.		Web-Only Switch		Web-Only Cont.		Mail-Only Switch		Mail-Only Cont.	
Prop. of Apprentices	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
0.00	4,147	80.60 %	4,131	78.72 %	293	78.54 %	286	76.63 %	282	82.61 %	269	74.69 %	249	78.81 %	244	75.69 %
0.01-100	2,385	19.40 %	2,374	21.28 %	160	21.46 %	164	23.37 %	164	17.39 %	182	25.31 %	139	21.19 %	140	24.31 %
Design Based Pearson χ^2:	0.698															

Table 4.A.9: Descriptive Statistics - Prop. of Female Employees, BHP 2020

	Mail-Web Switch		Mail-Web Cont.		Web-to-Mail Switch		Web-to-Mail Cont.		Web-Only Switch		Web-Only Cont.		Mail-Only Switch		Mail-Only Cont.	
Prop. of Female Employees	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
0.00 - 18.18	1,728	22.54 %	1,691	23.77 %	129	24.61 %	125	18.77 %	132	24.27 %	115	19.44 %	113	22.26 %	95	19.88 %
18.19 - 40.97	1,684	17.36 %	1,675	18.52 %	111	16.28 %	116	25.22 %	99	15.79 %	119	19.06 %	92	24.46 %	104	18.55 %
40.98 - 67.12	1,491	19.41 %	1,556	20.70 %	109	19.37 %	108	23.38 %	101	14.48 %	111	23.59 %	86	20.22 %	85	19.92 %
>67.13	1,629	40.69 %	1,583	37.02 %	104	39.73 %	101	32.62 %	114	45.46 %	106	37.92 %	97	33.06 %	100	41.65 %
Design Based Pearson χ^2:	0.803															

Table 4.A.10: Descriptive Statistics - Prop. of Fixed-Term Contracts, BHP 2020

	Mail-Web Switch		Mail-Web Cont.		Web-to-Mail Switch		Web-to-Mail Cont.		Web-Only Switch		Web-Only Cont.		Mail-Only Switch		Mail-Only Cont.	
Prop. of Fixed-Term Contracts	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
0.00	2,448	63.38 %	2,438	66.07 %	167	65.64 %	166	58.36 %	156	64.77 %	177	67.47 %	152	55.53 %	145	60.07 %
0.01 - 15.99	1,919	14.16 %	1,923	12.20 %	148	12.50 %	124	14.38 %	149	14.77 %	126	11.20 %	115	17.99 %	105	10.06 %
≥16.00	2,165	22.45 %	2,144	21.73 %	138	21.85 %	160	27.26 %	141	20.46 %	148	21.33 %	121	26.48 %	134	29.87 %
Design Based Pearson χ^2:	0.521															

Table 4.A.11: Descriptive Statistics - Prop. of Full-Time Contracts, BHP 2020

	Mail-Web Switch		Mail-Web Cont.		Web-to-Mail Switch		Web-to-Mail Cont.		Web-Only Switch		Web-Only Cont.		Mail-Only Switch		Mail-Only Cont.	
Prop. of Full-Time Contracts	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
0.00 - 36.38	1,651	45.22 %	1,651	44.40 %	102	46.95 %	111	41.59 %	101	45.66 %	111	39.56 %	100	46.41 %	118	49.29 %
36.39 - 66.66	1,666	25.08 %	1,668	22.86 %	109	17.40 %	110	15.25 %	120	23.56 %	112	26.08 %	99	23.98 %	89	23.60 %
66.67 - 85.28	1,757	14.53 %	1,766	15.63 %	131	15.70 %	121	25.97 %	126	15.26 %	124	17.05 %	102	15.04 %	105	13.17 %
>85.29	1,458	15.17 %	1,420	17.11 %	111	19.95 %	108	17.20 %	99	15.52 %	104	17.30 %	87	14.57 %	72	13.94 %
Design Based Pearson χ^2:	0.600															

Table 4.A.12: Descriptive Statistics - Prop. of German Citizens, BHP 2020

	Mail-Web Switch		Mail-Web Cont.		Web-to-Mail Switch		Web-to-Mail Cont.		Web-Only Switch		Web-Only Cont.		Mail-Only Switch		Mail-Only Cont.	
Prop. of German Citizens	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
100.00	2,919	63.24 %	2,865	62.12 %	187	63.46 %	187	61.66 %	186	60.00 %	204	69.35 %	175	54.05 %	180	64.05 %
0.00-99.99	3,613	36.76 %	3,640	37.88 %	266	36.54 %	263	38.34 %	260	40.00 %	247	30.65 %	213	45.95 %	204	35.95 %
Design Based Pearson χ^2:	0.464															

Table 4.A.13: Descriptive Statistics - Prop. of High-Educated Employees, BHP 2020

	Mail-Web Switch		Mail-Web Cont.		Web-to-Mail Switch		Web-to-Mail Cont.		Web-Only Switch		Web-Only Cont.		Mail-Only Switch		Mail-Only Cont.	
Prop. of High-Educated Employees	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
0.00	1,974	54.19 %	2,029	54.42 %	131	57.09 %	126	37.38 %	134	50.61 %	135	51.22 %	113	52.91 %	114	48.78 %
0.01 - 14.99	2,265	14.58 %	2,219	14.26 %	154	14.86 %	152	15.32 %	142	11.97 %	164	17.49 %	128	17.06 %	134	15.76 %
≥15.00	2,293	31.23 %	2,257	31.32 %	168	28.05 %	172	47.31 %	170	37.41 %	152	31.30 %	147	30.03 %	136	35.45 %
Design Based Pearson χ^2:	0.184															

Table 4.A.14: Descriptive Statistics - Prop. of Mid-Educated Employees, BHP 2020

	Mail-Web Switch		Mail-Web Cont.		Web-to-Mail Switch		Web-to-Mail Cont.		Web-Only Switch		Web-Only Cont.		Mail-Only Switch		Mail-Only Cont.	
Prop. of Mid-Educated Employees	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
0.00 - 50.00	1,600	30.00 %	1,621	30.60 %	119	26.25 %	107	31.12 %	113	33.93 %	80	21.37 %	97	29.64 %	103	34.66 %
50.01 - 70.58	1,387	15.43 %	1,409	15.88 %	100	16.36 %	110	20.31 %	105	17.27 %	111	19.53 %	88	22.08 %	66	17.98 %
70.59 - 84.99	1,761	18.23 %	1,673	16.93 %	103	16.05 %	122	23.09 %	128	12.61 %	131	23.94 %	93	13.10 %	101	14.43 %
>85.00	1,784	36.33 %	1,802	36.59 %	131	41.34 %	111	25.49 %	100	36.19 %	129	35.16 %	110	35.18 %	114	32.93 %
Design Based Pearson χ^2:	0.495															

Table 4.A.15: Descriptive Statistics - Prop. of Low-Educated Employees, BHP 2020

	Mail-Web Switch		Mail-Web Cont.		Web-to-Mail Switch		Web-to-Mail Cont.		Web-Only Switch		Web-Only Cont.		Mail-Only Switch		Mail-Only Cont.	
Prop. of Low-Educated Employees	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
0.00	2,326	57.95 %	2,255	57.00 %	152	53.89 %	162	53.21 %	146	61.17 %	156	55.32 %	146	52.47 %	147	55.41 %
0.01 - 11.99	2,245	12.78 %	2,208	12.87 %	165	14.74 %	150	15.95 %	169	14.65 %	161	19.56 %	130	12.34 %	133	13.45 %
≥12.00	1,961	29.27 %	2,042	30.13 %	136	31.37 %	138	30.84 %	131	24.18 %	134	25.12 %	112	35.19 %	104	31.14 %
Design Based Pearson χ^2:	0.717															

Table 4.A.16: Descriptive Statistics - Prop. of Unknown-Educated Employees, BHP 2020

	Mail-Web Switch		Mail-Web Cont.		Web-to-Mail Switch		Web-to-Mail Cont.		Web-Only Switch		Web-Only Cont.		Mail-Only Switch		Mail-Only Cont.	
Prop. of Unknown-Educated Employees	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
0.00	3,856	70.45 %	3,866	74.18 %	271	77.61 %	260	78.54 %	253	77.57 %	267	70.90 %	226	63.52 %	226	72.08 %
0.01-100.00	2,676	29.55 %	2,639	25.82 %	182	22.39 %	190	21.46 %	193	22.43 %	184	29.10 %	162	36.48 %	158	27.92 %
Design Based Pearson χ^2:	0.119															

Table 4.A.17: Descriptive Statistics - Prop. of Marginal Contracts, BHP 2020

	Mail-Web Switch		Mail-Web Cont.		Web-to-Mail Switch		Web-to-Mail Cont.		Web-Only Switch		Web-Only Cont.		Mail-Only Switch		Mail-Only Cont.	
Prop. of Marginal Contracts	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
0.00	2,184	40.26 %	2,155	41.47 %	148	36.60 %	158	43.14 %	155	47.97 %	158	44.72 %	131	36.82 %	112	39.66 %
0.00-14.99	2,281	13.54 %	2,283	14.28 %	168	16.80 %	157	13.51 %	171	16.43 %	160	16.64 %	139	14.81 %	144	15.15 %
≥15.00	2,067	46.20 %	2,067	44.25 %	137	46.61 %	135	43.35 %	120	35.59 %	133	38.63 %	118	48.37 %	128	45.19 %
Design Based Pearson χ^2:	0.764															

Table 4.A.18: Descriptive Statistics - Prop. of Part-Time Contracts, BHP 2020

	Mail-Web Switch		Mail-Web Cont.		Web-to-Mail Switch		Web-to-Mail Cont.		Web-Only Switch		Web-Only Cont.		Mail-Only Switch		Mail-Only Cont.	
Prop. of Part-Time Contracts	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
0.00	1,240	28.14 %	1,203	29.05 %	92	32.31 %	90	29.32 %	83	23.53 %	96	30.33 %	86	26.42 %	72	27.59 %
0.01 - 19.99	2,452	15.94 %	2,484	17.91 %	174	13.89 %	172	19.65 %	170	16.60 %	163	18.85 %	150	18.79 %	143	16.04 %
≥20.00	2,840	55.92 %	2,818	53.03 %	187	53.80 %	188	51.03 %	193	59.87 %	192	50.82 %	152	54.79 %	169	56.37 %
Design Based Pearson χ^2:	0.944															

Table 4.A.19: Descriptive Statistics - Prop. of Regular Contracts, BHP 2020

	Mail-Web Switch		Mail-Web Cont.		Web-to-Mail Switch		Web-to-Mail Cont.		Web-Only Switch		Web-Only Cont.		Mail-Only Switch		Mail-Only Cont.	
Prop. of Regular Contracts	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.	unwgt. Obs.	wgt. Prop.
0.00 - 75.00	1,982	47.25 %	1,999	46.17 %	123	48.58 %	118	34.74 %	118	35.04 %	138	48.87 %	117	48.36 %	120	48.17 %
75.01 - 88.88	1,555	13.10 %	1,602	14.37 %	112	13.05 %	123	24.41 %	115	12.66 %	111	14.36 %	90	14.03 %	105	13.62 %
88.89 - 97.43	1,515	7.24 %	1,489	6.85 %	117	10.36 %	100	6.75 %	106	10.75 %	99	6.54 %	97	8.75 %	88	8.75 %
>97.44	1,480	32.41 %	1,415	32.60 %	101	28.00 %	109	34.09 %	107	41.55 %	103	30.24 %	84	28.86 %	71	29.47 %
Design Based Pearson χ^2:	0.144															

4.A.2 Variable Overview

Table 4.A.20: Variable Overview

Variable	Bias Measure	Participation Models
Research Objective	**RQ2**	**RQ3**
Establishment Characteristics		
East/West Germany	X	-
Foundation Year	X	X
Industry	X	X
Number of Employees	X	X
Employee Characteristics		
Avg. Age of Employees	X	-
Proportion of Female	X	-
Proportion of Fixed-Term	X	-
Proportion of Apprentices	X	-
Proportion of Full-Time	X	-
Proportion of Part-Time	X	-
Proportion of Germans	X	-
Proportion of Regular	X	-
Proportion of Marginal	X	-
Proportion of High-Educated	X	-
Proportion of Mid-Educated	X	-
Proportion of Low-Educated	X	-
Proportion of Unknown Educated	X	-
Quartile of Wage Distribution	X	-

4.B Response Rates

Table 4.B.1: Survey Response Summary Statistics, IAB-JVS 2020 - 2021

	Mail-Web		Web-to-Mail		Web-Only		Mail-Only		Total
Full Sample - First Wave	109,924		7,510		7,493		7,506		132,433
Respondents - First Wave	13,298		924		913		790		15,925
	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.	Total
Full Sample - Follow-Up Wave	6,648	6,619	465	458	457	456	396	391	15,890
Web Respondents - Follow-Up Wave	0	1,387	0	232	0	309	0	0	1,928
Mail Respondents - Follow-Up Wave	0	3,639	0	79	0	0	0	308	4,026
CATI Respondents - Follow-Up Wave	4,193	0	260	0	293	0	257	0	5,003
Follow-Up Response Rate (unweighted)	63.1	75.9	55.9	67.9	64.1	67.8	64.9	78.8	69.0
Follow-Up Response Rate (weighted)	58.7	72.4	52.4	59.8	57.9	64.8	52.0	76.9	61.8
Follow-Up Web Response Rate (unweighted)	0.0	21.0	0.0	50.7	0.0	67.8	0.0	0.0	24.3
Follow-Up Web Response Rate (weighted)	0.0	17.5	0.0	41.1	0.0	64.8	0.0	0.0	30.9
Follow-Up Mail Response Rate (unweighted)	0.0	55.0	0.0	17.2	0.0	0.0	0.0	78.8	50.8
Follow-Up Mail Response Rate (weighted)	0.0	54.9	0.0	18.6	0.0	0.0	0.0	76.9	37.6
Follow-Up CATI Response Rate (unweighted)	63.1	0.0	55.9	0.0	64.1	0.0	64.9	0.0	62.8
Follow-Up CATI Response Rate (weighted)	58.7	0.0	52.4	0.0	57.9	0.0	52.0	0.0	55.2

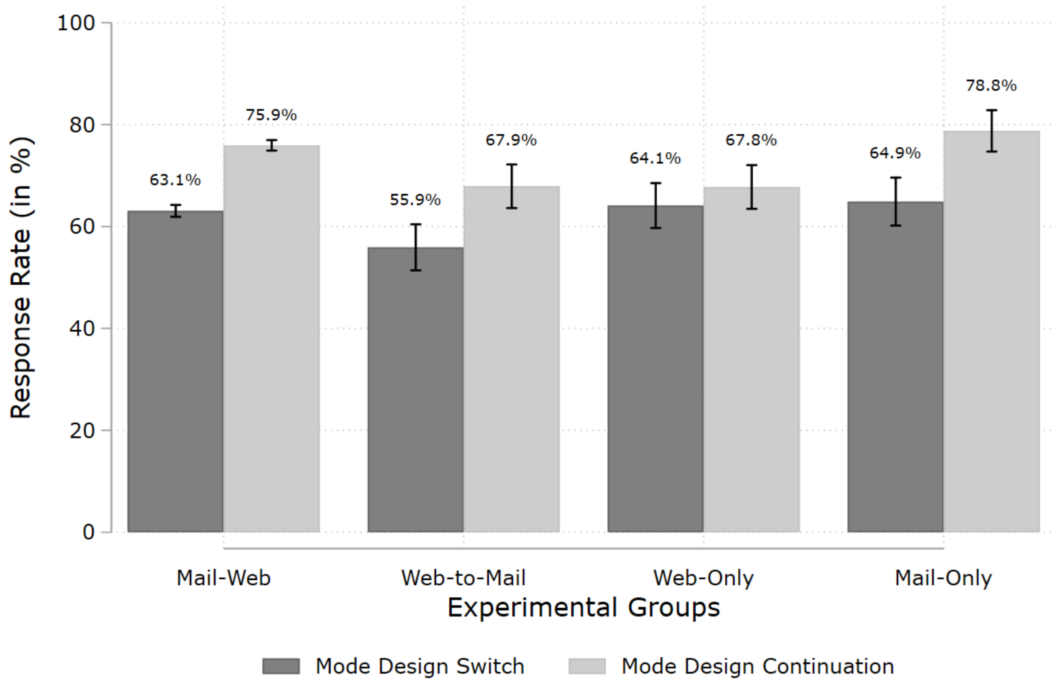


Figure 4.B.1: Follow-Up Response Rate (Unweighted) and 95% Confidence Interval by Experimental Group, IAB-JVS 2021/Q1

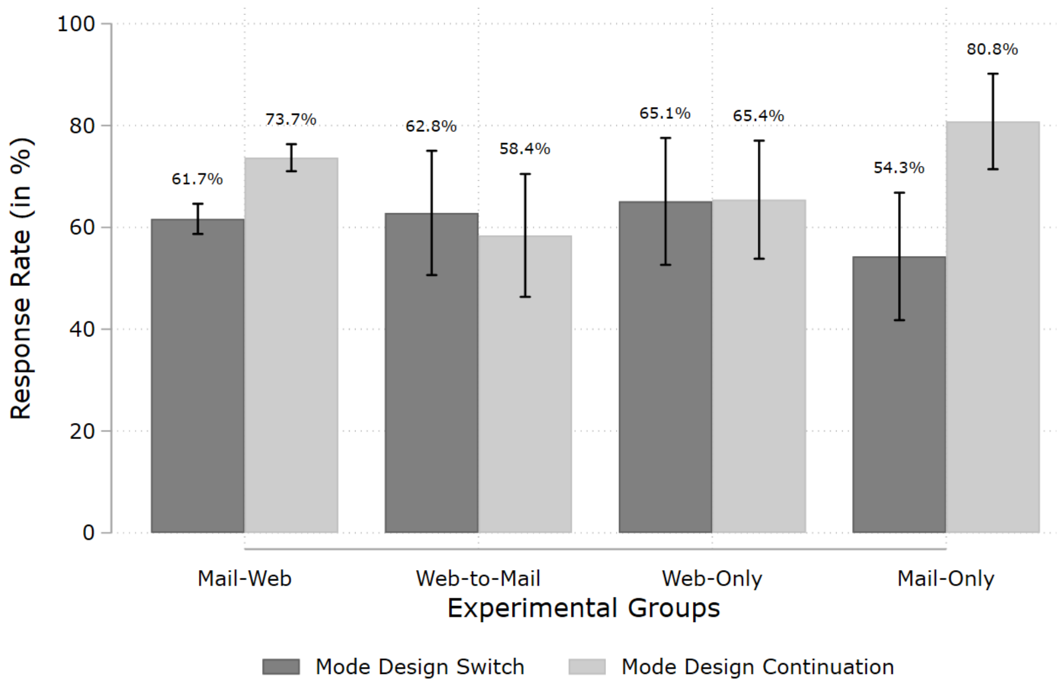


Figure 4.B.2: Follow-Up Response Rate (Nonresponse-Adjusted) and 95% Confidence Interval by Experimental Group if Contact Person is Stated in First Wave Questionnaire, IAB-JVS 2021/Q1

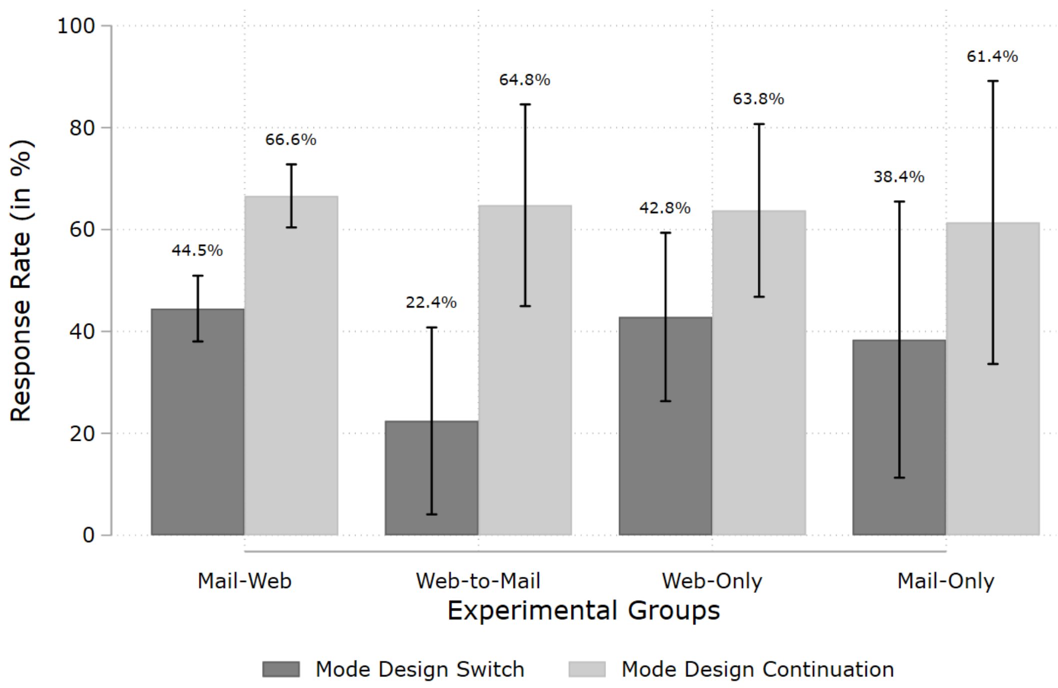


Figure 4.B.3: Follow-Up Response Rate (Nonresponse-Adjusted) and 95% Confidence Interval by Experimental Group if No Contact Person is Stated in First Wave Questionnaire, IAB-JVS 2021/Q1

4.B.1 Sample Tranches

Respondents from the first wave of the 2020 panel were divided into Tranche 1 and Tranche 2 for contact in the follow-up wave. Due to the process of registering respondents from the first wave of the panel, checking that they met the requirements to be included in the follow-up wave, and avoiding responses to both waves within only a few days, respondents registered after 10th of December 2020 were assigned to Tranche 2. Tranche 1 started with ”thank you” letters sent on December 28th, and CATI calls started on January 11th, 2021. Self-administered invitation letters were scheduled to arrive on Saturday, January 9th, for a comparable field period. Tranche 1 post-due-date reminders were sent on March 1st. Tranche 2 thank you letters were sent out on February 8th, CATI calls and invitation letters were carried out from February 15th, and post-due-date reminders for the self-administered mode designs were sent out on March 15th.

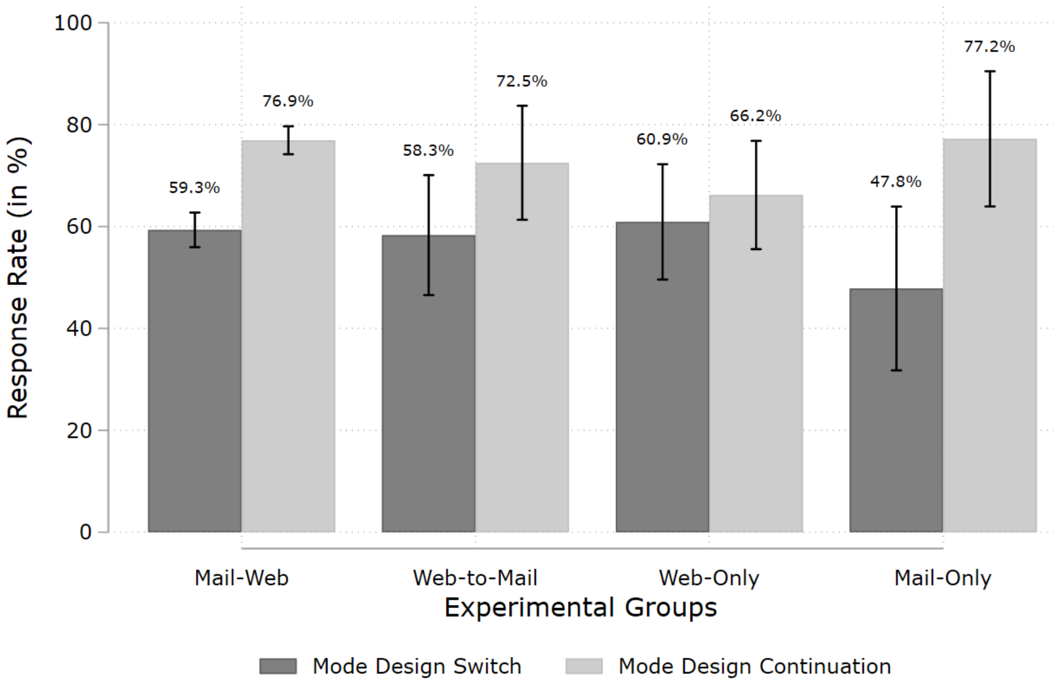


Figure 4.B.4: Follow-Up Response Rate (Nonresponse-Adjusted) and 95% Confidence Interval by Experimental Group, Tranche 1 IAB-JVS 2021/Q1

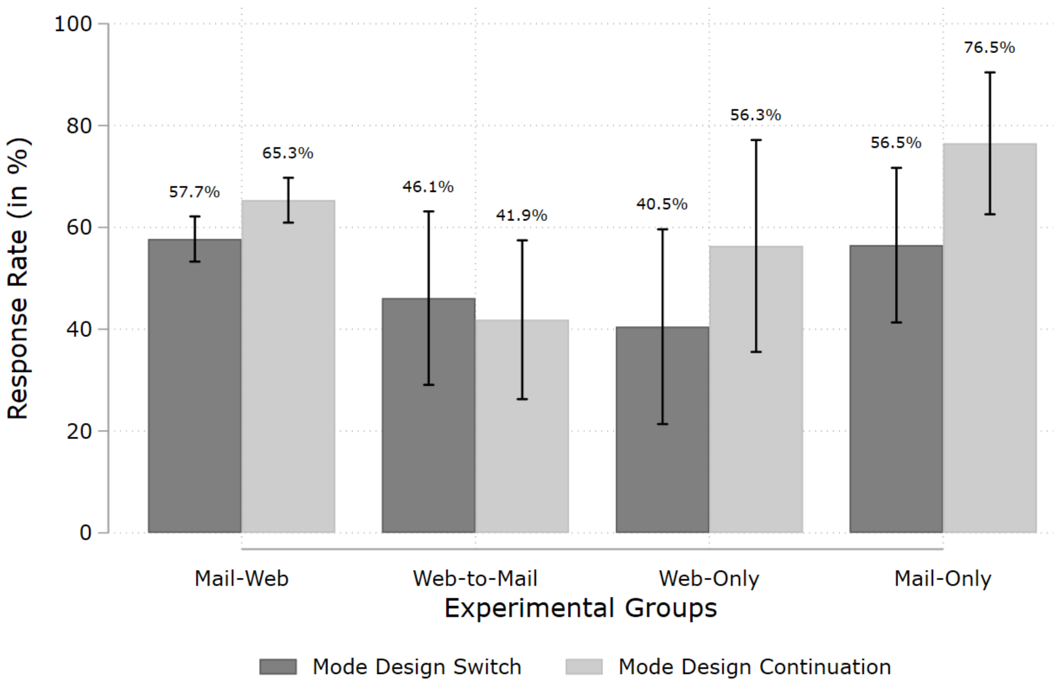


Figure 4.B.5: Follow-Up Response Rate (Nonresponse-Adjusted) and 95% Confidence Interval by Experimental Group, Tranche 2 IAB-JVS 2021/Q1

4.C Nonresponse Bias

4.C.1 Estimators for Nonresponse Bias

Equation 4.3 of the main text shows the formula we use to estimate nonresponse bias for the follow-up panel wave by comparing the estimate of the statistic of interest based on respondents ($Y_{fup,exp,k,r}$) to the estimate of the corresponding statistic of interest based on the fielded sample ($Y_{fup,exp,k,n}$). In this analysis, we account for differential nonresponse in the first panel wave. To estimate $Y_{fup,exp,k,r}$, the following estimator is used:

$$\hat{Y}_{fup,exp,k,r,p} = \frac{\sum_{i=1}^{r_{fup,exp}} (\pi_i \hat{\theta}_i)^{-1} y_{fup,exp,i,k}}{\sum_{i=1}^{r_{fup,exp}} (\pi_i \hat{\theta}_i)^{-1}}, \tag{4.11}$$

where $y_{fup,exp,i,k}$ is the k^{th} variable of interest for the element i of the net sample with size $r_{fup,exp}$ of the experimental group exp of the follow-up wave fup, π_i is the inclusion probability of the first panel wave, $\hat{\theta}_i$ is the estimated propensity to respond in the first panel wave. To estimate $Y_{fup,exp,n}$ we use estimator:

$$\hat{Y}_{fup,exp,n,p} = \frac{\sum_{i=1}^{n_{fup,exp}} (\pi_i \hat{\theta}_i)^{-1} y_{fup,exp,i,k}}{\sum_{i=1}^{r_{fup,exp}} (\pi_i \hat{\theta}_i)^{-1}}, \tag{4.12}$$

where $y_{fup,exp,i,k}$ is the k^{th} survey variable for the element i of the fielded sample with size $n_{fup,exp}$ of the experimental group exp of the follow-up wave fup, π_i is the inclusion probability of the first panel wave, and $\hat{\theta}_i$ is the estimated propensity to respond in the first panel wave.

To estimate the cumulative bias (see equation 4.4), we only apply design weights and hence our estimators for the statistic of interest are based on the following weighted means:

$$\hat{Y}_{w,exp,k,r,d} = \frac{\sum_{i=1}^{r_{w,exp}} \pi_i^{-1} y_{w,exp,i,k}}{\sum_{i=1}^{r_{w,exp}} \pi_i^{-1}}, \quad w = fir, fup\ , \tag{4.13}$$

where $y_{w,exp,i,k}$ is the k^{th} survey variable for element i of the net sample with size $r_{w,exp}$ of the panel wave w in experimental group exp, and π_i is the inclusion probability of the first panel wave. Further,

$$\hat{Y}_{w,exp,k,n,d} = \frac{\sum_{i=1}^{n_{w,exp}} \pi_i^{-1} y_{w,exp,i,k}}{\sum_{i=1}^{n_{w,exp}} \pi_i^{-1}}, \quad w = fir, fup\ , \tag{4.14}$$

where $y_{w,exp,i,k}$ is the k^{th} survey variable for element i of the fielded sample with size $n_{w,exp}$ of the panel wave w in experimental group exp, and π_i is the inclusion probability of the first panel wave.

4.C.2 Aggregate Nonresponse Bias Estimates

Follow-Up Wave Nonresponse Bias

Table 4.C.1: Average Absolute Nonresponse Bias Estimates (Nonresponse-Adjusted) and 95% Confidence Interval by Experimental Group for the Follow-Up Wave, All Administrative Variables BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
Estimate	2.938	2.082	3.942	3.421	3.350	2.879	4.232	1.903
Lower Bound	1.580	1.048	1.454	1.126	1.316	1.201	1.574	0.195
Upper Bound	4.296	3.115	6.431	5.716	5.385	4.557	6.890	3.612

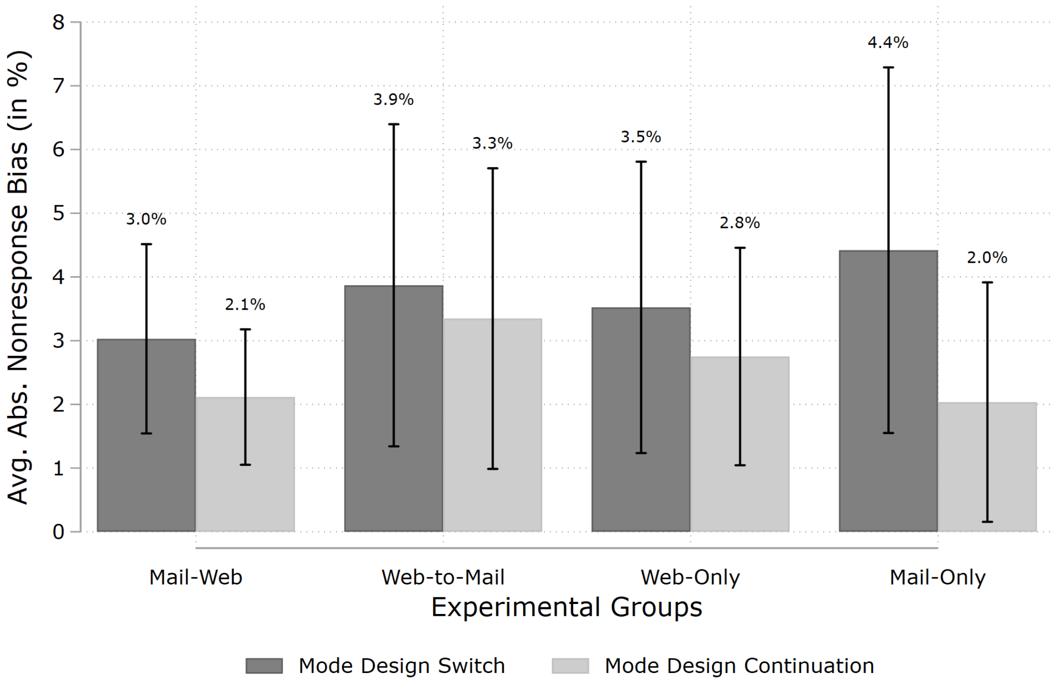


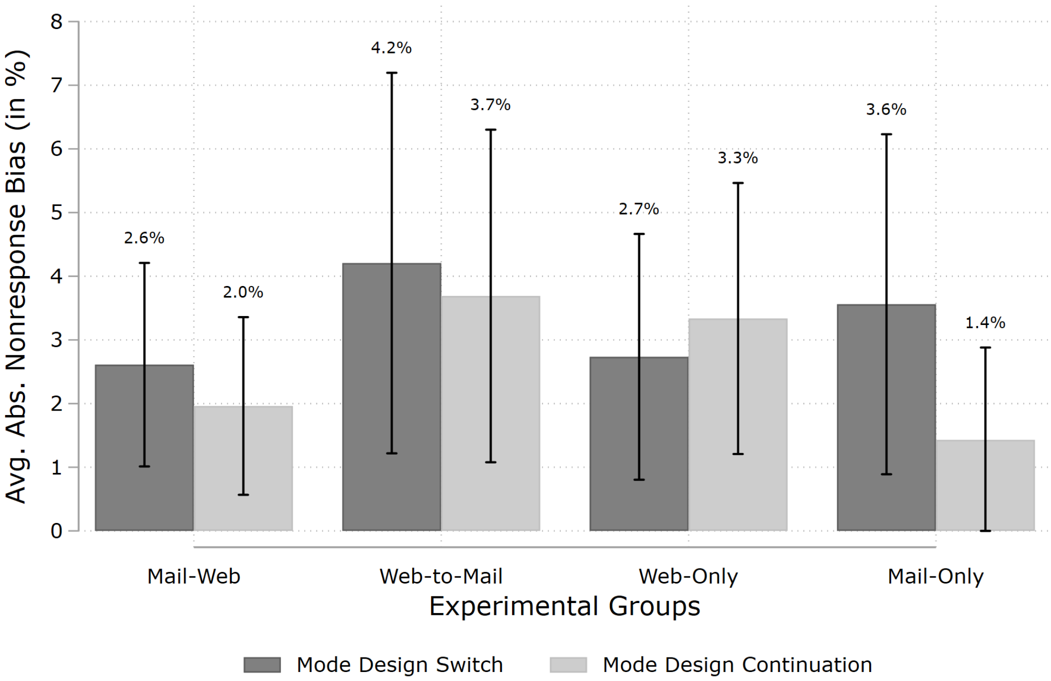
Figure 4.C.1: Average Absolute Bias for the Follow-Up Wave (Nonresponse-Adjusted) by Experimental Group, Employee Characteristics BHP 2020

Table 4.C.2: Average Absolute Nonresponse Bias Estimates (Nonresponse-Adjusted) and 95% Confidence Interval by Experimental Group for the Follow-Up Wave, Employee Characteristics BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
Estimate	3.029	2.115	3.869	3.346	3.522	2.751	4.419	2.035
Lower Bound	1.544	1.052	1.341	0.987	1.236	1.045	1.550	0.156
Upper Bound	4.514	3.178	6.396	5.705	5.809	4.457	7.289	3.915

Table 4.C.3: Average Absolute Nonresponse Bias Estimates (Nonresponse-Adjusted) and 95% Confidence Interval by Experimental Group for the Follow-Up Wave, Establishment Characteristics BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
Estimate	2.611	1.962	4.207	3.690	2.734	3.336	3.560	1.429
Lower Bound	1.013	0.567	1.218	1.078	0.804	1.208	0.890	0.000
Upper Bound	4.209	3.358	7.195	6.302	4.664	5.465	6.230	2.880



Note: The lower bound of the confidence interval of the mail-only continuation group bottom-coded to zero.

Figure 4.C.2: Average Absolute Bias for the Follow-Up Wave (Nonresponse-Adjusted) by Experimental Group, Establishment Characteristics BHP 2020

Cumulative Nonresponse Bias

Table 4.C.4: Average Absolute Nonresponse Bias Estimates (Design-Weighted) and 95% Confidence Interval by Experimental Group for the First and Follow-Up Wave, All Administrative Variables BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
Cumulative First Wave + Follow-Up Wave								
Estimate	4.280	3.853	4.301	5.628	3.942	4.026	4.134	4.390
Lower Bound	2.950	2.698	2.570	3.805	2.214	2.414	1.857	2.825
Upper Bound	5.611	5.007	6.033	7.450	5.670	5.639	6.410	5.954
Follow-Up Wave								
Estimate	2.920	2.025	3.493	3.178	3.458	2.959	4.377	1.710
Lower Bound	1.629	1.094	1.749	1.270	1.500	1.186	2.068	0.201
Upper Bound	4.210	2.956	5.236	5.086	5.416	4.731	6.686	3.219
First Wave								
Estimate	3.335	3.275	2.877	3.468	3.271	2.891	2.614	3.134
Lower Bound	2.360	2.257	1.675	2.292	1.825	1.665	1.331	1.753
Upper Bound	4.311	4.294	4.079	4.644	4.717	4.116	3.897	4.515

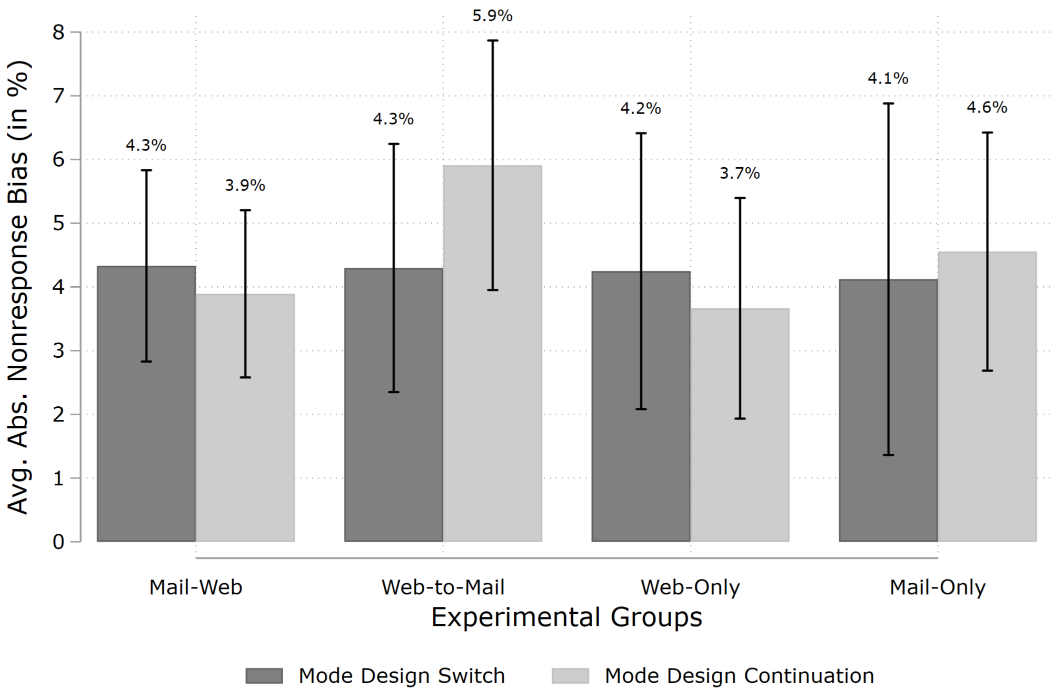


Figure 4.C.3: Cumulative Average Absolute Bias for the First and Follow-Up Waves (Design-Weighted) by Experimental Group, Employee Characteristics BHP 2020

Table 4.C.5: Average Absolute Nonresponse Bias Estimates (Design-Weighted) and 95% Confidence Interval by Experimental Group for the First and Follow-Up Wave, Employee Characteristics BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
Cumulative First Wave + Follow-Up Wave								
Estimate	4.330	3.891	4.297	5.910	4.248	3.664	4.122	4.555
Lower Bound	2.829	2.579	2.349	3.951	2.083	1.933	1.363	2.686
Upper Bound	5.832	5.203	6.246	7.868	6.413	5.396	6.880	6.424
Follow-Up Wave								
Estimate	3.009	2.059	3.558	3.151	3.668	2.813	4.709	1.870
Lower Bound	1.603	1.085	1.693	1.163	1.498	1.014	2.096	0.156
Upper Bound	4.415	3.034	5.423	5.138	5.837	4.612	7.321	3.584
First Wave								
Estimate	3.341	3.318	2.723	3.755	3.532	3.076	2.189	3.191
Lower Bound	2.234	2.150	1.350	2.426	1.818	1.696	0.690	1.501
Upper Bound	4.448	4.485	4.095	5.083	5.246	4.456	3.689	4.882

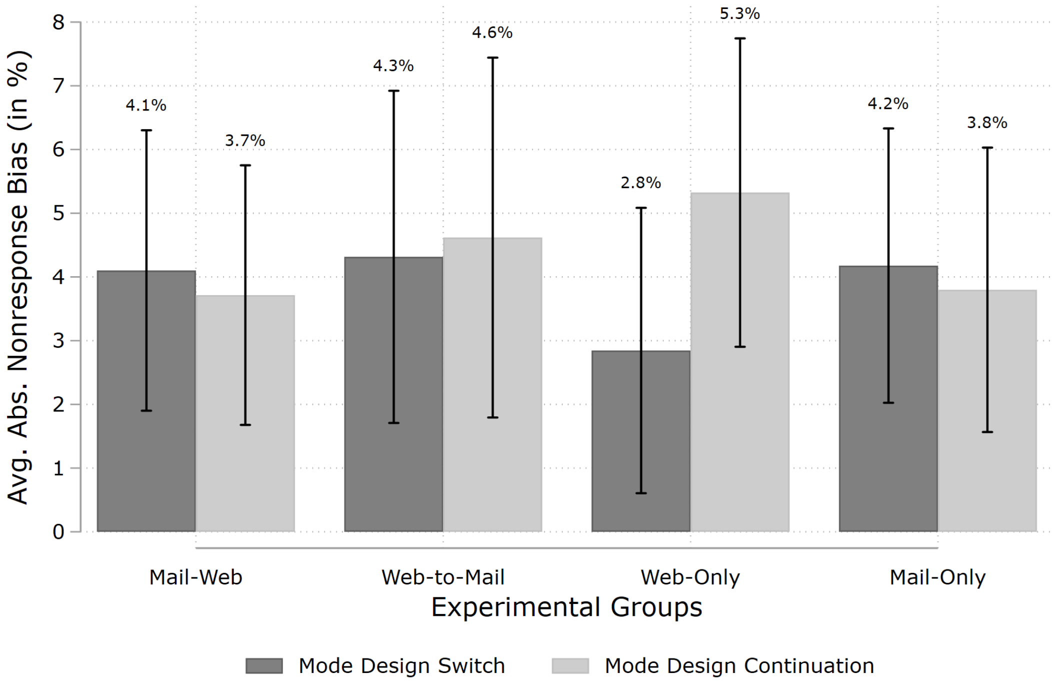


Figure 4.C.4: Cumulative Average Absolute Bias for the First and Follow-Up Waves (Design-Weighted) by Experimental Group, Establishment Characteristics BHP 2020

Table 4.C.6: Average Absolute Nonresponse Bias Estimates (Design-Weighted) and 95% Confidence Interval by Experimental Group for the First and Follow-Up Wave, Establishment Characteristics BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
Cumulative First Wave + Follow-Up Wave								
Estimate	4.101	3.715	4.315	4.618	2.845	5.324	4.177	3.798
Lower Bound	1.900	1.678	1.708	1.794	0.606	2.904	2.024	1.566
Upper Bound	6.302	5.751	6.922	7.442	5.085	7.744	6.331	6.030
Follow-Up Wave								
Estimate	2.600	1.902	3.259	3.276	2.708	3.480	3.188	1.136
Lower Bound	1.017	0.612	0.826	1.037	0.660	1.275	0.804	0.001
Upper Bound	4.183	3.193	5.692	5.515	4.755	5.684	5.572	2.270
First Wave								
Estimate	3.316	3.124	3.430	2.441	2.337	2.227	4.135	2.927
Lower Bound	1.652	1.496	1.450	0.535	0.533	0.525	2.360	1.087
Upper Bound	4.981	4.751	5.410	4.347	4.141	3.929	5.910	4.767

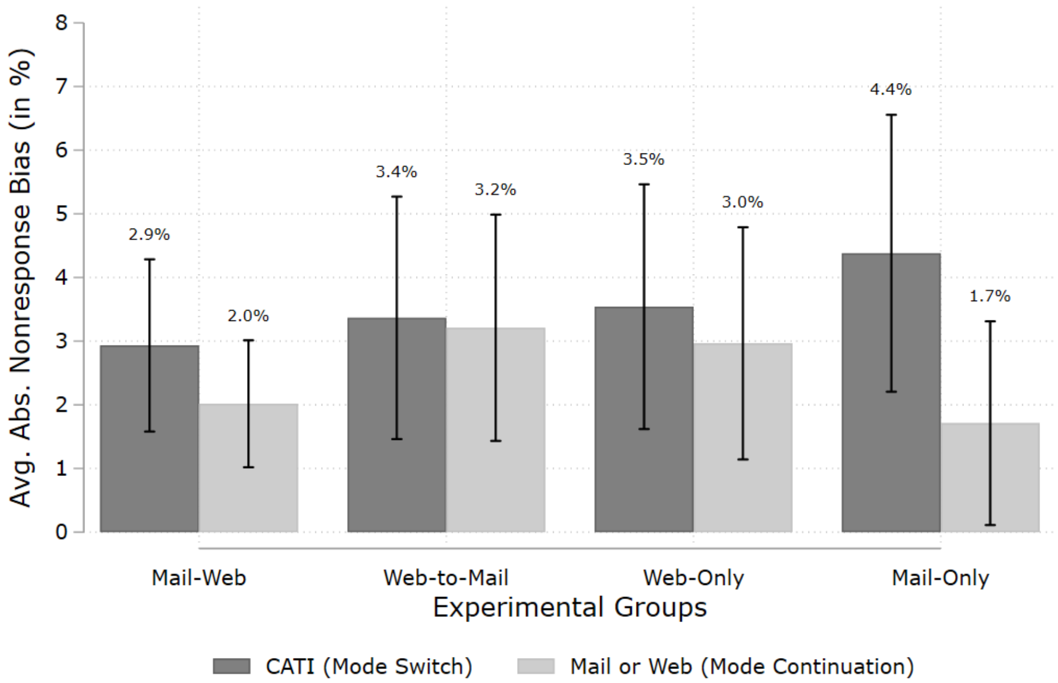


Figure 4.C.5: Average Absolute Bias for the Follow-Up Wave (Design-Weighted) by Experimental Group, All Variables BHP 2020

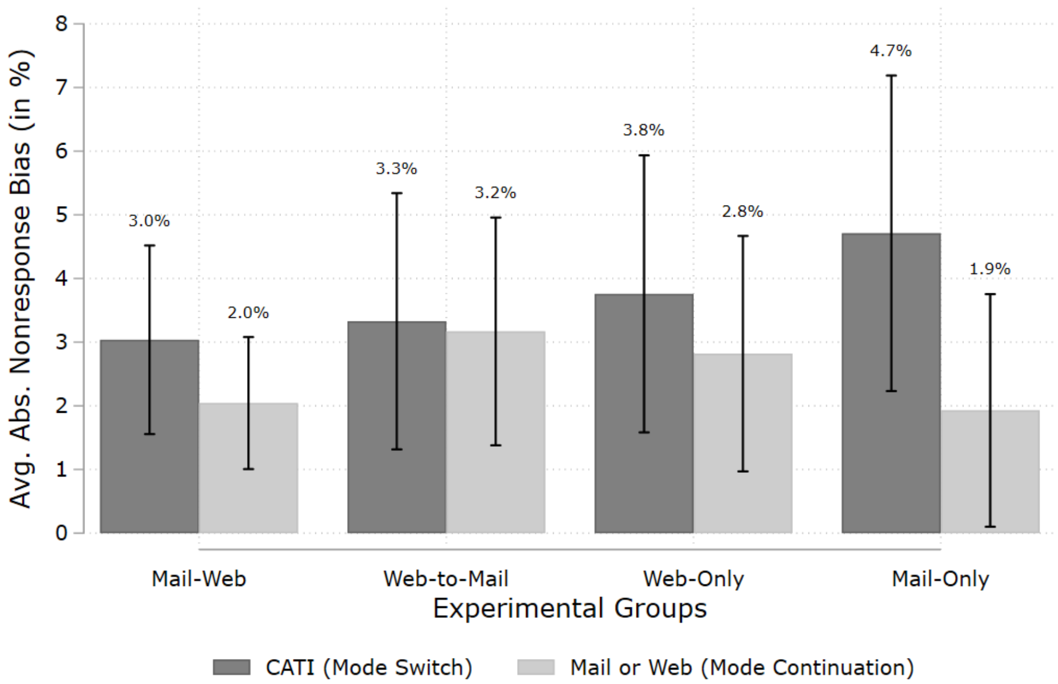
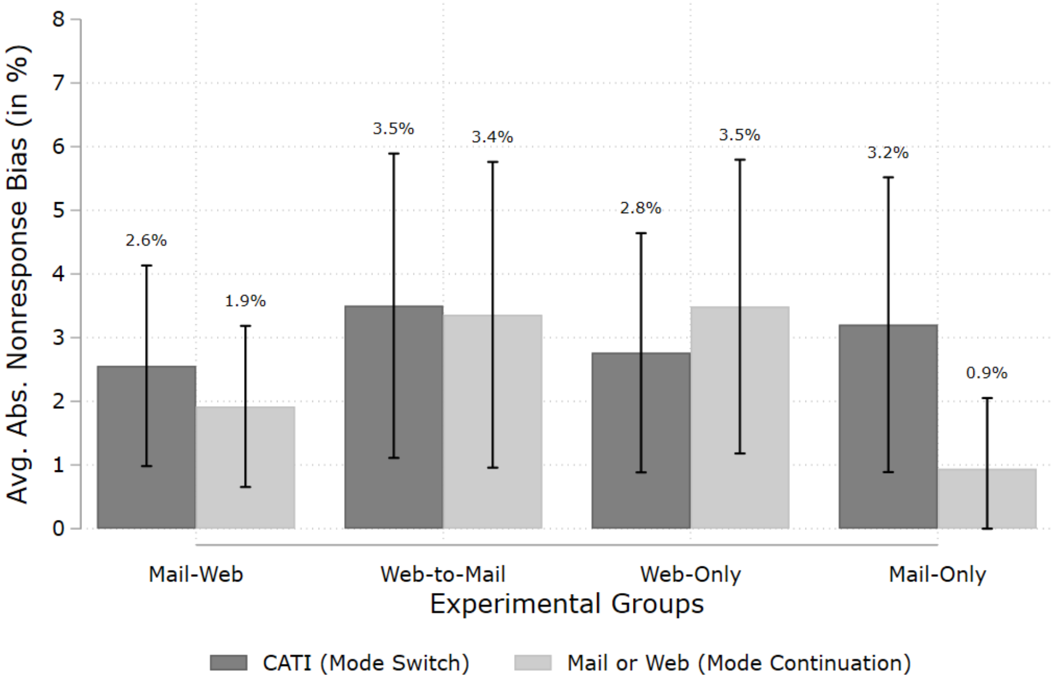


Figure 4.C.6: Average Absolute Bias for the Follow-Up Wave (Design-Weighted) by Experimental Group, Employee Characteristics BHP 2020



Note: The lower bound of the confidence interval of the mail-only continuation group bottom-coded to zero.

Figure 4.C.7: Average Absolute Bias for the Follow-Up Wave (Design-Weighted) by Experimental Group, Establishment Characteristics BHP 2020

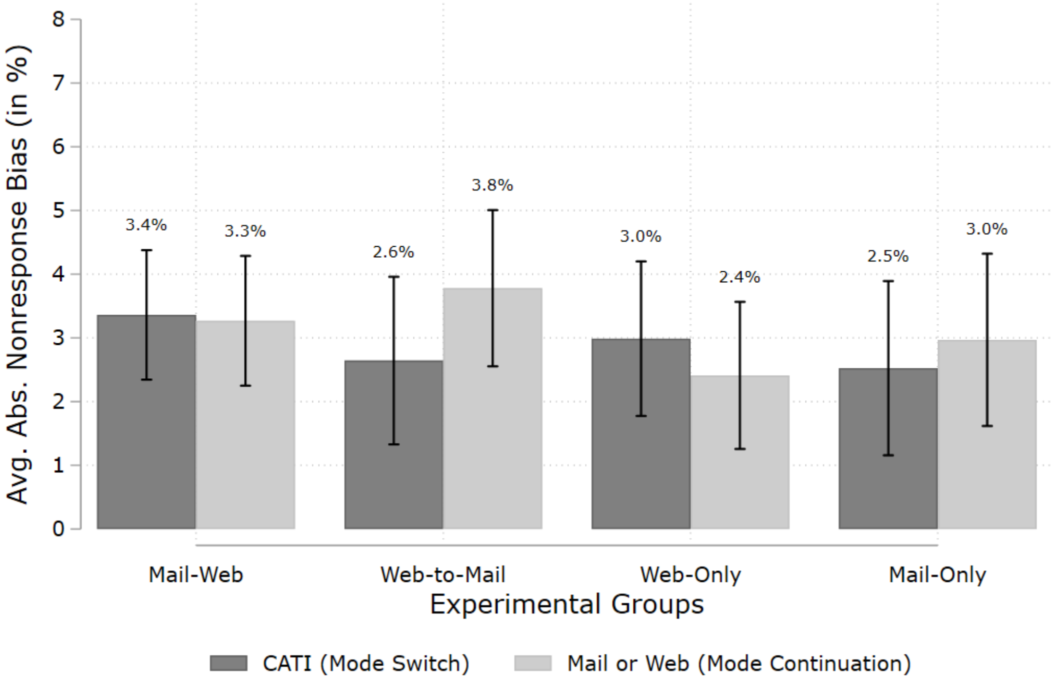


Figure 4.C.8: Average Absolute Bias for the First Wave (Design-Weighted) by Experimental Group, All Variables BHP 2020

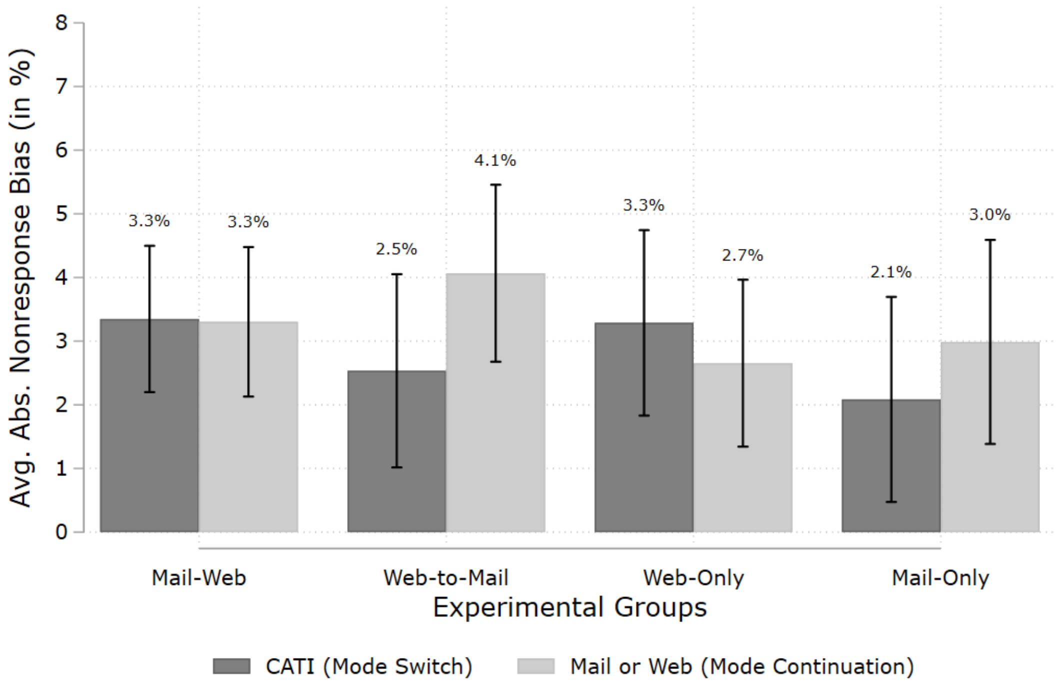


Figure 4.C.9: Average Absolute Bias for the First Wave (Design-Weighted) by Experimental Group, Employee Characteristics BHP 2020

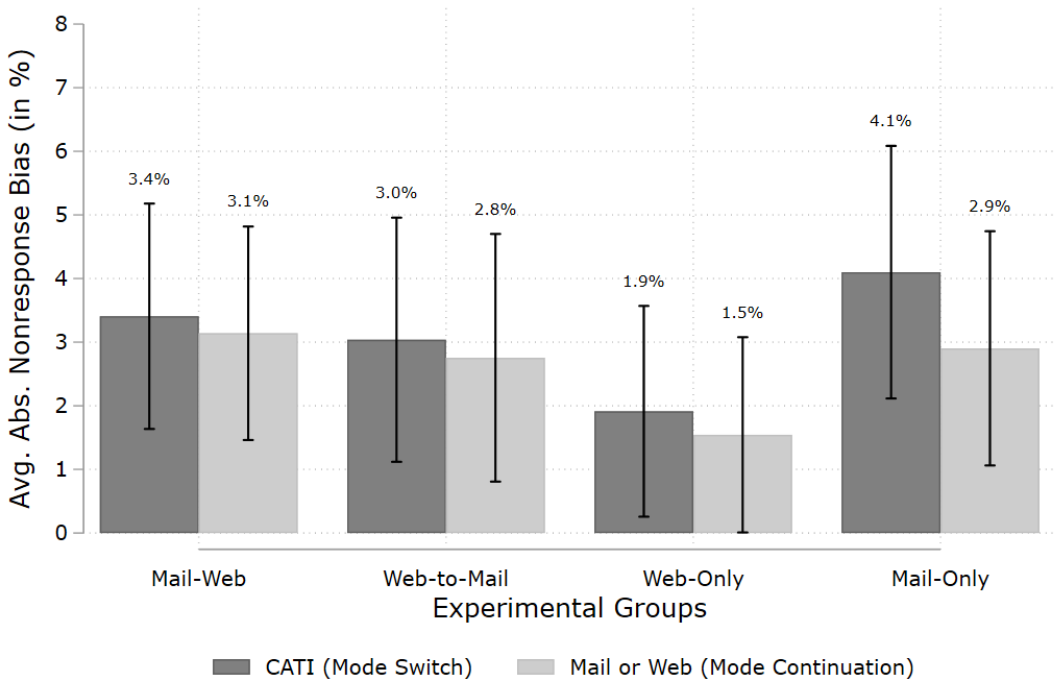


Figure 4.C.10: Average Absolute Bias for the First Wave (Design-Weighted) by Experimental Group, Establishment Characteristics BHP 2020

Median Absolute Nonresponse Bias

Table 4.C.7: Median Absolute Nonresponse Bias Estimates and 95% Confidence Interval by Experimental Group, All Administrative Variables BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
Cumulative - First Wave + Follow-Up (Design-Weighted)								
Estimate	3.419	3.094	2.905	4.774	2.426	3.393	2.555	3.473
Lower Bound	2.003	1.872	1.072	2.458	0.708	1.677	0.145	1.900
Upper Bound	4.836	4.317	4.738	7.090	4.144	5.109	4.965	5.045
Follow-Up Wave (Nonresponse-Adjusted)								
Estimate	2.429	1.731	3.090	2.821	2.906	2.570	4.137	1.466
Lower Bound	1.580	1.048	1.454	1.126	1.316	1.201	1.574	0.195
Upper Bound	3.739	2.714	5.449	5.075	4.810	4.216	6.717	2.977

Table 4.C.8: Median Absolute Nonresponse Bias Estimates and 95% Confidence Interval by Experimental Group, Employee Characteristics BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
Cumulative - First Wave + Follow-Up (Design-Weighted)								
Estimate	3.536	3.207	3.198	4.955	2.622	2.980	2.842	3.546
Lower Bound	1.942	1.808	1.221	2.353	0.464	1.162	0.000	1.724
Upper Bound	5.131	4.606	5.175	7.557	4.779	4.797	5.712	5.367
Follow-Up Wave (Nonresponse-Adjusted)								
Estimate	2.552	1.781	3.090	2.779	3.004	2.567	4.218	1.466
Lower Bound	1.544	1.052	1.341	0.987	1.236	1.045	1.550	0.156
Upper Bound	3.995	2.834	5.515	5.129	5.159	4.300	7.057	3.229

Table 4.C.9: Median Absolute Nonresponse Bias Estimates and 95% Confidence Interval by Experimental Group, Establishment Characteristics BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
Cumulative - First Wave + Follow-Up (Design-Weighted)								
Estimate	3.204	3.204	2.593	3.032	2.153	3.917	2.012	2.556
Lower Bound	0.944	0.944	0.000	0.000	0.000	0.917	0.000	0.000
Upper Bound	5.464	5.464	5.514	6.229	4.903	6.917	4.769	5.279
Follow-Up Wave (Nonresponse-Adjusted)								
Estimate	2.130	1.631	3.595	3.114	2.609	2.726	2.141	1.437
Lower Bound	1.013	0.567	1.218	1.078	0.804	1.208	0.890	0.000
Upper Bound	3.772	2.992	6.482	5.778	4.470	5.038	4.928	2.940

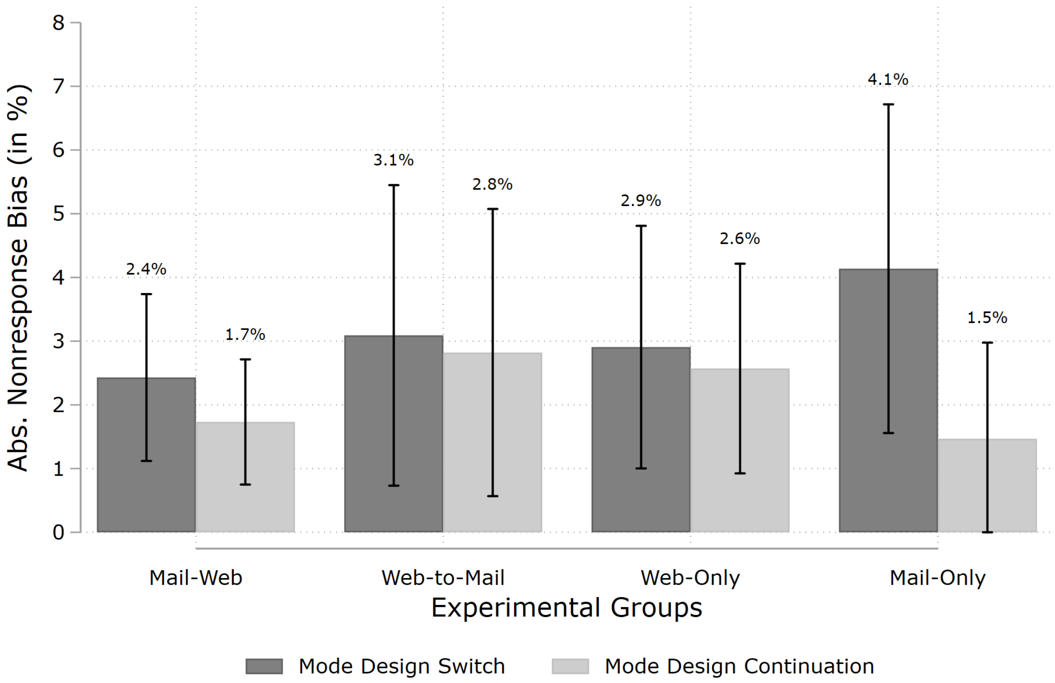


Figure 4.C.11: Median Absolute Bias for the Follow-Up Wave (Nonresponse-Adjusted) by Experimental Group, All Variables BHP 2020

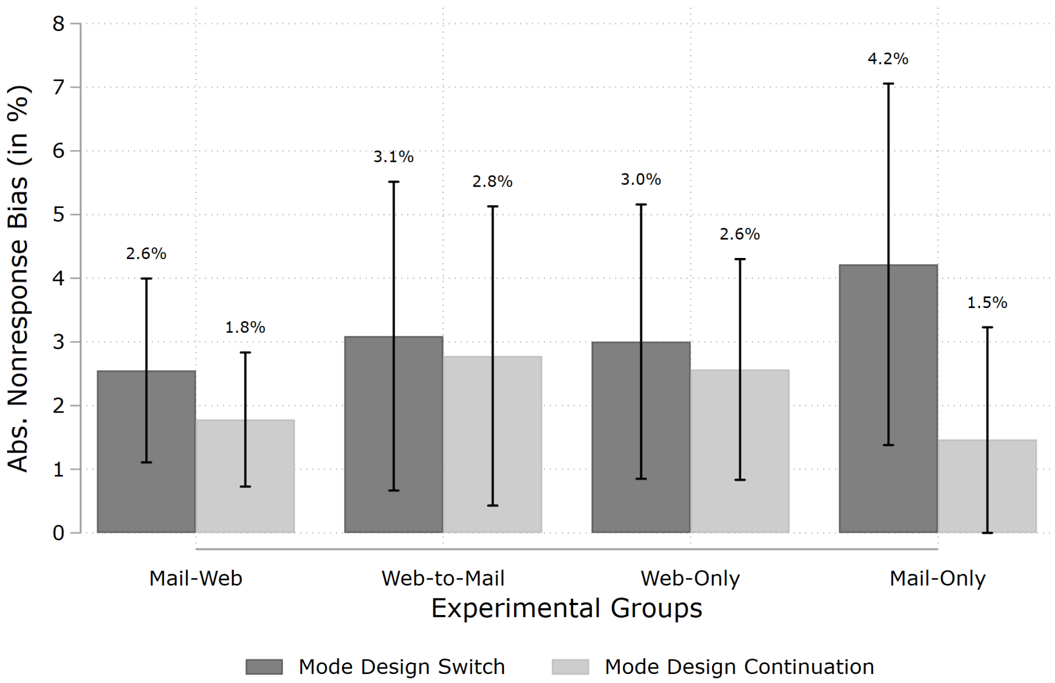
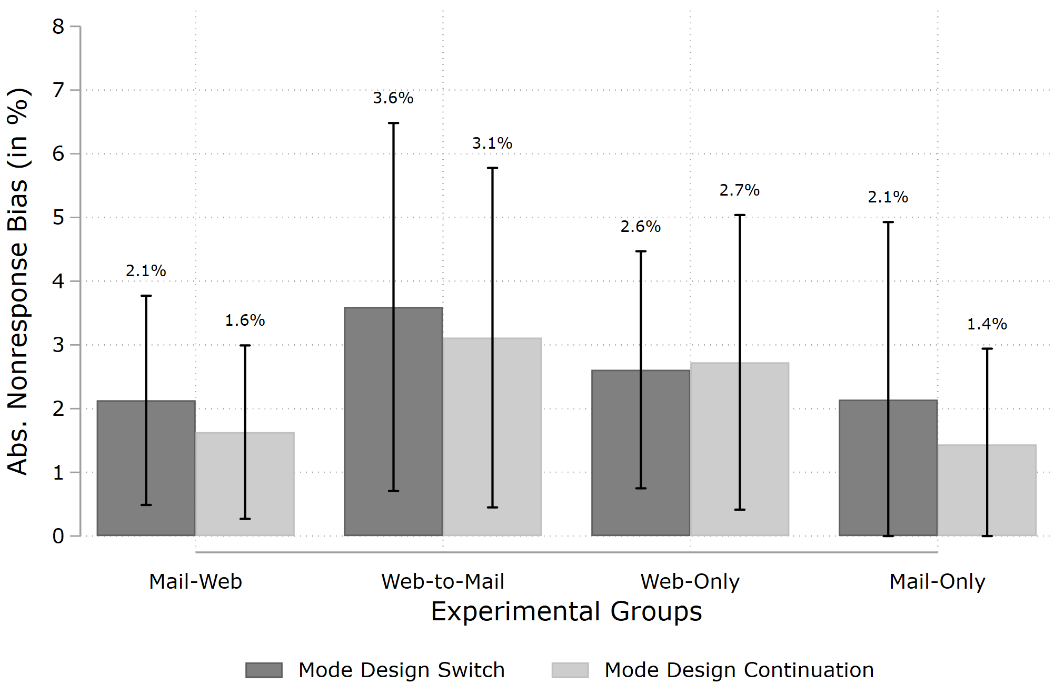
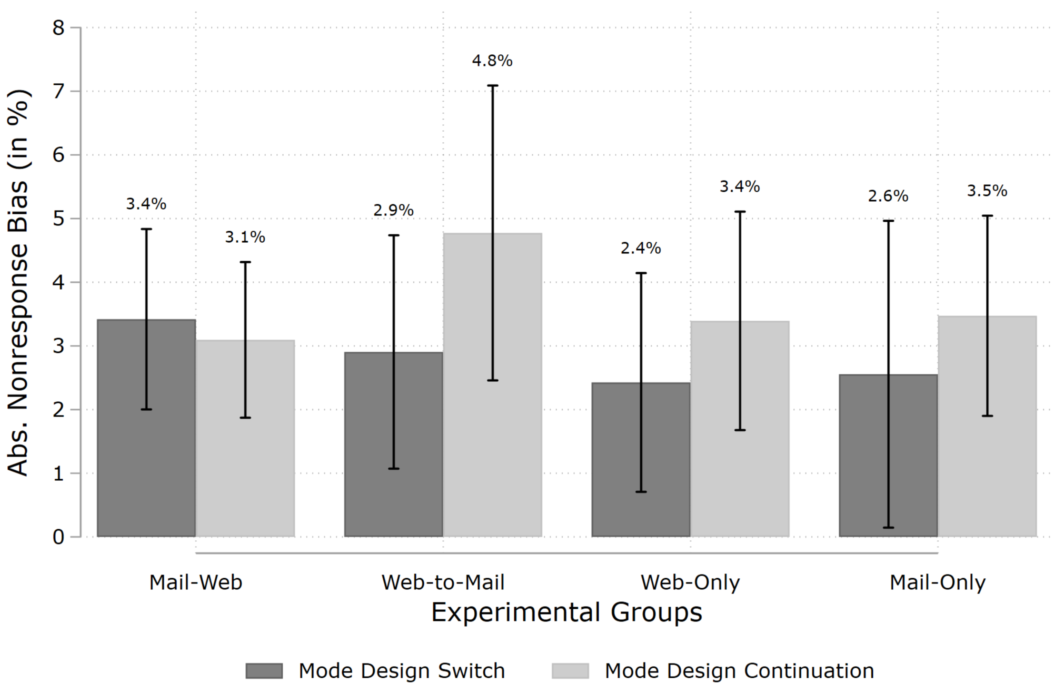


Figure 4.C.12: Median Absolute Bias for the Follow-Up Wave (Nonresponse-Adjusted) by Experimental Group, Employee Characteristics BHP 2020



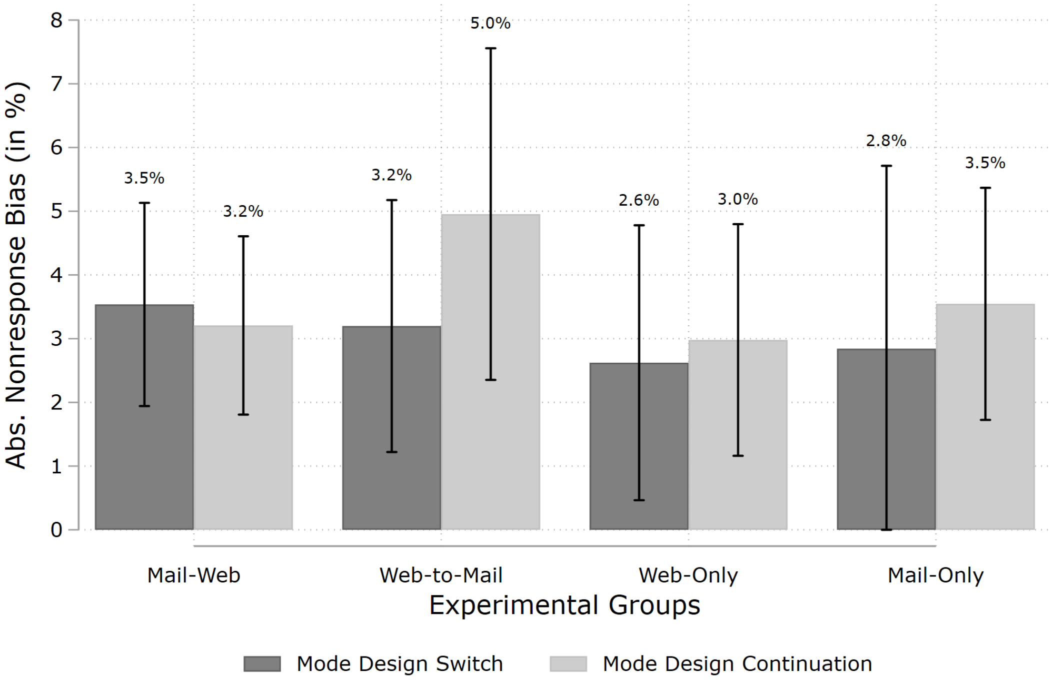
Note: The lower bound of the confidence interval of the mail-only continuation group bottom-coded to zero.

Figure 4.C.13: Median Absolute Bias for the Follow-Up Wave (Nonresponse-Adjusted) by Experimental Group, Establishment Characteristics BHP 2020



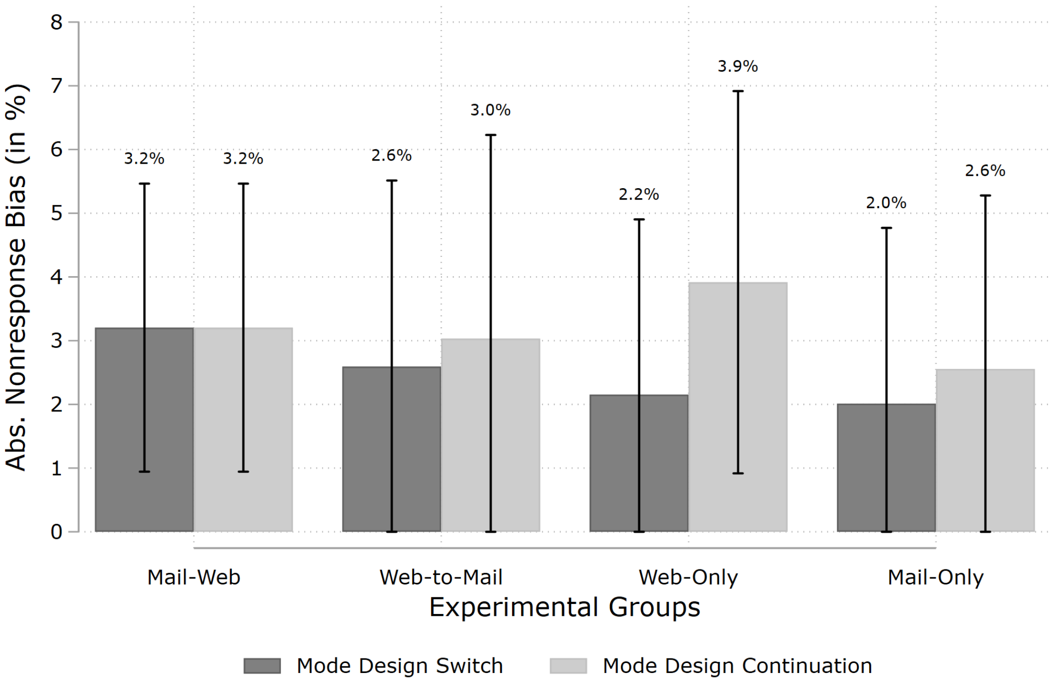
Note: The lower bound of the confidence interval of the mail-only switch group bottom-coded to zero.

Figure 4.C.14: Cumulative Median Absolute Bias for the First and Follow-Up Waves (Design-Weighted) by Experimental Group, All Variables BHP 2020



Note: The lower bound of the confidence interval of the mail-only switch group bottom-coded to zero.

Figure 4.C.15: Cumulative Median Absolute Bias for the First and Follow-Up Waves (Design-Weighted) by Experimental Group, Employee Characteristics BHP 2020



Note: The lower bound of the confidence interval of the web-to-mail continuation and the mail-only switch group bottom-coded to zero.

Figure 4.C.16: Cumulative Median Absolute Bias for the First and Follow-Up Waves (Design-Weighted) by Experimental Group, Establishment Characteristics BHP 2020

4.C.3 Individual Nonresponse Bias Estimates - Follow-up Wave

Table 4.C.10: Nonresponse Bias Estimates and 95% Confidence Interval of Number of Employees by Experimental Group for the Follow-Up Wave (Nonresponse-Adjusted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
1-9								
Estimate	-0.725	-2.148	-6.096	-3.665	-1.499	-3.804	-1.474	2.083
Upper Bound	5.836	2.190	2.091	3.142	4.162	3.206	8.988	6.405
Lower Bound	-7.285	-6.485	-14.284	-10.473	-7.159	-10.815	-11.935	-2.239
10-19								
Estimate	-1.265	0.790	2.308	1.191	-0.555	1.777	-2.754	-2.424
Upper Bound	4.553	3.920	6.943	5.921	2.803	7.646	7.854	1.171
Lower Bound	-7.083	-2.340	-2.327	-3.538	-3.914	-4.092	-13.363	-6.019
20-49								
Estimate	1.056	0.822	2.443	1.426	1.572	1.692	4.187	0.265
Upper Bound	3.696	2.570	6.316	4.282	3.979	4.190	7.484	2.141
Lower Bound	-1.584	-0.927	-1.431	-1.430	-0.834	-0.806	0.891	-1.611
≥50								
Estimate	0.934	0.536	1.346	1.048	0.482	0.336	0.041	0.076
Upper Bound	2.655	1.658	3.654	3.062	2.245	1.857	2.460	1.157
Lower Bound	-0.788	-0.586	-0.963	-0.966	-1.281	-1.186	-2.379	-1.006

Table 4.C.11: Nonresponse Bias Estimates and 95% Confidence Interval of East/West Germany by Experimental Group for the Follow-Up Wave (Nonresponse-Adjusted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
East Germany (Ref.: West Germany)								
Estimate	-0.053	-1.099	2.161	-2.441	-4.198	-2.640	1.528	2.209
Upper Bound	5.670	3.519	9.830	4.474	1.038	2.979	8.212	5.941
Lower Bound	-5.776	-5.717	-5.508	-9.356	-9.433	-8.260	-5.155	-1.522

Table 4.C.12: Nonresponse Bias Estimates and 95% Confidence Interval of Industry by Experimental Group for the Follow-Up Wave (Nonresponse-Adjusted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
Agric./Manufacturing								
Estimate	1.049	1.751	-0.774	5.618	-3.268	2.812	7.382	1.568
Upper Bound	7.453	6.192	6.548	11.748	3.020	7.705	14.993	4.937
Lower Bound	-5.356	-2.690	-8.095	-0.513	-9.556	-2.081	-0.228	-1.800
Service								
Estimate	0.693	-1.859	-4.747	-8.735	5.916	2.386	-0.627	-2.874
Upper Bound	9.143	4.083	5.872	-0.447	14.153	9.339	9.788	3.108
Lower Bound	-7.757	-7.801	-15.365	-17.024	-2.320	-4.567	-11.042	-8.856
Public/Educ./Health/Arts								
Estimate	-1.742	0.108	5.520	3.118	-2.648	-5.198	-6.755	1.306
Upper Bound	5.753	5.092	14.586	10.201	3.866	1.390	2.337	6.158
Lower Bound	-9.238	-4.876	-3.545	-3.965	-9.162	-11.786	-15.847	-3.546

Table 4.C.13: Nonresponse Bias Estimates and 95% Confidence Interval of Foundation Year by Experimental Group for the Follow-Up Wave (Nonresponse-Adjusted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
70s/80s								
Estimate	0.936	1.463	-1.378	4.216	3.167	5.075	1.125	0.948
Upper Bound	7.140	5.400	5.494	10.036	7.677	10.063	7.177	4.559
Lower Bound	-5.268	-2.474	-8.251	-1.604	-1.343	0.087	-4.926	-2.664
90s								
Estimate	0.758	0.592	5.344	1.194	0.596	-1.246	1.402	0.803
Upper Bound	7.535	5.129	13.302	8.469	6.884	3.131	10.477	7.355
Lower Bound	-6.018	-3.946	-2.615	-6.080	-5.692	-5.624	-7.673	-5.750
00s								
Estimate	0.556	-0.164	-11.164	3.109	2.571	4.619	-8.984	-2.174
Upper Bound	7.333	4.760	-0.151	8.978	9.115	11.065	2.135	4.081
Lower Bound	-6.220	-5.087	-22.177	-2.759	-3.974	-1.828	-20.103	-8.429
10s/20s								
Estimate	-2.251	-1.891	7.199	-8.520	-6.334	-8.448	6.457	0.423
Upper Bound	5.791	4.317	16.359	0.527	2.896	-0.494	14.297	5.187
Lower Bound	-10.292	-8.100	-1.962	-17.567	-15.564	-16.401	-1.383	-4.340

Table 4.C.14: Nonresponse Bias Estimates and 95% Confidence Interval of Avg. Age of Employees by Experimental Group for the Follow-Up Wave (Nonresponse-Adjusted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
0.00-38.99								
Estimate	1.009	-1.334	5.158	5.431	0.928	2.373	-5.781	-0.823
Upper Bound	8.947	4.575	13.846	12.705	8.681	8.890	5.655	3.751
Lower Bound	-6.930	-7.244	-3.530	-1.844	-6.826	-4.143	-17.217	-5.397
39.00-43.49								
Estimate	0.326	0.821	0.627	-1.424	-3.415	0.168	5.293	1.466
Upper Bound	6.676	5.408	5.884	6.915	3.488	5.761	13.161	5.103
Lower Bound	-6.023	-3.765	-4.630	-9.762	-10.318	-5.424	-2.575	-2.170
43.50-47.99								
Estimate	-0.396	-0.454	-3.623	-1.668	6.760	-2.583	-0.218	0.177
Upper Bound	5.906	4.254	2.669	5.107	13.927	3.706	5.991	3.764
Lower Bound	-6.699	-5.162	-9.915	-8.443	-0.407	-8.873	-6.427	-3.410
≥48.00								
Estimate	-0.939	0.967	-2.162	-2.339	-4.273	0.042	0.706	-0.820
Upper Bound	7.538	6.742	9.135	4.809	2.981	6.838	10.408	5.964
Lower Bound	-9.415	-4.808	-13.459	-9.487	-11.528	-6.754	-8.996	-7.604

Table 4.C.15: Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of Apprentices by Experimental Group for the Follow-Up Wave (Nonresponse-Adjusted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
0.00 (Ref.: 0.01-100)								
Estimate	-2.085	-1.004	-3.531	-6.473	-4.895	-6.227	0.398	-1.025
Upper Bound	3.433	3.172	3.847	-0.133	-0.323	-0.828	7.091	3.196
Lower Bound	-7.602	-5.181	-10.910	-12.813	-9.466	-11.627	-6.294	-5.245

Table 4.C.16: Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of Female Employees by Experimental Group for the Follow-Up Wave (Nonresponse-Adjusted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
0.00 - 18.18								
Estimate	-0.276	-0.474	2.938	4.469	-2.210	1.115	6.053	1.994
Upper Bound	6.321	5.167	10.764	10.002	4.166	5.848	13.276	5.400
Lower Bound	-6.872	-6.116	-4.889	-1.063	-8.587	-3.618	-1.171	-1.411
18.19 - 40.97								
Estimate	1.720	0.929	-0.356	2.187	3.209	-2.858	1.438	0.243
Upper Bound	7.371	5.231	7.219	8.425	9.010	3.633	12.791	3.873
Lower Bound	-3.930	-3.372	-7.932	-4.051	-2.593	-9.348	-9.916	-3.388
40.98 - 67.12								
Estimate	1.359	0.141	-1.566	-7.674	2.722	2.567	-2.968	-3.919
Upper Bound	7.719	4.775	5.013	0.834	7.200	8.598	5.117	2.439
Lower Bound	-5.000	-4.494	-8.145	-16.182	-1.756	-3.465	-11.053	-10.278
>67.13								
Estimate	-2.804	-0.596	-1.015	1.018	-3.721	-0.824	-4.523	1.682
Upper Bound	6.166	5.445	9.771	9.361	4.766	6.735	5.032	8.066
Lower Bound	-11.774	-6.636	-11.802	-7.326	-12.207	-8.383	-14.078	-4.701

Table 4.C.17: Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of Fixed-Term Contracts by Experimental Group for the Follow-Up Wave (Nonresponse-Adjusted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
0.00								
Estimate	-1.273	-1.208	-2.264	-7.096	-6.481	-3.119	6.476	-0.961
Upper Bound	6.449	4.111	7.112	1.637	0.669	3.262	17.365	4.885
Lower Bound	-8.995	-6.526	-11.640	-15.829	-13.630	-9.501	-4.413	-6.808
0.01 - 15.99								
Estimate	0.355	0.725	3.371	2.738	1.706	-1.142	-4.218	0.557
Upper Bound	5.630	3.676	7.955	6.950	5.653	2.846	6.169	2.619
Lower Bound	-4.920	-2.225	-1.214	-1.474	-2.242	-5.131	-14.605	-1.505
≥16.00								
Estimate	0.918	0.482	-1.107	4.358	4.775	4.262	-2.258	0.404
Upper Bound	7.600	5.049	6.712	11.503	10.385	9.292	5.978	6.167
Lower Bound	-5.764	-4.085	-8.926	-2.788	-0.835	-0.769	-10.493	-5.359

Table 4.C.18: Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of Full-Time Contracts by Experimental Group for the Follow-Up Wave (Nonresponse-Adjusted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
0.00 - 36.38								
Estimate	-2.531	-0.797	-10.188	-9.420	-7.166	0.901	-10.591	-0.143
Upper Bound	6.340	5.239	1.328	-0.439	1.706	7.766	0.084	6.636
Lower Bound	-11.402	-6.833	-21.705	-18.400	-16.038	-5.964	-21.266	-6.922
36.39 - 66.66								
Estimate	2.375	0.516	3.724	2.349	3.567	-7.862	0.442	3.199
Upper Bound	9.415	5.321	10.410	7.050	9.682	-0.615	8.975	7.345
Lower Bound	-4.665	-4.289	-2.963	-2.352	-2.548	-15.109	-8.092	-0.947
66.67 - 85.28								
Estimate	1.149	1.010	5.200	9.318	2.013	4.391	8.322	-2.043
Upper Bound	6.188	4.640	10.643	15.714	7.021	8.904	14.601	1.420
Lower Bound	-3.890	-2.619	-0.242	2.922	-2.996	-0.123	2.043	-5.506
>85.29								
Estimate	-0.994	-0.729	1.265	-2.247	1.586	2.570	1.828	-1.012
Upper Bound	4.868	4.261	8.767	4.139	6.805	8.017	7.748	4.749
Lower Bound	-6.855	-5.720	-6.238	-8.634	-3.632	-2.876	-4.093	-6.774

Table 4.C.19: Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of German Citizens by Experimental Group for the Follow-Up Wave (Nonresponse-Adjusted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
100.00 (Ref.: 0.00-99.99)								
Estimate	-2.475	0.612	-5.077	3.691	0.276	0.374	1.149	5.093
Upper Bound	5.447	6.387	4.524	11.888	8.716	6.345	11.961	11.414
Lower Bound	-10.397	-5.164	-14.678	-4.506	-8.164	-5.597	-9.663	-1.227

Table 4.C.20: Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of High-Educated Employees by Experimental Group for the Follow-Up Wave (Nonresponse-Adjusted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
0.00								
Estimate	-2.514	-0.831	3.331	-4.260	-10.099	2.047	2.522	-0.827
Upper Bound	5.782	4.946	13.106	3.757	-0.961	9.646	12.488	5.254
Lower Bound	-10.809	-6.609	-6.444	-12.277	-19.237	-5.552	-7.444	-6.907
0.01 - 14.99								
Estimate	1.300	1.307	0.164	4.504	1.313	1.596	4.137	-3.418
Upper Bound	6.032	4.111	5.313	8.873	4.501	7.015	9.640	2.453
Lower Bound	-3.431	-1.497	-4.986	0.135	-1.875	-3.822	-1.366	-9.290
≥15.00								
Estimate	1.214	-0.476	-3.495	-0.244	8.786	-3.643	-6.659	4.245
Upper Bound	8.779	5.176	6.269	8.620	16.640	3.605	2.239	9.377
Lower Bound	-6.352	-6.127	-13.259	-9.109	0.932	-10.892	-15.556	-0.887

Table 4.C.21: Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of Mid-Educated Employees by Experimental Group for the Follow-Up Wave (Nonresponse-Adjusted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
0.00 - 50.00								
Estimate	-1.189	-1.699	-1.029	-4.374	0.871	1.067	-4.542	2.130
Upper Bound	6.675	4.330	7.240	4.212	8.766	6.753	4.440	7.376
Lower Bound	-9.054	-7.727	-9.299	-12.959	-7.024	-4.618	-13.525	-3.117
50.01 - 70.58								
Estimate	1.151	0.471	-1.315	5.541	4.363	3.858	-6.404	-5.121
Upper Bound	6.653	5.113	8.353	11.009	9.807	8.723	4.434	1.408
Lower Bound	-4.350	-4.170	-10.983	0.072	-1.081	-1.008	-17.241	-11.651
70.59 - 84.99								
Estimate	1.254	0.397	3.090	1.065	2.263	-4.751	3.242	1.844
Upper Bound	7.393	4.304	9.708	8.778	5.994	2.263	8.560	4.485
Lower Bound	-4.884	-3.510	-3.527	-6.649	-1.469	-11.765	-2.076	-0.797
>85.00								
Estimate	-1.216	0.830	-0.746	-2.231	-7.497	-0.174	7.704	1.147
Upper Bound	7.048	6.408	9.868	4.853	1.405	7.215	17.191	7.437
Lower Bound	-9.480	-4.747	-11.360	-9.316	-16.399	-7.563	-1.783	-5.143

Table 4.C.22: Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of Low-Educated Employees by Experimental Group for the Follow-Up Wave (Nonresponse-Adjusted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
0.00								
Estimate	-1.214	-0.842	2.705	-5.855	-8.403	-3.617	0.957	1.844
Upper Bound	6.689	5.089	12.692	2.719	-0.564	4.264	11.622	7.991
Lower Bound	-9.118	-6.772	-7.281	-14.429	-16.242	-11.497	-9.708	-4.303
0.01 - 11.99								
Estimate	1.460	1.337	2.102	3.314	2.906	1.396	1.424	-0.242
Upper Bound	5.014	3.937	7.128	7.630	6.715	6.879	5.376	2.354
Lower Bound	-2.094	-1.263	-2.924	-1.002	-0.903	-4.087	-2.528	-2.838
≥12.00								
Estimate	-0.246	-0.495	-4.807	2.541	5.497	2.220	-2.381	-1.602
Upper Bound	7.349	5.090	4.300	9.813	12.046	8.105	8.976	4.705
Lower Bound	-7.841	-6.081	-13.914	-4.732	-1.053	-3.665	-13.738	-7.908

Table 4.C.23: Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of Unknown-Educated Employees by Experimental Group for the Follow-Up Wave (Nonresponse-Adjusted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
0.00 (Ref.: 0.01-100.00)								
Estimate	-1.389	0.235	-1.835	0.037	1.075	-1.438	4.804	8.291
Upper Bound	5.898	5.346	5.278	5.341	6.956	4.686	15.223	14.951
Lower Bound	-8.675	-4.876	-8.949	-5.268	-4.806	-7.563	-5.616	1.631

Table 4.C.24: Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of Marginal Contracts by Experimental Group for the Follow-Up Wave (Nonresponse-Adjusted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
0.00								
Estimate	-2.213	-0.394	9.183	4.080	-3.004	6.804	3.346	-3.514
Upper Bound	6.244	6.091	17.855	12.627	5.409	13.741	12.873	3.645
Lower Bound	-10.670	-6.879	0.511	-4.467	-11.417	-0.133	-6.181	-10.673
0.00-14.99								
Estimate	1.924	1.711	2.305	1.066	3.529	-1.045	4.594	-1.558
Upper Bound	5.934	4.401	8.344	4.616	7.625	3.467	9.567	1.630
Lower Bound	-2.086	-0.978	-3.734	-2.485	-0.567	-5.557	-0.379	-4.746
≥15.00								
Estimate	0.289	-1.317	-11.488	-5.146	-0.525	-5.759	-7.940	5.072
Upper Bound	8.948	5.305	-0.981	4.078	7.432	1.509	3.179	11.207
Lower Bound	-8.369	-7.939	-21.995	-14.369	-8.482	-13.027	-19.060	-1.064

Table 4.C.25: Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of Part-Time Contracts by Experimental Group for the Follow-Up Wave (Nonresponse-Adjusted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
0.00								
Estimate	0.287	-1.025	-7.551	-3.645	-2.754	1.761	-5.365	-0.435
Upper Bound	7.783	5.275	2.460	5.413	4.092	9.019	3.411	5.760
Lower Bound	-7.208	-7.324	-17.561	-12.703	-9.601	-5.498	-14.141	-6.629
0.01 - 19.99								
Estimate	1.181	1.331	4.497	1.088	3.088	5.746	8.267	0.672
Upper Bound	6.130	4.778	9.407	6.427	7.644	10.305	14.517	3.440
Lower Bound	-3.768	-2.116	-0.412	-4.252	-1.467	1.188	2.018	-2.097
≥20.00								
Estimate	-1.468	-0.306	3.053	2.557	-0.334	-7.507	-2.903	-0.237
Upper Bound	6.728	6.101	13.138	10.788	7.326	-0.100	7.306	5.855
Lower Bound	-9.665	-6.714	-7.031	-5.673	-7.994	-14.914	-13.111	-6.329

Table 4.C.26: Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of Regular Contracts by Experimental Group for the Follow-Up Wave (Nonresponse-Adjusted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
0.00 - 75.00								
Estimate	-0.371	-1.134	-15.565	-2.821	-1.060	-3.104	-14.407	4.099
Upper Bound	7.927	5.311	-5.081	5.828	6.910	4.422	-3.622	10.502
Lower Bound	-8.670	-7.579	-26.050	-11.471	-9.031	-10.631	-25.192	-2.305
75.01 - 88.88								
Estimate	1.697	0.473	5.096	0.737	3.444	-0.306	7.592	0.741
Upper Bound	6.506	3.897	10.684	8.628	6.954	4.574	13.387	3.327
Lower Bound	-3.112	-2.951	-0.493	-7.154	-0.065	-5.186	1.796	-1.845
88.89 - 97.43								
Estimate	1.393	0.640	1.851	-0.392	0.353	0.350	1.068	-1.074
Upper Bound	3.663	2.149	5.949	1.809	4.540	2.084	4.097	1.607
Lower Bound	-0.877	-0.869	-2.247	-2.593	-3.834	-1.384	-1.961	-3.754
>97.44								
Estimate	-2.718	0.021	8.619	2.477	-2.737	3.060	5.747	-3.766
Upper Bound	5.348	6.034	16.886	10.644	5.759	9.772	14.849	4.113
Lower Bound	-10.785	-5.991	0.352	-5.690	-11.233	-3.651	-3.355	-11.645

4.C.4 Individual Nonresponse Bias Estimates - Cumulative Nonresponse Bias

Table 4.C.27: Cumulative Nonresponse Bias Estimates and 95% Confidence Interval of Number of Employees by Experimental Group for the First and Follow-Up Wave (Design-Weighted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
1-9								
Cumulative - First Wave + Follow-Up Wave								
Estimate	1.543	1.255	2.543	-2.779	4.802	-4.025	0.600	11.811
Upper Bound	9.542	9.436	11.573	6.365	12.888	5.833	10.036	16.967
Lower Bound	-6.456	-6.927	-6.487	-11.923	-3.283	-13.883	-8.835	6.655
Follow-Up Wave								
Estimate	-0.721	-1.984	-4.042	-2.910	-1.491	-2.685	-3.545	1.874
Upper Bound	5.479	2.011	2.749	2.830	3.745	4.236	4.684	5.003
Lower Bound	-6.921	-5.979	-10.833	-8.650	-6.727	-9.606	-11.775	-1.255
First Wave								
Estimate	2.264	3.239	6.585	0.131	6.293	-1.340	4.146	9.937
Upper Bound	8.421	9.777	12.333	6.660	12.344	6.397	11.708	14.961
Lower Bound	-3.894	-3.300	0.837	-6.397	0.242	-9.076	-3.416	4.914
10-19								
Cumulative - First Wave + Follow-Up Wave								
Estimate	-0.571	0.367	-2.642	2.621	-5.066	1.832	0.280	-7.528
Upper Bound	5.621	6.923	3.654	9.835	-0.085	8.414	7.534	-3.774
Lower Bound	-6.763	-6.190	-8.939	-4.592	-10.048	-4.751	-6.974	-11.282
Follow-Up Wave								
Estimate	-1.059	0.802	2.164	1.294	-0.617	0.318	-0.029	-1.859
Upper Bound	4.454	3.920	6.286	5.398	2.461	6.217	7.172	0.781
Lower Bound	-6.573	-2.316	-1.958	-2.810	-3.695	-5.582	-7.231	-4.499
First Wave								
Estimate	0.488	-0.436	-4.807	1.327	-4.449	1.514	0.310	-5.669
Upper Bound	5.721	4.980	-0.516	6.411	-0.266	7.609	7.068	-1.750
Lower Bound	-4.744	-5.851	-9.097	-3.756	-8.632	-4.581	-6.449	-9.588
20-49								
Cumulative - First Wave + Follow-Up Wave								
Estimate	-0.041	-0.315	0.718	0.178	1.185	3.809	1.200	-1.741
Upper Bound	3.343	2.683	4.701	3.664	5.276	8.703	5.243	0.827
Lower Bound	-3.424	-3.312	-3.265	-3.308	-2.907	-1.085	-2.844	-4.309
Follow-Up Wave								
Estimate	1.007	0.747	1.113	1.143	1.728	2.084	3.308	-0.035
Upper Bound	3.351	2.219	4.016	3.226	4.193	4.846	5.979	1.275
Lower Bound	-1.336	-0.726	-1.789	-0.939	-0.737	-0.678	0.637	-1.345
First Wave								
Estimate	-1.048	-1.061	-0.396	-0.965	-0.543	1.725	-2.109	-1.706
Upper Bound	1.230	1.346	2.041	1.562	2.194	5.157	0.307	0.593
Lower Bound	-3.326	-3.469	-2.832	-3.493	-3.281	-1.706	-4.524	-4.005
≥50								
Cumulative - First Wave + Follow-Up Wave								
Estimate	-0.932	-1.307	-0.619	-0.020	-0.921	-1.616	-2.080	-2.543
Upper Bound	0.999	0.223	1.777	2.367	1.018	0.074	-0.326	-1.286
Lower Bound	-2.862	-2.837	-3.015	-2.408	-2.859	-3.306	-3.834	-3.799
Follow-Up Wave								
Estimate	0.773	0.435	0.764	0.473	0.380	0.284	0.266	0.020
Upper Bound	2.038	1.236	2.518	2.057	1.612	1.312	1.620	0.629
Lower Bound	-0.493	-0.367	-0.990	-1.111	-0.852	-0.744	-1.087	-0.589
First Wave								
Estimate	-1.704	-1.742	-1.383	-0.493	-1.301	-1.900	-2.347	-2.563
Upper Bound	-0.471	-0.535	0.079	1.154	0.134	-0.622	-1.044	-1.504
Lower Bound	-2.938	-2.948	-2.845	-2.140	-2.735	-3.177	-3.649	-3.621

Table 4.C.28: Cumulative Nonresponse Bias Estimates and 95% Confidence Interval of East/West Germany by Experimental Group for the First and Follow-Up Wave (Design-Weighted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
East Germany (Ref.: West Germany)								
Cumulative - First Wave + Follow-Up Wave								
Estimate	0.028	-1.313	2.696	-1.469	-7.528	-3.694	-1.111	2.544
Upper Bound	8.137	5.329	13.173	6.587	-1.854	3.463	7.894	11.248
Lower Bound	-8.081	-7.956	-7.782	-9.525	-13.201	-10.851	-10.117	-6.159
Follow-Up Wave								
Estimate	-0.009	-0.897	0.703	-1.839	-3.916	-2.337	0.612	1.838
Upper Bound	5.563	3.388	8.047	3.599	0.976	2.921	7.415	5.244
Lower Bound	-5.580	-5.182	-6.641	-7.277	-8.807	-7.595	-6.191	-1.567
First Wave								
Estimate	0.037	-0.416	1.993	0.370	-3.612	-1.357	-1.723	0.706
Upper Bound	6.071	5.325	9.246	6.721	1.787	4.828	4.313	7.843
Lower Bound	-5.997	-6.156	-5.259	-5.981	-9.011	-7.542	-7.760	-6.431

Table 4.C.29: Cumulative Nonresponse Bias Estimates and 95% Confidence Interval of Industry by Experimental Group for the First and Follow-Up Wave (Design-Weighted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
Agric./Manufacturing								
Cumulative - First Wave + Follow-Up Wave								
Estimate	4.096	4.536	-0.388	5.598	-1.043	3.641	11.261	1.240
Upper Bound	14.445	13.875	9.539	16.559	8.039	13.272	24.605	10.625
Lower Bound	-6.254	-4.804	-10.315	-5.362	-10.124	-5.991	-2.084	-8.145
Follow-Up Wave								
Estimate	1.147	1.662	-1.957	4.469	-3.338	3.187	7.251	0.968
Upper Bound	8.227	6.599	5.903	10.312	3.373	8.274	15.990	4.676
Lower Bound	-5.934	-3.274	-9.817	-1.375	-10.049	-1.900	-1.487	-2.740
First Wave								
Estimate	2.949	2.873	1.569	1.130	2.296	0.454	4.009	0.272
Upper Bound	10.554	10.308	9.007	8.898	9.995	7.412	12.384	8.077
Lower Bound	-4.655	-4.561	-5.869	-6.638	-5.404	-6.505	-4.366	-7.533
Service								
Cumulative - First Wave + Follow-Up Wave								
Estimate	-4.947	-6.553	-11.115	-15.619	4.225	1.235	-1.944	-3.808
Upper Bound	7.063	4.548	2.419	-3.586	16.851	12.879	11.229	7.528
Lower Bound	-16.956	-17.653	-24.649	-27.653	-8.400	-10.408	-15.116	-15.144
Follow-Up Wave								
Estimate	0.651	-1.687	-2.911	-7.936	6.559	2.469	0.402	-1.884
Upper Bound	9.221	4.232	7.326	-0.174	15.088	9.844	10.916	3.682
Lower Bound	-7.919	-7.606	-13.148	-15.697	-1.969	-4.907	-10.112	-7.449
First Wave								
Estimate	-5.598	-4.866	-8.204	-7.684	-2.334	-1.233	-2.345	-1.925
Upper Bound	3.298	4.538	1.433	2.111	7.545	8.421	8.329	8.321
Lower Bound	-14.494	-14.269	-17.841	-17.478	-12.213	-10.888	-13.020	-12.170
Public/Educ./Health/Arts								
Cumulative - First Wave + Follow-Up Wave								
Estimate	0.851	2.017	11.503	10.021	-3.183	-4.876	-9.317	2.568
Upper Bound	11.415	11.050	25.390	22.375	6.665	4.348	-1.393	12.728
Lower Bound	-9.713	-7.016	-2.384	-2.333	-13.030	-14.099	-17.241	-7.593
Follow-Up Wave								
Estimate	-1.798	0.025	4.868	3.467	-3.221	-5.656	-7.653	0.915
Upper Bound	6.084	5.270	14.483	11.186	3.860	1.485	1.855	5.616
Lower Bound	-9.680	-5.220	-4.747	-4.252	-10.303	-12.797	-17.161	-3.785
First Wave								
Estimate	2.649	1.992	6.635	6.554	0.039	0.780	-1.664	1.652
Upper Bound	10.481	9.493	15.875	15.696	7.918	9.574	7.472	10.309
Lower Bound	-5.183	-5.509	-2.605	-2.588	-7.841	-8.014	-10.800	-7.004

Table 4.C.30: Cumulative Nonresponse Bias Estimates and 95% Confidence Interval of Foundation Year by Experimental Group for the First and Follow-Up Wave (Design-Weighted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
70s/80s								
Cumulative - First Wave + Follow-Up Wave								
Estimate	3.496	2.961	1.754	3.285	2.276	8.837	0.962	-1.175
Upper Bound	13.040	10.716	11.480	14.277	10.273	19.758	8.801	6.615
Lower Bound	-6.047	-4.794	-7.972	-7.706	-5.722	-2.083	-6.877	-8.965
Follow-Up Wave								
Estimate	0.896	1.330	-1.487	3.936	3.087	6.079	-0.452	0.823
Upper Bound	7.185	5.397	6.227	9.603	7.813	11.275	6.074	4.386
Lower Bound	-5.394	-2.737	-9.201	-1.730	-1.640	0.884	-6.979	-2.740
First Wave								
Estimate	2.601	1.631	3.241	-0.651	-0.811	2.758	1.414	-1.998
Upper Bound	9.639	8.005	10.345	6.514	4.865	10.437	8.281	4.661
Lower Bound	-4.437	-4.742	-3.862	-7.816	-6.487	-4.921	-5.452	-8.657
90s								
Cumulative - First Wave + Follow-Up Wave								
Estimate	3.368	1.534	6.047	5.268	0.820	-4.636	10.206	5.896
Upper Bound	14.002	9.926	18.148	15.678	11.291	1.884	21.712	17.526
Lower Bound	-7.266	-6.858	-6.054	-5.142	-9.650	-11.156	-1.300	-5.734
Follow-Up Wave								
Estimate	0.896	0.352	4.494	1.837	0.848	-1.086	0.306	1.295
Upper Bound	7.813	4.962	12.607	7.970	7.274	3.379	9.841	6.937
Lower Bound	-6.020	-4.258	-3.619	-4.297	-5.579	-5.551	-9.229	-4.347
First Wave								
Estimate	2.472	1.182	1.552	3.431	-0.027	-3.550	9.900	4.601
Upper Bound	9.969	8.040	8.916	11.293	7.206	2.088	18.682	14.820
Lower Bound	-5.025	-5.676	-5.811	-4.430	-7.260	-9.188	1.118	-5.618
00s								
Cumulative - First Wave + Follow-Up Wave								
Estimate	-0.606	-1.353	-9.778	-2.552	-1.066	10.742	-2.974	-0.400
Upper Bound	9.593	7.898	-0.538	7.593	11.217	23.361	8.625	8.576
Lower Bound	-10.805	-10.604	-19.018	-12.696	-13.348	-1.876	-14.574	-9.376
Follow-Up Wave								
Estimate	0.453	-0.137	-8.805	2.118	1.686	5.289	-7.143	-1.144
Upper Bound	7.197	4.738	1.013	8.408	8.571	11.796	3.075	4.408
Lower Bound	-6.292	-5.012	-18.623	-4.172	-5.200	-1.218	-17.362	-6.697
First Wave								
Estimate	-1.058	-1.216	-0.973	-4.669	-2.751	5.453	4.169	0.744
Upper Bound	6.675	6.641	8.456	3.118	5.682	14.745	14.063	8.895
Lower Bound	-8.791	-9.073	-10.402	-12.457	-11.184	-3.839	-5.725	-7.406
10s/20s								
Cumulative - First Wave + Follow-Up Wave								
Estimate	-6.259	-3.142	1.977	-6.002	-2.030	-14.943	-8.194	-4.321
Upper Bound	5.207	7.485	15.591	5.616	11.405	-4.789	5.074	7.229
Lower Bound	-17.724	-13.769	-11.636	-17.620	-15.465	-25.098	-21.461	-15.870
Follow-Up Wave								
Estimate	-2.244	-1.545	5.798	-7.891	-5.620	-10.282	7.290	-0.973
Upper Bound	5.682	4.487	15.072	0.773	3.829	-1.926	16.159	3.902
Lower Bound	-10.171	-7.577	-3.477	-16.555	-15.068	-18.639	-1.579	-5.848
First Wave								
Estimate	-4.015	-1.598	-3.820	1.889	3.589	-4.661	-15.484	-3.347
Upper Bound	4.582	7.466	5.331	11.201	13.716	4.925	-6.714	6.403
Lower Bound	-12.611	-10.661	-12.971	-7.422	-6.537	-14.247	-24.253	-13.098

Table 4.C.31: Cumulative Nonresponse Bias Estimates and 95% Confidence Interval of Avg. Age of Employees by Experimental Group for the First and Follow-Up Wave (Design-Weighted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
0.00-38.99								
Cumulative - First Wave + Follow-Up Wave								
Estimate	-1.375	-2.414	-2.649	0.634	-2.263	-0.343	-1.265	2.877
Upper Bound	10.651	7.273	9.601	13.013	10.656	11.273	9.781	13.836
Lower Bound	-13.401	-12.101	-14.899	-11.746	-15.181	-11.960	-12.311	-8.082
Follow-Up Wave								
Estimate	1.009	-1.032	3.179	4.992	0.951	1.919	-3.449	-1.171
Upper Bound	8.798	4.503	11.426	11.649	8.423	8.335	6.848	3.609
Lower Bound	-6.781	-6.567	-5.067	-1.665	-6.521	-4.498	-13.746	-5.950
First Wave								
Estimate	-2.384	-1.382	-5.828	-4.359	-3.214	-2.262	2.184	4.047
Upper Bound	6.183	6.624	2.165	4.169	6.004	6.294	12.085	13.329
Lower Bound	-10.950	-9.388	-13.821	-12.886	-12.432	-10.819	-7.716	-5.235
39.00-43.49								
Cumulative - First Wave + Follow-Up Wave								
Estimate	-0.652	-1.160	-2.792	2.730	-6.599	-2.980	4.700	1.005
Upper Bound	8.100	6.682	4.382	13.040	-1.022	5.134	17.577	10.343
Lower Bound	-9.403	-9.001	-9.967	-7.580	-12.176	-11.093	-8.177	-8.332
Follow-Up Wave								
Estimate	0.452	0.764	-0.341	-0.530	-3.661	-0.371	5.924	1.425
Upper Bound	6.502	4.983	4.910	6.431	2.417	4.182	14.431	5.099
Lower Bound	-5.598	-3.455	-5.592	-7.492	-9.738	-4.924	-2.583	-2.249
First Wave								
Estimate	-1.103	-1.924	-2.451	3.260	-2.938	-2.609	-1.224	-0.420
Upper Bound	5.468	4.643	2.822	11.506	3.645	3.892	7.654	7.168
Lower Bound	-7.675	-8.490	-7.725	-4.985	-9.522	-9.110	-10.102	-8.008
43.50-47.99								
Cumulative - First Wave + Follow-Up Wave								
Estimate	0.344	0.024	-5.801	-2.240	10.612	-0.917	-1.391	-0.752
Upper Bound	9.464	7.925	-0.485	6.177	22.923	6.609	5.402	7.167
Lower Bound	-8.775	-7.877	-11.117	-10.658	-1.699	-8.443	-8.184	-8.671
Follow-Up Wave								
Estimate	-0.202	-0.762	-6.089	-3.389	7.745	-2.429	-2.033	0.271
Upper Bound	6.109	4.302	1.291	4.324	15.410	4.669	5.602	3.388
Lower Bound	-6.513	-5.826	-13.468	-11.101	0.080	-9.527	-9.667	-2.845
First Wave								
Estimate	0.546	0.786	0.288	1.148	2.867	1.512	0.641	-1.023
Upper Bound	7.913	7.888	7.050	9.023	11.671	8.889	7.982	5.601
Lower Bound	-6.821	-6.316	-6.475	-6.726	-5.938	-5.865	-6.699	-7.646
≥48.00								
Cumulative - First Wave + Follow-Up Wave								
Estimate	1.682	3.550	11.242	-1.124	-1.750	4.240	-2.044	-3.130
Upper Bound	14.047	13.915	24.997	9.265	9.911	16.495	9.739	7.619
Lower Bound	-10.682	-6.815	-2.513	-11.512	-13.411	-8.015	-13.827	-13.880
Follow-Up Wave								
Estimate	-1.258	1.030	3.250	-1.073	-5.036	0.881	-0.442	-0.526
Upper Bound	7.432	7.035	13.590	5.818	3.195	8.103	9.082	5.646
Lower Bound	-9.949	-4.974	-7.090	-7.965	-13.266	-6.342	-9.966	-6.697
First Wave								
Estimate	2.941	2.520	7.991	-0.050	3.286	3.359	-1.602	-2.605
Upper Bound	11.297	11.494	17.635	7.994	12.316	13.202	7.273	7.319
Lower Bound	-5.415	-6.454	-1.653	-8.094	-5.745	-6.484	-10.477	-12.528

Table 4.C.32: Cumulative Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of Apprentices by Experimental Group for the First and Follow-Up Wave (Design-Weighted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
0.00 (Ref.: 0.01-100)								
Cumulative - First Wave + Follow-Up Wave								
Estimate	-0.649	-0.877	-0.998	-7.655	-0.775	-11.294	0.050	-4.996
Upper Bound	7.483	7.143	8.332	3.737	7.698	-1.418	9.459	5.045
Lower Bound	-8.780	-8.896	-10.328	-19.046	-9.248	-21.169	-9.358	-15.037
Follow-Up Wave								
Estimate	-1.983	-0.746	-1.242	-5.862	-4.590	-6.385	0.408	-0.815
Upper Bound	3.422	3.416	5.705	0.153	-0.147	-1.195	7.687	3.410
Lower Bound	-7.387	-4.908	-8.188	-11.877	-9.033	-11.575	-6.871	-5.039
First Wave								
Estimate	1.334	-0.131	0.243	-1.792	3.815	-4.908	-0.358	-4.182
Upper Bound	7.035	6.370	6.581	5.672	9.579	1.941	7.116	4.183
Lower Bound	-4.367	-6.632	-6.094	-9.257	-1.949	-11.758	-7.831	-12.547

Table 4.C.33: Cumulative Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of Female Employees by Experimental Group for the First and Follow-Up Wave (Design-Weighted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
0.00 - 18.18								
Cumulative - First Wave + Follow-Up Wave								
Estimate	-1.835	-0.601	-0.935	-4.979	-1.706	0.258	3.140	-2.183
Upper Bound	8.209	9.065	9.544	4.975	7.074	10.758	14.538	7.034
Lower Bound	-11.878	-10.267	-11.414	-14.933	-10.486	-10.241	-8.259	-11.400
Follow-Up Wave								
Estimate	-0.467	-0.250	0.899	2.137	-1.888	1.953	6.805	1.750
Upper Bound	6.356	5.072	8.161	7.126	4.313	7.082	14.581	5.129
Lower Bound	-7.290	-5.571	-6.364	-2.852	-8.089	-3.176	-0.972	-1.629
First Wave								
Estimate	-1.368	-0.352	-1.834	-7.116	0.182	-1.695	-3.665	-3.933
Upper Bound	6.379	7.450	5.196	-0.346	7.309	5.878	4.165	3.913
Lower Bound	-9.114	-8.153	-8.863	-13.887	-6.946	-9.267	-11.495	-11.779
18.19 - 40.97								
Cumulative - First Wave + Follow-Up Wave								
Estimate	1.807	1.590	-3.738	11.616	-0.393	0.908	8.906	3.572
Upper Bound	10.761	10.074	5.524	22.938	10.491	8.285	22.175	12.383
Lower Bound	-7.146	-6.894	-13.000	0.293	-11.278	-6.468	-4.363	-5.238
Follow-Up Wave								
Estimate	1.875	0.792	0.187	1.638	2.175	-2.578	5.705	0.138
Upper Bound	7.585	5.122	7.309	7.970	8.483	4.122	15.084	3.815
Lower Bound	-3.834	-3.539	-6.934	-4.694	-4.132	-9.278	-3.673	-3.539
First Wave								
Estimate	-0.068	0.799	-3.925	9.978	-2.569	3.486	3.201	3.434
Upper Bound	6.313	7.769	3.041	17.802	4.990	10.395	12.012	10.992
Lower Bound	-6.449	-6.172	-10.891	2.154	-10.128	-3.424	-5.611	-4.125
40.98 - 67.12								
Cumulative - First Wave + Follow-Up Wave								
Estimate	0.504	0.501	-0.463	-5.649	-1.518	-1.006	-3.426	-4.774
Upper Bound	10.493	8.868	6.948	1.330	7.419	9.560	6.226	3.132
Lower Bound	-9.486	-7.865	-7.874	-12.628	-10.455	-11.573	-13.077	-12.680
Follow-Up Wave								
Estimate	1.244	0.261	-3.974	-5.691	3.500	0.492	-5.433	-3.456
Upper Bound	7.473	4.721	3.112	1.472	8.173	7.051	3.406	2.255
Lower Bound	-4.985	-4.200	-11.060	-12.854	-1.174	-6.068	-14.272	-9.167
First Wave								
Estimate	-0.741	0.241	3.511	0.041	-5.018	-1.498	2.007	-1.319
Upper Bound	6.737	7.379	10.633	7.657	0.627	6.653	10.277	6.351
Lower Bound	-8.218	-6.898	-3.610	-7.575	-10.663	-9.649	-6.263	-8.988
>67.13								
Cumulative - First Wave + Follow-Up Wave								
Estimate	-0.476	-1.490	5.135	-0.987	3.617	-0.160	-8.620	3.385
Upper Bound	11.631	9.466	18.932	12.034	16.960	12.126	1.388	14.965
Lower Bound	-12.584	-12.447	-8.661	-14.009	-9.726	-12.447	-18.628	-8.194
Follow-Up Wave								
Estimate	-2.652	-0.802	2.888	1.916	-3.787	0.133	-7.077	1.567
Upper Bound	6.278	5.173	12.951	10.147	4.797	7.870	2.790	7.302
Lower Bound	-11.583	-6.778	-7.175	-6.316	-12.372	-7.604	-16.945	-4.168
First Wave								
Estimate	2.176	-0.688	2.247	-2.903	7.405	-0.293	-1.543	1.818
Upper Bound	11.141	8.302	12.065	6.884	17.321	9.348	8.081	11.630
Lower Bound	-6.789	-9.678	-7.570	-12.690	-2.511	-9.935	-11.166	-7.993

Table 4.C.34: Cumulative Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of Fixed-Term Contracts by Experimental Group for the First and Follow-Up Wave (Design-Weighted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
0.00								
Cumulative - First Wave + Follow-Up Wave								
Estimate	0.921	2.726	7.063	-6.608	-2.426	1.615	2.416	-2.739
Upper Bound	11.253	12.002	17.244	5.954	9.994	12.138	13.628	8.546
Lower Bound	-9.410	-6.550	-3.118	-19.170	-14.846	-8.908	-8.797	-14.024
Follow-Up Wave								
Estimate	-1.345	-1.159	2.399	-5.284	-6.731	-2.828	4.889	-0.714
Upper Bound	6.115	3.981	10.795	3.208	0.633	3.735	15.163	4.680
Lower Bound	-8.804	-6.298	-5.997	-13.776	-14.095	-9.390	-5.386	-6.107
First Wave								
Estimate	2.266	3.884	4.664	-1.324	4.305	4.443	-2.473	-2.026
Upper Bound	9.974	11.617	12.562	7.922	13.185	12.616	7.326	7.721
Lower Bound	-5.442	-3.849	-3.234	-10.570	-4.575	-3.730	-12.272	-11.772
0.01 - 15.99								
Cumulative - First Wave + Follow-Up Wave								
Estimate	0.552	-0.371	-0.121	3.934	0.274	-3.351	-1.472	-1.103
Upper Bound	6.993	4.610	4.632	11.966	7.665	0.431	3.681	4.757
Lower Bound	-5.888	-5.352	-4.875	-4.098	-7.117	-7.134	-6.625	-6.964
Follow-Up Wave								
Estimate	0.453	0.671	1.458	2.570	1.672	-1.130	-1.131	0.702
Upper Bound	5.425	3.549	4.990	6.737	5.482	3.369	5.536	2.691
Lower Bound	-4.520	-2.206	-2.074	-1.597	-2.138	-5.629	-7.799	-1.288
First Wave								
Estimate	0.100	-1.042	-1.579	1.364	-1.398	-2.221	-0.341	-1.805
Upper Bound	5.202	3.060	1.594	6.783	3.809	2.454	5.983	2.905
Lower Bound	-5.002	-5.145	-4.752	-4.055	-6.605	-6.897	-6.665	-6.514
≥16.00								
Cumulative - First Wave + Follow-Up Wave								
Estimate	-1.474	-2.355	-6.942	2.674	2.152	1.736	-0.943	3.842
Upper Bound	7.689	5.796	1.372	13.705	12.674	11.313	9.457	14.038
Lower Bound	-10.636	-10.505	-15.255	-8.358	-8.371	-7.841	-11.344	-6.353
Follow-Up Wave								
Estimate	0.892	0.487	-3.857	2.714	5.059	3.958	-3.757	0.012
Upper Bound	7.337	4.890	3.584	9.940	11.103	9.127	5.383	5.401
Lower Bound	-5.553	-3.916	-11.297	-4.512	-0.985	-1.212	-12.898	-5.377
First Wave								
Estimate	-2.366	-2.842	-3.085	-0.040	-2.907	-2.221	2.814	3.830
Upper Bound	4.581	4.115	4.146	8.314	4.073	4.598	11.757	12.692
Lower Bound	-9.313	-9.799	-10.316	-8.394	-9.887	-9.041	-6.129	-5.031

Table 4.C.35: Cumulative Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of Full-Time Contracts by Experimental Group for the First and Follow-Up Wave (Design-Weighted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
0.00 - 36.38								
Cumulative - First Wave + Follow-Up Wave								
Estimate	-3.067	-2.378	-4.867	-15.040	-7.005	-4.096	-9.618	3.546
Upper Bound	9.525	8.744	9.294	-4.492	5.984	7.813	2.381	15.192
Lower Bound	-15.659	-13.501	-19.028	-25.588	-19.994	-16.005	-21.616	-8.101
Follow-Up Wave								
Estimate	-2.297	-0.879	-7.001	-7.503	-6.907	1.751	-11.967	-0.333
Upper Bound	6.541	5.034	3.915	0.662	1.758	8.904	-1.599	5.922
Lower Bound	-11.134	-6.792	-17.916	-15.667	-15.573	-5.402	-22.334	-6.588
First Wave								
Estimate	-0.770	-1.499	2.134	-7.537	-0.097	-5.847	2.349	3.879
Upper Bound	8.089	8.044	11.756	1.697	10.235	3.676	11.992	13.976
Lower Bound	-9.630	-11.043	-7.489	-16.771	-10.430	-15.370	-7.294	-6.219
36.39 - 66.66								
Cumulative - First Wave + Follow-Up Wave								
Estimate	5.361	1.629	-0.024	-0.016	6.428	-3.393	2.040	5.801
Upper Bound	16.357	10.837	9.588	9.956	17.927	4.645	13.030	16.178
Lower Bound	-5.635	-7.580	-9.636	-9.988	-5.071	-11.431	-8.949	-4.576
Follow-Up Wave								
Estimate	2.184	0.456	2.147	2.861	4.036	-8.614	-0.315	3.466
Upper Bound	9.318	5.323	9.528	7.986	10.924	-0.756	8.504	7.280
Lower Bound	-4.950	-4.411	-5.234	-2.264	-2.852	-16.473	-9.134	-0.349
First Wave								
Estimate	3.177	1.173	-2.171	-2.876	2.392	5.221	2.355	2.336
Upper Bound	10.837	8.788	4.450	3.864	10.690	13.510	10.377	10.883
Lower Bound	-4.482	-6.442	-8.793	-9.617	-5.906	-3.067	-5.666	-6.212
66.67 - 85.28								
Cumulative - First Wave + Follow-Up Wave								
Estimate	1.774	1.345	3.010	17.338	0.298	6.773	8.045	-4.507
Upper Bound	9.250	8.652	10.144	29.587	8.696	17.037	20.929	-0.536
Lower Bound	-5.702	-5.961	-4.124	5.088	-8.100	-3.490	-4.839	-8.478
Follow-Up Wave								
Estimate	1.339	0.887	3.664	8.339	1.086	4.336	9.196	-2.241
Upper Bound	6.450	4.606	8.612	14.423	6.810	8.839	16.093	1.110
Lower Bound	-3.772	-2.833	-1.284	2.256	-4.639	-0.167	2.299	-5.591
First Wave								
Estimate	0.435	0.459	-0.654	8.998	-0.788	2.437	-1.151	-2.266
Upper Bound	5.821	6.288	3.961	17.511	5.460	9.699	6.096	2.226
Lower Bound	-4.951	-5.371	-5.270	0.485	-7.035	-4.824	-8.398	-6.759
>85.29								
Cumulative - First Wave + Follow-Up Wave								
Estimate	-4.068	-0.595	1.881	-2.282	0.279	0.716	-0.467	-4.840
Upper Bound	3.466	7.208	13.619	6.135	9.698	11.881	7.700	2.593
Lower Bound	-11.602	-8.399	-9.857	-10.698	-9.140	-10.450	-8.634	-12.273
Follow-Up Wave								
Estimate	-1.226	-0.464	1.189	-3.697	1.786	2.527	3.086	-0.892
Upper Bound	4.897	4.223	8.984	3.268	6.772	7.627	9.184	4.354
Lower Bound	-7.350	-5.150	-6.605	-10.662	-3.201	-2.573	-3.011	-6.138
First Wave								
Estimate	-2.841	-0.132	0.692	1.416	-1.506	-1.812	-3.553	-3.948
Upper Bound	3.507	6.892	8.046	8.872	5.135	5.668	2.077	3.327
Lower Bound	-9.189	-7.156	-6.663	-6.041	-8.148	-9.291	-9.184	-11.223

Table 4.C.36: Cumulative Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of German Citizens by Experimental Group for the First and Follow-Up Wave (Design-Weighted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
100.00 (Ref.: 0.00-99.99)								
Cumulative - First Wave + Follow-Up Wave								
Estimate	1.792	4.055	-0.112	5.759	-1.747	8.218	1.927	10.442
Upper Bound	13.746	13.726	13.190	17.138	10.646	18.298	14.503	19.709
Lower Bound	-10.162	-5.617	-13.415	-5.621	-14.139	-1.862	-10.649	1.176
Follow-Up Wave								
Estimate	-2.354	0.571	-2.900	2.881	-1.746	0.421	0.069	4.689
Upper Bound	5.451	6.131	6.589	10.398	6.496	6.544	10.283	10.550
Lower Bound	-10.159	-4.990	-12.390	-4.636	-9.988	-5.702	-10.146	-1.172
First Wave								
Estimate	4.146	3.484	2.788	2.878	-0.001	7.797	1.858	5.754
Upper Bound	12.589	11.656	11.888	12.159	9.446	15.979	11.499	14.462
Lower Bound	-4.297	-4.688	-6.312	-6.403	-9.448	-0.385	-7.783	-2.955

Table 4.C.37: Cumulative Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of High-Educated Employees by Experimental Group for the First and Follow-Up Wave (Design-Weighted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
0.00								
Cumulative - First Wave + Follow-Up Wave								
Estimate	-2.222	-1.223	5.140	-16.873	-13.260	4.259	2.305	-5.565
Upper Bound	9.946	9.993	16.552	-4.631	0.166	16.393	14.303	5.665
Lower Bound	-14.391	-12.439	-6.271	-29.114	-26.686	-7.874	-9.694	-16.795
Follow-Up Wave								
Estimate	-2.380	-0.854	4.304	-4.738	-10.986	4.811	4.364	-0.529
Upper Bound	5.850	4.746	13.220	3.152	-1.907	12.527	14.279	4.944
Lower Bound	-10.611	-6.454	-4.612	-12.629	-20.066	-2.906	-5.551	-6.002
First Wave								
Estimate	0.158	-0.369	0.836	-12.134	-2.273	-0.551	-2.060	-5.036
Upper Bound	8.730	9.277	9.397	-2.351	7.465	9.187	8.217	4.861
Lower Bound	-8.414	-10.016	-7.724	-21.918	-12.012	-10.290	-12.336	-14.932
0.01 - 14.99								
Cumulative - First Wave + Follow-Up Wave								
Estimate	-0.709	-0.793	-2.832	3.080	-2.631	-0.043	-0.526	-5.154
Upper Bound	5.886	4.842	2.266	11.070	2.359	6.005	5.949	-1.511
Lower Bound	-7.303	-6.428	-7.930	-4.909	-7.620	-6.091	-7.001	-8.796
Follow-Up Wave								
Estimate	1.277	1.151	-1.270	4.064	1.289	0.473	2.895	-3.066
Upper Bound	5.778	3.911	3.492	8.205	4.262	6.049	7.422	2.239
Lower Bound	-3.224	-1.610	-6.033	-0.076	-1.683	-5.103	-1.633	-8.371
First Wave								
Estimate	-1.986	-1.944	-1.562	-0.984	-3.920	-0.517	-3.420	-2.088
Upper Bound	2.577	2.490	2.608	4.085	-0.243	5.500	1.362	3.261
Lower Bound	-6.549	-6.378	-5.732	-6.053	-7.597	-6.533	-8.203	-7.436
≥15.00								
Cumulative - First Wave + Follow-Up Wave								
Estimate	2.931	2.016	-2.308	13.793	15.890	-4.216	-1.779	10.718
Upper Bound	14.501	12.400	7.407	26.088	29.284	6.133	8.467	22.052
Lower Bound	-8.639	-8.367	-12.024	1.498	2.496	-14.565	-12.025	-0.616
Follow-Up Wave								
Estimate	1.103	-0.297	-3.034	0.674	9.697	-5.284	-7.259	3.595
Upper Bound	8.734	5.170	5.025	8.653	17.632	2.337	2.494	8.268
Lower Bound	-6.528	-5.763	-11.093	-7.304	1.762	-12.906	-17.012	-1.078
First Wave								
Estimate	1.828	2.313	0.725	13.118	6.193	1.068	5.480	7.124
Upper Bound	10.112	11.162	8.510	22.844	15.722	9.832	15.147	16.739
Lower Bound	-6.456	-6.535	-7.060	3.392	-3.335	-7.696	-4.187	-2.492

Table 4.C.38: Cumulative Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of Mid-Educated Employees by Experimental Group for the First and Follow-Up Wave (Design-Weighted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
0.00 - 50.00								
Cumulative - First Wave + Follow-Up Wave								
Estimate	-3.432	-3.333	-5.585	-7.519	3.438	-7.216	-4.608	9.761
Upper Bound	7.628	6.499	4.949	3.739	16.580	2.929	6.610	21.114
Lower Bound	-14.493	-13.165	-16.118	-18.778	-9.704	-17.362	-15.826	-1.592
Follow-Up Wave								
Estimate	-1.090	-1.622	-2.851	-4.120	1.794	-0.414	-6.986	1.765
Upper Bound	6.654	4.319	5.042	3.499	9.717	6.060	3.055	6.935
Lower Bound	-8.834	-7.564	-10.744	-11.739	-6.128	-6.888	-17.027	-3.406
First Wave								
Estimate	-2.342	-1.711	-2.734	-3.400	1.644	-6.802	2.378	7.996
Upper Bound	5.878	6.671	5.388	5.426	11.008	1.236	12.296	17.859
Lower Bound	-10.563	-10.093	-10.856	-12.225	-7.721	-14.840	-7.540	-1.866
50.01 - 70.58								
Cumulative - First Wave + Follow-Up Wave								
Estimate	-0.266	-0.357	-2.385	9.208	2.329	4.806	-1.860	-4.540
Upper Bound	7.669	7.750	5.965	19.694	13.314	15.276	4.983	3.989
Lower Bound	-8.201	-8.465	-10.736	-1.278	-8.657	-5.663	-8.704	-13.069
Follow-Up Wave								
Estimate	1.063	0.660	-0.154	5.765	4.593	3.712	-4.407	-4.405
Upper Bound	6.308	4.950	6.474	10.870	9.872	8.546	3.947	1.585
Lower Bound	-4.181	-3.629	-6.782	0.659	-0.686	-1.122	-12.761	-10.395
First Wave								
Estimate	-1.329	-1.018	-2.231	3.443	-2.264	1.095	2.547	-0.135
Upper Bound	4.854	5.441	4.006	10.741	4.990	8.599	10.395	8.598
Lower Bound	-7.512	-7.476	-8.469	-3.855	-9.518	-6.409	-5.302	-8.868
70.59 - 84.99								
Cumulative - First Wave + Follow-Up Wave								
Estimate	2.135	0.798	0.015	6.408	1.216	0.066	-3.277	-2.804
Upper Bound	10.977	8.619	8.972	17.510	8.903	6.712	6.141	3.059
Lower Bound	-6.706	-7.024	-8.941	-4.695	-6.471	-6.579	-12.695	-8.667
Follow-Up Wave								
Estimate	1.422	0.123	1.408	1.380	2.572	-4.901	3.649	1.165
Upper Bound	7.500	4.246	7.965	8.407	6.674	1.866	8.960	3.343
Lower Bound	-4.657	-4.000	-5.149	-5.648	-1.529	-11.668	-1.662	-1.013
First Wave								
Estimate	0.714	0.674	-1.393	5.028	-1.357	4.967	-6.926	-3.969
Upper Bound	7.223	7.417	4.726	13.497	3.745	12.540	-0.793	0.930
Lower Bound	-5.796	-6.069	-7.511	-3.442	-6.458	-2.606	-13.059	-8.868
>85.00								
Cumulative - First Wave + Follow-Up Wave								
Estimate	1.563	2.893	7.955	-8.096	-6.983	2.344	9.746	-2.417
Upper Bound	13.686	13.618	22.310	2.564	4.517	14.808	22.518	8.295
Lower Bound	-10.559	-7.833	-6.400	-18.756	-18.482	-10.121	-3.027	-13.129
Follow-Up Wave								
Estimate	-1.395	0.839	1.597	-3.025	-8.960	1.604	7.744	1.475
Upper Bound	6.888	6.332	12.446	4.449	0.091	9.068	17.575	6.998
Lower Bound	-9.678	-4.654	-9.252	-10.500	-18.010	-5.861	-2.087	-4.048
First Wave								
Estimate	2.958	2.054	6.358	-5.071	1.977	0.740	2.001	-3.892
Upper Bound	11.964	11.321	16.181	3.854	11.614	10.424	12.094	5.717
Lower Bound	-6.048	-7.214	-3.465	-13.996	-7.660	-8.944	-8.091	-13.501

Table 4.C.39: Cumulative Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of Low-Educated Employees by Experimental Group for the First and Follow-Up Wave (Design-Weighted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
0.00								
Cumulative - First Wave + Follow-Up Wave								
Estimate	4.190	3.055	7.168	-5.735	-0.510	-2.500	3.908	4.136
Upper Bound	15.544	13.482	19.232	6.808	12.647	9.399	16.017	15.671
Lower Bound	-7.165	-7.373	-4.896	-18.278	-13.667	-14.399	-8.200	-7.400
Follow-Up Wave								
Estimate	-1.199	-0.622	6.013	-5.371	-7.943	-3.614	-0.017	1.285
Upper Bound	6.576	5.114	15.216	2.477	-0.125	4.391	9.946	6.986
Lower Bound	-8.974	-6.359	-3.190	-13.219	-15.761	-11.619	-9.980	-4.416
First Wave								
Estimate	5.389	3.677	1.155	-0.364	7.433	1.114	3.925	2.851
Upper Bound	13.721	12.673	10.272	9.250	16.660	10.210	13.442	12.960
Lower Bound	-2.944	-5.319	-7.962	-9.978	-1.794	-7.982	-5.592	-7.258
0.01 - 11.99								
Cumulative - First Wave + Follow-Up Wave								
Estimate	0.064	0.199	1.088	4.955	3.131	4.328	-1.425	-3.473
Upper Bound	4.621	5.304	6.241	12.646	8.797	10.538	2.794	-0.250
Lower Bound	-4.493	-4.906	-4.064	-2.736	-2.534	-1.882	-5.645	-6.696
Follow-Up Wave								
Estimate	1.321	1.250	1.207	3.133	2.211	0.515	1.830	-0.365
Upper Bound	4.687	3.655	5.042	7.300	5.657	6.190	4.711	1.454
Lower Bound	-2.044	-1.154	-2.629	-1.035	-1.235	-5.160	-1.052	-2.185
First Wave								
Estimate	-1.258	-1.051	-0.118	1.822	0.920	3.813	-3.255	-3.107
Upper Bound	2.179	2.786	3.422	6.861	4.810	9.763	-0.193	-0.049
Lower Bound	-4.694	-4.887	-3.658	-3.217	-2.970	-2.137	-6.317	-6.165
≥12.00								
Cumulative - First Wave + Follow-Up Wave								
Estimate	-4.254	-3.254	-8.257	0.780	-2.622	-1.827	-2.483	-0.663
Upper Bound	6.582	6.537	2.489	12.287	10.416	8.791	9.176	10.814
Lower Bound	-15.089	-13.045	-19.003	-10.727	-15.660	-12.446	-14.142	-12.139
Follow-Up Wave								
Estimate	-0.122	-0.628	-7.220	2.238	5.732	3.099	-1.813	-0.920
Upper Bound	7.286	4.829	1.774	8.921	12.311	9.267	8.095	4.924
Lower Bound	-7.531	-6.084	-16.213	-4.445	-0.847	-3.068	-11.721	-6.764
First Wave								
Estimate	-4.131	-2.626	-1.037	-1.459	-8.354	-4.927	-0.670	0.257
Upper Bound	3.789	5.969	7.649	6.960	0.325	2.732	8.609	10.428
Lower Bound	-12.051	-11.221	-9.723	-9.877	-17.032	-12.586	-9.950	-9.914

Table 4.C.40: Cumulative Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of Unknown-Educated Employees by Experimental Group for the First and Follow-Up Wave (Design-Weighted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
0.00 (Ref.: 0.01-100.00)								
Cumulative - First Wave + Follow-Up Wave								
Estimate	0.450	5.580	8.787	12.472	7.264	1.467	1.124	10.012
Upper Bound	11.957	13.792	18.156	19.669	15.629	11.138	11.757	18.039
Lower Bound	-11.057	-2.632	-0.582	5.275	-1.101	-8.203	-9.508	1.985
Follow-Up Wave								
Estimate	-1.558	0.254	-0.273	0.977	0.972	-0.951	3.173	8.084
Upper Bound	5.423	5.235	6.065	5.615	6.772	5.001	12.429	14.446
Lower Bound	-8.538	-4.727	-6.611	-3.661	-4.827	-6.903	-6.083	1.723
First Wave								
Estimate	2.008	5.326	9.060	11.495	6.292	2.419	-2.049	1.928
Upper Bound	10.461	12.674	15.243	17.351	13.153	10.385	7.380	11.058
Lower Bound	-6.446	-2.023	2.878	5.639	-0.570	-5.548	-11.477	-7.203

Table 4.C.41: Cumulative Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of Marginal Contracts by Experimental Group for the First and Follow-Up Wave (Design-Weighted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
0.00								
Cumulative - First Wave + Follow-Up Wave								
Estimate	-3.515	-0.528	5.176	4.774	6.521	7.789	2.555	-6.743
Upper Bound	8.383	10.784	18.496	17.482	20.031	19.944	15.427	4.918
Lower Bound	-15.414	-11.840	-8.143	-7.934	-6.988	-4.366	-10.317	-18.404
Follow-Up Wave								
Estimate	-2.433	-0.367	9.620	3.080	-1.398	6.602	3.620	-3.134
Upper Bound	5.968	6.016	18.488	11.379	7.136	13.736	13.608	3.337
Lower Bound	-10.835	-6.750	0.752	-5.218	-9.931	-0.532	-6.368	-9.605
First Wave								
Estimate	-1.082	-0.162	-4.443	1.694	7.919	1.187	-1.065	-3.609
Upper Bound	8.288	9.251	4.646	11.564	17.837	11.092	9.035	6.721
Lower Bound	-10.452	-9.574	-13.532	-8.177	-1.999	-8.719	-11.166	-13.940
0.00-14.99								
Cumulative - First Wave + Follow-Up Wave								
Estimate	1.091	1.659	1.458	0.205	4.339	0.098	3.974	-2.479
Upper Bound	6.962	7.033	7.045	4.734	11.929	5.520	12.411	0.923
Lower Bound	-4.780	-3.716	-4.129	-4.324	-3.252	-5.324	-4.464	-5.881
Follow-Up Wave								
Estimate	1.794	1.561	-0.016	0.622	3.676	-1.131	5.171	-1.327
Upper Bound	5.769	4.185	5.448	3.604	7.735	3.750	10.123	0.975
Lower Bound	-2.181	-1.064	-5.481	-2.360	-0.383	-6.013	0.219	-3.628
First Wave								
Estimate	-0.703	0.098	1.474	-0.417	0.663	1.229	-1.197	-1.152
Upper Bound	3.455	4.561	6.397	3.189	5.812	6.549	3.528	2.140
Lower Bound	-4.861	-4.365	-3.448	-4.023	-4.487	-4.091	-5.923	-4.445
≥15.00								
Cumulative - First Wave + Follow-Up Wave								
Estimate	2.424	-1.131	-6.634	-4.979	-10.860	-7.887	-6.528	9.222
Upper Bound	14.777	9.988	6.636	6.961	1.999	2.983	6.496	21.204
Lower Bound	-9.929	-12.249	-19.904	-16.918	-23.719	-18.756	-19.553	-2.759
Follow-Up Wave								
Estimate	0.640	-1.194	-9.603	-3.702	-2.279	-5.471	-8.791	4.461
Upper Bound	9.167	5.284	0.279	4.647	6.010	1.894	2.197	10.299
Lower Bound	-7.888	-7.672	-19.486	-12.051	-10.568	-12.836	-19.780	-1.378
First Wave								
Estimate	1.785	0.063	2.969	-1.277	-8.581	-2.416	2.263	4.762
Upper Bound	11.202	9.344	12.634	8.411	1.022	6.768	12.503	15.100
Lower Bound	-7.632	-9.217	-6.696	-10.965	-18.185	-11.600	-7.977	-5.577

Table 4.C.42: Cumulative Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of Part-Time Contracts by Experimental Group for the First and Follow-Up Wave (Design-Weighted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
0.00								
Cumulative - First Wave + Follow-Up Wave								
Estimate	-0.617	1.104	-7.703	-4.487	-7.224	8.568	-8.587	2.129
Upper Bound	10.956	11.903	5.139	6.238	4.560	22.206	1.247	12.800
Lower Bound	-12.190	-9.694	-20.544	-15.212	-19.009	-5.070	-18.421	-8.543
Follow-Up Wave								
Estimate	-0.005	-0.575	-8.796	-4.999	-3.545	2.645	-4.828	-0.454
Upper Bound	7.577	5.374	1.583	3.282	4.149	10.217	4.270	5.378
Lower Bound	-7.587	-6.524	-19.174	-13.281	-11.239	-4.927	-13.926	-6.286
First Wave								
Estimate	-0.613	1.679	1.093	0.512	-3.679	5.923	-3.759	2.583
Upper Bound	8.295	10.821	10.804	9.822	5.594	16.135	5.499	11.812
Lower Bound	-9.521	-7.462	-8.618	-8.797	-12.952	-4.288	-13.017	-6.646
0.01 - 19.99								
Cumulative - First Wave + Follow-Up Wave								
Estimate	-0.110	1.275	0.791	2.405	1.427	3.169	8.922	-2.908
Upper Bound	6.718	7.966	6.600	9.869	9.667	12.020	18.704	2.184
Lower Bound	-6.937	-5.416	-5.018	-5.059	-6.813	-5.681	-0.859	-8.000
Follow-Up Wave								
Estimate	1.144	1.218	2.777	1.099	2.840	4.755	8.403	0.557
Upper Bound	5.965	4.518	6.753	5.537	7.171	8.914	14.524	2.820
Lower Bound	-3.678	-2.082	-1.198	-3.340	-1.491	0.597	2.282	-1.706
First Wave								
Estimate	-1.253	0.057	-1.986	1.307	-1.413	-1.586	0.519	-3.465
Upper Bound	3.825	5.486	1.635	6.723	3.939	4.531	6.152	0.943
Lower Bound	-6.332	-5.373	-5.607	-4.109	-6.765	-7.703	-5.113	-7.874
≥20.00								
Cumulative - First Wave + Follow-Up Wave								
Estimate	0.727	-2.379	6.911	2.082	5.797	-11.737	-0.335	0.779
Upper Bound	13.196	8.821	19.754	13.810	18.453	0.752	11.952	11.874
Lower Bound	-11.742	-13.580	-5.931	-9.646	-6.859	-24.227	-12.623	-10.315
Follow-Up Wave								
Estimate	-1.139	-0.643	6.018	3.901	0.705	-7.400	-3.575	-0.103
Upper Bound	7.039	5.547	15.957	11.685	8.658	0.397	6.500	5.572
Lower Bound	-9.317	-6.833	-3.920	-3.883	-7.248	-15.197	-13.651	-5.778
First Wave								
Estimate	1.866	-1.736	0.893	-1.819	5.092	-4.337	3.240	0.882
Upper Bound	10.952	7.785	10.201	7.464	14.760	5.915	13.209	10.642
Lower Bound	-7.220	-11.257	-8.415	-11.101	-4.576	-14.590	-6.729	-8.878

Table 4.C.43: Cumulative Nonresponse Bias Estimates and 95% Confidence Interval of Prop. of Regular Contracts by Experimental Group for the First and Follow-Up Wave (Design-Weighted), BHP 2020

	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web-Only Switch	Web-Only Cont.	Mail-Only Switch	Mail-Only Cont.
0.00 - 75.00								
Cumulative - First Wave + Follow-Up Wave								
Estimate	0.978	-0.691	-10.916	-10.628	-12.588	2.460	-12.694	10.321
Upper Bound	13.124	10.283	2.253	0.490	0.083	14.642	-0.838	21.497
Lower Bound	-11.168	-11.665	-24.084	-21.746	-25.258	-9.722	-24.549	-0.855
Follow-Up Wave								
Estimate	-0.181	-1.139	-13.330	-1.851	-2.357	-4.617	-15.427	3.218
Upper Bound	8.043	5.182	-3.164	5.916	5.945	2.973	-4.704	9.248
Lower Bound	-8.404	-7.460	-23.495	-9.617	-10.660	-12.207	-26.151	-2.813
First Wave								
Estimate	1.158	0.448	2.414	-8.777	-10.230	7.077	2.733	7.103
Upper Bound	10.828	9.492	11.619	0.079	-0.883	16.475	12.898	16.908
Lower Bound	-8.512	-8.595	-6.791	-17.634	-19.578	-2.321	-7.431	-2.702
75.01 - 88.88								
Cumulative - First Wave + Follow-Up Wave								
Estimate	1.493	1.201	2.681	8.436	2.204	0.501	7.468	2.497
Upper Bound	8.656	7.479	10.521	18.967	9.750	7.001	18.745	9.952
Lower Bound	-5.671	-5.078	-5.159	-2.095	-5.342	-6.000	-3.810	-4.958
Follow-Up Wave								
Estimate	1.826	0.364	3.239	0.347	3.252	0.829	7.612	1.171
Upper Bound	6.553	3.842	7.917	7.458	6.872	5.532	13.496	3.604
Lower Bound	-2.902	-3.114	-1.438	-6.764	-0.367	-3.873	1.728	-1.261
First Wave								
Estimate	-0.333	0.837	-0.559	8.089	-1.048	-0.329	-0.145	1.325
Upper Bound	4.710	6.181	4.042	16.144	4.000	4.978	6.330	7.305
Lower Bound	-5.376	-4.508	-5.160	0.034	-6.096	-5.636	-6.619	-4.655
88.89 - 97.43								
Cumulative - First Wave + Follow-Up Wave								
Estimate	0.614	-0.287	3.198	-1.613	0.702	-1.019	0.580	-2.114
Upper Bound	4.105	2.610	7.928	0.957	5.085	1.250	4.091	-0.164
Lower Bound	-2.878	-3.185	-1.533	-4.183	-3.681	-3.289	-2.930	-4.063
Follow-Up Wave								
Estimate	1.318	0.646	1.780	-0.101	0.212	0.116	1.410	-0.918
Upper Bound	3.542	1.970	5.021	1.515	3.982	1.742	3.782	0.949
Lower Bound	-0.905	-0.677	-1.460	-1.717	-3.557	-1.511	-0.961	-2.784
First Wave								
Estimate	-0.705	-0.934	1.418	-1.512	0.489	-1.135	-0.830	-1.196
Upper Bound	1.752	1.309	4.208	0.566	4.339	0.809	1.388	1.058
Lower Bound	-3.161	-3.177	-1.372	-3.591	-3.361	-3.079	-3.048	-3.450
>97.44								
Cumulative - First Wave + Follow-Up Wave								
Estimate	-3.084	-0.222	5.037	3.805	9.682	-1.942	4.646	-10.704
Upper Bound	8.315	10.511	18.088	17.399	23.101	10.048	17.388	-0.267
Lower Bound	-14.483	-10.955	-8.014	-9.789	-3.737	-13.931	-8.097	-21.142
Follow-Up Wave								
Estimate	-2.963	0.129	8.310	1.604	-1.107	3.672	6.404	-3.472
Upper Bound	5.105	6.018	17.073	9.936	7.406	10.026	16.129	3.511
Lower Bound	-11.031	-5.760	-0.453	-6.727	-9.621	-2.683	-3.320	-10.454
First Wave								
Estimate	-0.120	-0.351	-3.273	2.201	10.789	-5.613	-1.759	-7.232
Upper Bound	9.134	8.745	5.233	12.529	20.735	3.286	7.599	2.813
Lower Bound	-9.375	-9.447	-11.779	-8.128	0.844	-14.513	-11.117	-17.278

4.D Survey Participation

Table 4.D.1: Predicted Probabilities and First Differences based on Regressions on Participation in the Follow-Up Wave for Establishments with Mail-Web Design in the First Wave

	Pr(Response)	SE	P-Value	First Difference	SE	P-Value
Industry						
Agric./Manufacturing, Mail-Web Switch	0.609	(0.024)	0.000	0.609-0.777 = -0.168	0.031	0.000
Agric./Manufacturing, Mail-Web Continuation	0.777	(0.020)	0.000			
Service, Mail-Web Switch	0.600	(0.021)	0.000	0.600-0.718 = -0.118	0.028	0.000
Service, Mail-Web Continuation	0.718	(0.018)	0.000			
Public/Educ./Health/Arts, Mail-Web Switch	0.541	(0.28)	0.000	0.541-0.730 = -0.190	0.037	0.000
Public/Educ./Health/Arts, Mail-Web Continuation	0.730	(0.025)	0.000			
Number of Employees						
1-9 Employees, Mail-Web Switch	0.585	(0.019)	0.000	0.585-0.719 = -0.135	0.025	0.000
1-9 Employees, Mail-Web Continuation	0.719	(0.017)	0.000			
10-19 Employees, Mail-Web Switch	0.537	(0.032)	0.000	0.537-0.764 = -0.227	0.040	0.000
10-19 Employees, Mail-Web Continuation	0.764	(0.024)	0.000			
20-49 Employees, Mail-Web Switch	0.638	(0.019)	0.000	0.638-0.777 = -0.139	0.026	0.000
20-49 Employees, Mail-Web Continuation	0.777	(0.017)	0.000			
50-249 Employees, Mail-Web Switch	0.695	(0.021)	0.000	0.695-0.794 = -0.100	0.028	0.000
50-249 Employees, Mail-Web Continuation	0.794	(0.019)	0.000			
≥250 Employees, Mail-Web Switch	0.547	(0.041)	0.000	0.547-0.654 = -0.107	0.055	0.051
≥250 Employees, Mail-Web Continuation	0.654	(0.036)	0.000			
Decade of Foundation						
70s/80s, Mail-Web Switch	0.607	(0.032)	0.000	0.607-0.777 = -0.170	0.042	0.000
70s/80s, Mail-Web Continuation	0.777	(0.026)	0.000			
90s, Mail-Web Switch	0.606	(0.028)	0.000	0.606-0.759 = -0.153	0.037	0.000
90s, Mail-Web Continuation	0.759	(0.025)	0.000			
00s, Mail-Web Switch	0.603	(0.028)	0.000	0.603-0.729 = -0.126	0.038	0.001
00s, Mail-Web Continuation	0.729	(0.025)	0.000			
10s/20s, Mail-Web Switch	0.555	(0.026)	0.000	0.555-0.701 = -0.146	0.034	0.000
10s/20s, Mail-Web Continuation	0.701	(0.022)	0.000			

Table 4.D.2: Predicted Probabilities and First Differences based on Regressions on Participation in the Follow-Up Wave for Establishments with Web-to-Mail Design in the First Wave

	Pr(Response)	SE	P-Value	First Difference	SE	P-Value
Industry						
Agric./Manufacturing, Web-to-Mail Switch	0.470	(0.092)	0.000	0.470-0.774 = -0.304	0.115	0.008
Agric./Manufacturing, Web-to-Mail Continuation	0.774	(0.068)	0.000			
Service, Web-to-Mail Switch	0.479	(0.069)	0.000	0.479-0.512 = -0.034	0.109	0.759
Service, Web-to-Mail Continuation	0.512	(0.077)	0.000			
Public/Educ./Health/Arts, Web-to-Mail Switch	0.616	(0.102)	0.000	0.616-0.678 = -0.062	0.143	0.665
Public/Educ./Health/Arts, Web-to-Mail Continuation	0.678	(0.106)	0.000			
Number of Employees						
1-9 Employees, Web-to-Mail Switch	0.453	(0.064)	0.000	0.453-0.603 = -0.149	0.097	0.126
1-9 Employees, Web-to-Mail Continuation	0.603	(0.071)	0.000			
10-19 Employees, Web-to-Mail Switch	0.603	(0.095)	0.000	0.603-0.678 = -0.076	0.125	0.545
10-19 Employees, Web-to-Mail Continuation	0.678	(0.089)	0.000			
20-49 Employees, Web-to-Mail Switch	0.694	(0.079)	0.000	0.694-0.677 = 0.017	0.112	0.882
20-49 Employees, Web-to-Mail Continuation	0.677	(0.088)	0.000			
50-249 Employees, Web-to-Mail Switch	0.704	(0.083)	0.000	0.704-0.609 = 0.094	0.140	0.500
50-249 Employees, Web-to-Mail Continuation	0.609	(0.098)	0.000			
≥250 Employees, Web-to-Mail Switch	0.551	(0.148)	0.000	0.551-0.715 = -0.164	0.200	0.414
≥250 Employees, Web-to-Mail Continuation	0.715	(0.131)	0.000			
Decade of Foundation						
70s/80s, Web-to-Mail Switch	0.455	(0.117)	0.000	0.455-0.751 = -0.296	0.155	0.056
70s/80s, Web-to-Mail Continuation	0.751	(0.094)	0.000			
90s, Web-to-Mail Switch	0.644	(0.102)	0.000	0.644-0.640 = 0.004	0.148	0.978
90s, Web-to-Mail Continuation	0.640	(0.111)	0.000			
00s, Web-to-Mail Switch	0.312	(0.074)	0.000	0.312-0.735 = -0.423	0.119	0.000
00s, Web-to-Mail Continuation	0.735	(0.099)	0.000			
10s/20s, Web-to-Mail Switch	0.647	(0.084)	0.000	0.647-0.470 = 0.170	0.123	0.167
10s/20s, Web-to-Mail Continuation	0.470	(0.088)	0.000			

Table 4.D.3: Predicted Probabilities and First Differences based on Regressions on Participation in the Follow-Up Wave for Establishments with Single-Mode Web Design in the First Wave

	Pr(Response)	SE	P-Value	First Difference	SE	P-Value
Industry						
Agric./Manufacturing, Web-Only Switch	0.485	(0.024)	0.000	0.485-0.729 = -0.244	0.126	0.053
Agric./Manufacturing, Web-Only Continuation	0.729	(0.020)	0.000			
Service, Web-Only Switch	0.694	(0.021)	0.000	0.694-0.683 = 0.010	0.101	0.918
Service, Web-Only Continuation	0.683	(0.018)	0.000			
Public/Educ./Health/Arts, Web-Only Switch	0.534	(0.28)	0.000	0.534-0.579 = -0.045	0.151	0.765
Public/Educ./Health/Arts, Web-Only Continuation	0.579	(0.025)	0.000			
Number of Employees						
1-9 Employees, Web-Only Switch	0.606	(0.065)	0.000	0.606-0.635 = -0.029	0.095	0.759
1-9 Employees, Web-Only Continuation	0.635	(0.064)	0.000			
10-19 Employees, Web-Only Switch	0.571	(0.076)	0.000	0.571-0.754 = -0.183	0.126	0.146
10-19 Employees, Web-Only Continuation	0.754	(0.094)	0.000			
20-49 Employees, Web-Only Switch	0.709	(0.067)	0.000	0.709-0.750 = -0.041	0.088	0.640
20-49 Employees, Web-Only Continuation	0.750	(0.059)	0.000			
50-249 Employees, Web-Only Switch	0.592	(0.088)	0.000	0.592-0.656 = -0.064	0.114	0.574
50-249 Employees, Web-Only Continuation	0.656	(0.083)	0.000			
≥250 Employees, Web-Only Switch	0.759	(0.150)	0.000	0.759-0.505 = 0.254	0.250	0.309
≥250 Employees, Web-Only Continuation	0.505	(0.193)	0.009			
Decade of Foundation						
70s/80s, Web-Only Switch	0.763	(0.066)	0.000	0.763-0.806 = -0.043	0.096	0.651
70s/80s, Web-Only Continuation	0.806	(0.070)	0.000			
90s, Web-Only Switch	0.608	(0.102)	0.000	0.608-0.620 = -0.011	0.133	0.933
90s, Web-Only Continuation	0.620	(0.076)	0.000			
00s, Web-Only Switch	0.672	(0.078)	0.000	0.672-0.763 = -0.091	0.114	0.426
00s, Web-Only Continuation	0.763	(0.077)	0.000			
10s/20s, Web-Only Switch	0.502	(0.098)	0.000	0.502-0.490 = 0.012	0.143	0.931
10s/20s, Web-Only Continuation	0.490	(0.101)	0.000			

Table 4.D.4: Predicted Probabilities and First Differences based on Regressions on Participation in the Follow-Up Wave for Establishments with Single-Mode Mail Design in the First Wave

	Pr(Response)	SE	P-Value	First Difference	SE	P-Value
Industry						
Agric./Manufacturing, Mail-Only Switch	0.680	(0.070)	0.000	0.680-0.835 = -0.155	0.089	0.080
Agric./Manufacturing, Mail-Only Continuation	0.835	(0.045)	0.000			
Service, Mail-Only Switch	0.546	(0.078)	0.000	0.546-0.744 = -0.198	0.119	0.095
Service, Mail-Only Continuation	0.744	(0.082)	0.000			
Public/Educ./Health/Arts, Mail-Only Switch	0.349	(0.098)	0.000	0.349-0.806 = -0.457	0.113	0.000
Public/Educ./Health/Arts, Mail-Only Continuation	0.806	(0.077)	0.000			
Number of Employees						
1-9 Employees, Mail-Only Switch	0.514	(0.072)	0.000	0.514-0.803 = -0.289	0.094	0.002
1-9 Employees, Mail-Only Continuation	0.803	(0.061)	0.000			
10-19 Employees, Mail-Only Switch	0.490	(0.122)	0.000	0.490-0.624 = -0.137	0.150	0.359
10-19 Employees, Mail-Only Continuation	0.624	(0.100)	0.000			
20-49 Employees, Mail-Only Switch	0.760	(0.063)	0.000	0.760-0.788 = -0.028	0.093	0.767
20-49 Employees, Mail-Only Continuation	0.788	(0.065)	0.000			
50-249 Employees, Mail-Only Switch	0.541	(0.106)	0.000	0.541-0.768 = -0.227	0.139	0.102
50-249 Employees, Mail-Only Continuation	0.768	(0.091)	0.000			
≥250 Employees, Mail-Only Switch	0.422	(0.157)	0.007	0.422-0.714 = -0.292	0.239	0.221
≥250 Employees, Mail-Only Continuation	0.714	(0.178)	0.000			
Decade of Foundation						
70s/80s, Mail-Only Switch	0.541	(0.130)	0.000	0.541-0.836 = -0.295	0.153	0.053
70s/80s, Mail-Only Continuation	0.836	(0.093)	0.000			
90s, Mail-Only Switch	0.587	(0.101)	0.000	0.587-0.789 = -0.202	0.155	0.193
90s, Mail-Only Continuation	0.789	(0.117)	0.000			
00s, Mail-Only Switch	0.388	(0.099)	0.000	0.388-0.726 = -0.338	0.152	0.027
00s, Mail-Only Continuation	0.726	(0.102)	0.000			
10s/20s, Mail-Only Switch	0.686	(0.084)	0.000	0.686-0.783 = -0.096	0.108	0.373
10s/20s, Mail-Only Continuation	0.783	(0.071)	0.000			

Table 4.D.5: Predicted Probabilties of Cumulative Response in Mode Continuation and Mode Switch Groups by First Mode Design, IAB-JVS 2020/Q4 - 2021/Q1

Survey Participation in the First and Follow-Up Wave	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web Switch	Web Cont.	Mail Switch	Mail Cont.
Industry								
Agriculture/Forestry	0.107***	0.135***	0.091	0.069	0.086	0.064	0.080	0.073
	(0.078,0.137)	(0.102,0.168)	(-0.020,0.202)	(-0.028,0.165)	(-0.019,0.192)	(-0.020,0.148)	(-0.027,0.186)	(-0.022,0.167)
Production	0.102***	0.130***	0.072***	0.113***	0.085***	0.105***	0.103**	0.124***
	(0.089,0.116)	(0.115,0.146)	(0.030,0.115)	(0.055,0.172)	(0.043,0.128)	(0.050,0.160)	(0.041,0.164)	(0.067,0.181)
Trade/Transport/Hospitality	0.071***	0.090***	0.044***	0.040***	0.078***	0.085***	0.045***	0.088***
	(0.060,0.083)	(0.077,0.102)	(0.019,0.069)	(0.018,0.061)	(0.035,0.121)	(0.036,0.134)	(0.019,0.070)	(0.042,0.133)
Information/Finance/	0.096***	0.115***	0.081***	0.105***	0.109***	0.088***	0.081***	0.120***
Temporary/Other	(0.085,0.107)	(0.103,0.127)	(0.040,0.122)	(0.059,0.150)	(0.062,0.157)	(0.046,0.129)	(0.049,0.112)	(0.074,0.166)
Public/Educ./Health/Arts	0.090***	0.123***	0.134***	0.120***	0.091**	0.090***	0.035***	0.118***
	(0.076,0.105)	(0.106,0.141)	(0.058,0.211)	(0.053,0.187)	(0.033,0.149)	(0.041,0.138)	(0.020,0.050)	(0.049,0.188)
Number of Employees								
1-9	0.092***	0.115***	0.076***	0.080***	0.099***	0.089***	0.063***	0.133***
	(0.084,0.101)	(0.106,0.125)	(0.049,0.103)	(0.052,0.107)	(0.065,0.133)	(0.057,0.120)	(0.041,0.086)	(0.094,0.171)
10-19	0.085***	0.114***	0.062***	0.099***	0.062***	0.097***	0.065***	0.058***
	(0.073,0.096)	(0.100,0.128)	(0.033,0.090)	(0.047,0.150)	(0.038,0.087)	(0.059,0.135)	(0.035,0.096)	(0.035,0.081)
20-49	0.083***	0.103***	0.079***	0.080***	0.103***	0.118***	0.071***	0.091***
	(0.076,0.091)	(0.095,0.112)	(0.049,0.109)	(0.053,0.108)	(0.071,0.135)	(0.079,0.157)	(0.048,0.095)	(0.062,0.120)
50-249	0.074***	0.088***	0.066***	0.071***	0.082***	0.061***	0.042***	0.063***
	(0.066,0.082)	(0.080,0.096)	(0.037,0.094)	(0.039,0.102)	(0.053,0.110)	(0.037,0.085)	(0.025,0.059)	(0.036,0.089)
>250	0.027***	0.033***	0.022**	0.060*	0.030**	0.023**	0.016*	0.032**
	(0.021,0.034)	(0.027,0.039)	(0.005,0.038)	(0.006,0.114)	(0.010,0.050)	(0.007,0.038)	(0.002,0.029)	(0.011,0.052)
Decade of Foundation								
70s/80s	0.108***	0.131***	0.085**	0.094***	0.107***	0.144***	0.068***	0.114***
	(0.092,0.125)	(0.114,0.148)	(0.032,0.138)	(0.039,0.150)	(0.062,0.151)	(0.075,0.212)	(0.029,0.108)	(0.055,0.173)
90s	0.104***	0.122***	0.092***	0.105***	0.096***	0.074***	0.096***	0.138***
	(0.090,0.118)	(0.107,0.137)	(0.039,0.146)	(0.051,0.160)	(0.046,0.146)	(0.046,0.102)	(0.051,0.141)	(0.073,0.204)
00s	0.086***	0.106***	0.046***	0.075***	0.087***	0.136***	0.059***	0.101***
	(0.074,0.097)	(0.092,0.119)	(0.020,0.072)	(0.039,0.111)	(0.037,0.137)	(0.070,0.202)	(0.025,0.092)	(0.062,0.140)
10s/20s	0.074***	0.102***	0.081***	0.069***	0.084***	0.056***	0.051***	0.094***
	(0.065,0.084)	(0.091,0.113)	(0.042,0.119)	(0.035,0.103)	(0.044,0.124)	(0.025,0.088)	(0.027,0.076)	(0.050,0.137)
Observations	52879	52809	3609	3602	3603	3616	3607	3612

Notes: Confindence intervals in parentheses; * p<0.05, ** p<0.01, *** p<0.001.

Table 4.D.6: Results of Logistic Regression on Cumulative Response in Mode Continuation and Mode Switch Groups by First Wave Mode Design, IAB-JVS 2020/Q4 - 2021/Q1

Survey Participation in the First and Follow-Up Wave	Mail-Web Switch	Mail-Web Cont.	Web-to-Mail Switch	Web-to-Mail Cont.	Web Switch	Web Cont.	Mail Switch	Mail Cont.
Industry (Ref.: Production)	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Agriculture/Forestry	0.005	0.004	0.019	-0.045	0.001	-0.044	-0.023	-0.053
	(0.017)	(0.019)	(0.061)	(0.057)	(0.059)	(0.054)	(0.063)	(0.060)
Trade/Transport/Hospitality	-0.032***	-0.041***	-0.029	-0.075*	-0.007	-0.021	-0.059	-0.037
	(0.009)	(0.010)	(0.026)	(0.032)	(0.031)	(0.040)	(0.034)	(0.039)
Information/Communication/Finance/Insurance/Business-related Services/Real Estate/Other	-0.007	-0.016	0.009	-0.009	0.024	-0.018	-0.022	-0.004
	(0.009)	(0.010)	(0.033)	(0.038)	(0.034)	(0.035)	(0.036)	(0.040)
Public Administration/Education/Health/Arts	-0.012	-0.007	0.063	0.007	0.006	-0.016	-0.069*	-0.006
	(0.010)	(0.012)	(0.044)	(0.044)	(0.036)	(0.037)	(0.032)	(0.048)
Number of Employees (Ref.: 1-9)	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
10-19	-0.008	-0.001	-0.016	0.020	-0.037	0.009	0.002	-0.076**
	(0.007)	(0.009)	(0.022)	(0.032)	(0.021)	(0.027)	(0.021)	(0.023)
20-49	-0.009	-0.012	0.003	0.000	0.004	0.031	0.009	-0.042
	(0.006)	(0.007)	(0.022)	(0.022)	(0.023)	(0.027)	(0.018)	(0.025)
50-249	-0.018**	-0.028***	-0.011	-0.010	-0.018	-0.029	-0.023	-0.071**
	(0.006)	(0.006)	(0.022)	(0.024)	(0.022)	(0.022)	(0.016)	(0.024)
≥250	-0.066***	-0.083***	-0.059**	-0.021	-0.070***	-0.071***	-0.053***	-0.103***
	(0.006)	(0.006)	(0.019)	(0.034)	(0.020)	(0.020)	(0.015)	(0.023)
Decade of Foundation (Ref.: 70s/80s)	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
90s	-0.004	-0.010	0.007	0.012	-0.011	-0.070	0.029	0.025
	(0.011)	(0.011)	(0.038)	(0.040)	(0.034)	(0.038)	(0.030)	(0.047)
00s	-0.023*	-0.026*	-0.042	-0.020	-0.020	-0.007	-0.010	-0.013
	(0.010)	(0.011)	(0.032)	(0.036)	(0.032)	(0.047)	(0.027)	(0.039)
10s/20s	-0.034***	-0.030**	-0.005	-0.026	-0.023	-0.088*	-0.018	-0.021
	(0.010)	(0.011)	(0.037)	(0.037)	(0.032)	(0.039)	(0.026)	(0.039)
Observations	52879	52809	3609	3602	3603	3616	3607	3612

Notes: Average Marginal Effects; Standard errors in parentheses; * p<0.05, ** p<0.01, *** p<0.001.

4.E Qualitative Interviews

4.E.1 Short Structured Interviews

Table 4.E.1: Sample Characteristics for Short and In-Depth Qualitative Interviews

Characteristics	Short Interviews	In-Depth Interviews
Interview Mode		
– Telephone	46	2
– Video Telephone	0	6
Experimental Group - First Wave		
– Conc. Mixed-Mode (Mail-Web)	14	2
– Seq. Mixed-Mode (Web-to-Mail)	9	2
– Web	11	2
– Mail	12	2
Experimental Group - Follow-Up Wave		
– Continutation	27	4
– Switch	19	4
Establishment Size		
– < 50 Employees	20	1
– 50-249 Employees	10	2
– ≥ 250 Employees	16	5
Industry		
– Agriculture/Production	23	4
– Service	15	1
– Public Administration/Health/Education	8	3
Region		
– East Germany	13	3
– West Germany	33	5
N	46	8

The short structured interviews were conducted as part of a routine questionnaire pretest conducted by telephone. Toward the end of the pretest, interviewers probed respondents about their preferences for different modes (web, mail, CATI) and solicited their perspectives on the perceived advantages and disadvantages associated with each mode. By positioning these mode-related questions towards the end of the interview, respondents had become acquainted with the nature of the questions posed in the IAB-JVS, facilitating more informed and insightful responses pertaining to the modes. To analyze these interviews, an inductive approach was adopted, allowing for the interpretation and clustering of advantages and disadvantages into thematic categories. The outcomes of these short interviews are presented in Table 4.E.2.

Table 4.E.2: Advantages and Disadvantages of Web Mail, CATI Modes

Advantages	Disadvantages
Web	
• Time & local flexibility (23) • Speed (11) • Easy use of internal documents (7) • Easy handling processes (6) • Easy to enter/correct (4) • Sustainability (1)	• One-way communication prevents clarification of questions or communication of additional information (4) • Cumbersome log-in & handling processes (4) • Low memory capacity (3) • Error-proneness of answering the questionnaire (2) • Data privacy concerns (2)
Mail	
Advantages	**Disadvantages**
• Time flexibility (12) • Easy use of internal documents (7) • High memory capacity (4) • Better distribution within the establishment (2) • Questionnaire easy to handle (2) • Comparability with previous surveys / knowledge documentation (1) • Speed (1) • More intensive engagement with questionnaire (1)	• Long processing time (9) • Cumbersome handling (8) • Demanding return (6) • Unsustainable (6) • One-way communication prevents clarification of questions or communication of additional information (6) • Does not fit so well in operating procedure (2) • Error-proneness of answering the questionnaire (1)
CATI	
Advantages	**Disadvantages**
• Queries possible (11) • If planned, participation is good and binding (5) • Comfortable / Pleasant (5) • Possibility to provide further information (5) • Accuracy of data (3) • Reminding Effect (1)	• Difficult to realize in day-to-day business (13) • Data not suitable for spontaneous calls (9) • Scheduled calls cannot be fulfilled (4) • Requires more time (3) • Privacy concerns (2) • Proneness to errors in communication (e.g., misunderstanding with interviewer) (2)

Notes: Adapted and Extended Table of Küfner et al. (2024)
Number of mentions in parentheses. Establishments were asked about their mode preference and the perceived advantages and disadvantages of web, mail and CATI modes.
Source: 46 qualitative interviews, 2022.

4.E.2 In-Depth Interviews

As the in-depth qualitative interviews (March-May 2022) were conducted approximately one year after the experiment in the follow-up wave (Q1/2021), some establishments could not recall the specific response process they undertook in that wave. To tackle this challenge, we presented the interviewees with realistic mode scenarios that they have faced in the past and requested them to guide us through their potential response process for each scenario in detail. By employing this approach, we obtained answers that can be applied to real situations. For the analysis of the in-depth interviews, we used qualitative content analysis (Mayring, 2022) with MAXQDA (VERBI Software, 2021) for coding. The first interview was coded inductively by members of the research team individually to ensure coding validity. The codes and codings were then compared and discussed, and a code tree was created for the remaining interviews. Trained colleagues coded the 8 in-depth interviews, and another set of colleagues validated the codings in a second coding run. Finally, the interviews were interpreted in the team hermeneutically in their entirety to reconstruct the respective case in relation to the research question (Kurt & Herbrik, 2014; Ronald, 2004; Soeffner, 1989). To further investigate mode preferences and perceptions of changing the mode design in the follow-up waves and their effects on response processes, we conducted a comparative analysis of thematic codes. Additionally, all quotes were translated into English.

Table 4.E.3: Quotes from the In-Depth Qualitative Interviews illustrating Advantages of CATI

Number	*Keywords*	*Quote*	*Interview Partner*
Pro CATI			
1	Two-way communitaction; Personal communication	One can also ask questions [...]. You can communicate with each other much better.	*HR-Manager, Establishment with 50-249 employees*
2	Reminding Effect	It would be for me already better that one says [...] at the time is called and then we do it [the interview]. So otherwise [in the case of self-administered modes] it can be that it is lost to me, then I push it further and further out.	*Manager, Establishment with less than 50 employees*
3	Personal communication	In terms of personal exchange, it has a different character, because HR managers thrive on talking to people.	*HR-Manager, Establishment with more than 250 employees*
4	Two-Way Communication	Don’t you need more info? Or: I would like to give you more info, for example, about this job vacancy. And I’m probably way too boxed in there [when answering self-administered surveys].	*HR-Manager, Establishment with 50-249 employees*
5	Efficiency	Yes, it always depends on what you want to get out. If you just want to do a quick check: Does everything we asked once still fit? - then do it over the phone.	*HR-Manager, Establishment with more than 250 employees.*
6	Stronger Commitment	Yes. And honestly also the commitment. Even if I came a few minutes later today, but a query with the online, yes, of course I say: I’ll do it then. But if I know that I have an appointment with you today at 11:00 a.m., then of course the commitment is much higher, even afterwards.	*HR-Manager, Establishment with 50-249 employees*
7	Efficiency	That’s the way it is, I find it practical on the phone, because if you have me on the phone, [. . .] I can answer such general questions relatively quickly, that’s day-to-day business and where we have which positions open now, that’s something you usually know quite well. In this respect, then you have someone on the phone and can already answer that, that is easier and for me then also happens faster than filling out a form and then passing it on again somewhere, yes.	*HR-Manager, Establishment with more than 250 employees*

8	Reminding Effect	The only problem (in doing it online/self-administered mode) is that you forget that you have to [...] So for me it would be better to say that even if you do it on the phone, at that time we'll call and then we'll do it, otherwise it could be that I lose it, then I keep putting it off.	*Manager, Establishment with less than 50 employees*
9	Reminding Effect	Depending on the situation, I would say. So quite simply: Is it right at this moment or is it not right? Am I at the right place or is my colleague doing it, who is of course also on the road? So it's always nicer when we make an appointment, as we have done now. And then you can take the time to get information that is not collected at an inopportune moment.	*HR-Manager, Establishment with more than 250 employees*

Table 4.E.4: Quotes from the In-Depth Qualitative Interviews illustrating Disadvantages of CATI

Number	*Keywords*	*Quote*	*Interview Partner*
Con CATI			
1	Interruption of daily work	I would find it good if something like this [telephone interview] is announced to me. So it [without appointment] costs [...] each side time, if there is called and then is put off and then [said you can call:] maybe and here maybe. Then it also does not fit.	*HR-Manager, Establishment with more than 250 employees*
2	No preparation for answers	When they [the survey institute] say: O.k. We had the following situation at that time [previous wave]. Is the trend consistent, worse, better? You can do that by phone, you don't need precise numbers. If they [survey institute] say, I need to do a graph and [they ask if] I have 520 to 530 to 540 [job vacancies], I need to look that up. And then it makes sense to go online.	*HR-Manager, Establishment with more than 250 employees*
3	Data privacy concern	We do not provide information by telephone without further notice.	*HR-Manager, Establishment with more than 250 employees*
4	Data privacy concern	On the phone, anyone can tell you that they are any institution.	*HR-Manager, Establishment with more than 250 employees*
5	Unclear seriousness	So that's sometimes the crux of this unexpectedness because you're always [...] suspecting something else. [...] That's the defense reflex first.	*HR-Manager, Establishment with 50-249 employees*
6	No preparation for answers	Well, I have a relatively clear opinion on this. To be honest, I don't think much of telephone surveys. Now regardless of whether I know the person or not. I really often have people on the phone who say: Yes, I have a few questions. Like that. Sometimes these are questions that are interesting for us or where I know, okay, I can help with that if I really answer them. But I always find it easier to have it in front of me, also to have the possibility to consult again with other people and also not to have to just give an answer like that. So an ad hoc answer is also often not the right answer, especially when it comes to such numbers, where you first have to read in maybe.	*HR-Manager, Establishment with more than 250 employees*

7	Unclear seriousness	Sure, it depends on the daily schedule, of course. Do you really have time with the appointments? Not that you get it wrong ... sometimes you pick up the phone and have yes in the week, I think, that's really not a lie, ten or fifteen times from Stepstone, from Indeed, [...] you have yes always all these sales people and brokers on it. And the next one again: Hello, me, Huber from Indeed ... - and you think to yourself: You, I can just [...] - you don't feel like it anymore. And then when someone calls spontaneously: Hello, I'm Ms. Huber from [...] and it's about the interview - then the first moment you think again: Oh God, what am I saying? I don't have any time	*HR-Manager, Establishment with 50-249 employees*
8	Unclear seriousness	That's always a question: Do you belong in this network? Do they know each other? We don't give out any information over the phone. You have to have a certain degree of certainty that I know who my counterpart is, who my conversation partner is. So I would have to know that in any case: Who is this? If you call me now [. . .] and I know that it is you, we can do that. I know your voice. Or we can even make an appointment. That's fine then. If it would be somebody else from your institute, it goes through an exchange of emails first. That's what I want to know.	*HR-Manager, Establishment with more than 250 employees*
9	No preparation for answers; Availability of previous answers	So I couldn't answer all the questions directly, especially unannounced. That would be a problem. Then, I think it, you can't call that number back either, so, sorry. So that has been a problem in the past most of the time. And yeah, I don't think that makes sense. So just, one can - I think - through an online access there draw much better synergies also between the surveys. For example, as I said, the answers from the previous year or the previous period are already available, and you can build on them. In my opinion, that makes more sense than doing it unannounced by telephone.	*HR-Manager, Establishment with more than 250 employees*
10	Participation routines	You can just organize it yourself [using a self-administered mode]. As I said, I answer the phone and you say: I need five minutes now - and I say: I simply don't have five minutes now. Or: Five minutes [. . .] becomes ten minutes. Online I can say: O.k. I'll put that aside now and take it at 4:00 p.m. and work on it then. And I can't do that on the phone.	*HR-Manager, Establishment with more than 250 employees*

11	Unclear Seriousness	I keep getting calls from people where I have the feeling: What do they actually want from me? They don't really ask questions, they just want data. And that annoys me. But I can differentiate. I'm confident that I can figure out whether this is a serious survey that serves the state in some way, or whether it's someone who wants my data or even wants to deceive me. We'll figure that out.	*HR-Manager, Establishment with more than 250 employees*
12	Unclear Seriousness;	Then I would wonder what kind of number it is, and sometimes I call back, but sometimes not. It always depends. So from that point of view. I mean, if you know beforehand that you're going to be contacted, then that's certainly something different. [...] Yes, I don't know if I would even have the time.	*Manager, Establishment with less than 50 employees*

Table 4.E.5: Quotes from the In-Depth Qualitative Interviews about Mode Switches

Number	*Keywords*	*Quote*	*Interview Partner*
Mode Switch			
1	Efficiency through routines	Then [i.e., using a self-administered survey mode in the first panel wave] you already know what you have to prepare, and then it [answering in the second wave] goes quickly.	*Manager, Establishment with 50-249 employees*
2	Efficiency through routines	It also makes sense that you structure it [i.e., collect data] the same way [...] I think that [...] this uniformity is, I think, overall a bit more reasonable.	*HR-Manager, Establishment with more than 250 employees*
3	Efficiency through routines, Recognition	That [a constant mode] makes it easier. You have a recognition value and you know that it's not that extensive that you can integrate it well.	*Manager, Establishment with 50-249 employees*
4	Trust in routines	[asked about their response process in the continuation setting] answered the [...]questions and applied the usual procedure and sent back.	*Manager, Establishment with less than 50 employees*
5	Trust in routines	so back and forth change is rather problematic, I would rather stay with it, if it has already run online.	*HR-Manager, Establishment with more than 250 employees*

Literature for Appendix

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4.E.3 Semi-Structured Interview Guide of In-Depth Interviews

A specific set of questions were asked during the in-depth interviews. These questions were organized into distinct modules, guiding participants to respond to the central queries. Follow-up questions were introduced as required and relevant. Not every interview covered all the questions outlined in this semi-structured interview guide. Furthermore, certain modules in the interview guide extend beyond the scope of this paper.

Interview Guide:

Module 1: Introduction, Thank you:

Hello, my name is NN and this is XX. We are researcher at the Institute for Employment Research, the research department of the Federal Employment Agency. As you know from our cover letter and contact with our colleagues, we are currently conducting an evaluation study at the IAB to evaluate the IAB survey "IAB Job Vacancy Survey". We want to emphasize at this point that this research project is independent of the Federal Employment Agency. The interviews we conduct will be treated as strictly confidential and the research results will only be published in anonymous form, i.e., it will not be possible to draw conclusions about establishments and individuals.

Project information
As already mentioned, the subject of the study is the evaluation of the IAB Job Vacancy Survey, one of our establishment surveys. The aim is to find out more about the processes, participation and response to establishment surveys in order to improve the survey. To do this, we conduct interviews with establishment to examine their experiences with establishment surveys. A central role in our conversation will be the method of data collection, i.e., the question of whether it is a web survey, a mail survey or something similar. Our conversation with you helps us to better understand the processes of participating and answering surveys from a scientific perspective in order tailor the survey more closely to the needs of the establishments. For this reason, we would like to thank you again for allowing us to speak to you today.

Information about the interview and the course of the interview
Our interview will be a so-called open interview. Open means that although there are specific topic blocks that are important to us, we will not pre-structure the content of the interview much, as happens, for example, in standardized interviews using questionnaires. Since you are the expert, we will start with a general question and ask you to tell us everything that comes to your mind and is important to you. We will ask more detailed questions only afterwards.
We would like to record the conversation and, with your consent, transcribe it later in order to include it in the evaluation as part of the accompanying research. You will receive a consent form for this purpose. After transcription and evaluation, the recording will be deleted.
The interview content and information will be treated as strictly confidential and will not be passed on internally or to third parties except for transcription. For the communication and publication of results, we will make the information unrecognizable in accordance with existing data protection regulations so that no conclusions can be drawn about individual people or establishments. In publications, we will therefore use general statements where necessary and alienate passages that may allow conclusions to be drawn about people.
o Duration: approx. 30-45 minutes (based on the actual interview, not the preliminary and follow-up discussions); this depends on the exact course of the conversation

o The questions are kept open and we are interested in your personal experiences and assessments, so there are no wrong answers
o We now start recording.

Module 2 – Personal details of interview partner

Then let's start the interview. First, I'd like you to introduce yourself. Please describe your training and your current field of activity in the establishment.	
• Please tell me more about your activities in the establishment? • What are your tasks in the establishment? • In which department do you work in the establishment? And for which fields of activity is your department responsible? • How long have you been working in this field of activity, including before you started working here?	<u>Horizon of expectation:</u> • Professional background • Day-to-day tasks

Module 3 – General experience with surveys

Let's now turn to establishment surveys: In general, what experience with establishment surveys has your establishment already had?	
For example, can you remember if you were invited to participate in any of the following surveys? (e.g., surveys like the Structure of Earnings Survey, surveys by the Federal or State Statistical Office, ifo institute, surveys by the Chamber of Industry and Commerce or employers' associations, university surveys, BeCovid, IAB Job Vacancy Survey, IAB BeCovid, IAB Establishment Panel)	
• Can you say approximately how many survey invitations you receive? • If yes, which surveys are you invited to and how did you deal with them? • **What form of survey is it? Are there any differences in the coordination process?** • We know that establishments in particular are quite often invited to participate in several surveys a year - how do you decide which ones to participate in and which ones not? • **Is the handling of survey invitations regulated? Are there official rules or informal agreements regarding participation in surveys? If so, what are they?** • What distinction do you make between surveys conducted by government organizations and other organizations? • **How do you choose which surveys to take part in?** • Are the survey invitations recorded centrally? • Do you have an established process for participating in web surveys? How should we imagine this? • **How do I have to imagine the coordination process for participation in concrete terms?** • With whom do you coordinate the decision to participate?	<u>Horizon of expectation:</u> • Experience with surveys • General rules for participating in surveys • Selection criteria from various surveys • Internal coordination process for participation

• Is the decision to participate a matter for the boss? • What was the decision-making process like for you at the time?	

Module 4: Participation process in the fourth quarter of the IAB-JVS

[Questions were adapted to the experimental group the establishment was part of.]

Can you remember your participation in the IAB Job Vacancy Survey? **In the fourth quarter of 2020, you received an invitation letter to participate in the web survey “IAB Job Vacancy Survey” and then took part in the web survey. In the IAB Job Vacancy Survey, your establishment answered questions about job vacancies and recruitment processes. Can you explain to us step-by-step how this invitation letter and request were handled in your establishment? Please start your description at the time you received the invitation letter and end it when you sent the questionnaire.** **[If no or little recollection of the specific survey: Presentation of the survey charateristics (voluntary, from Federal Employment Agency, etc.)].**	
<u>If no memory of IAB Job Vacancy Survey:</u> **Ok, in this case I would like to discuss a fictitious scenario with you.** **Imagine that the Institute for Employment Research together with the Federal Employment Agency send you a letter asking you to participate in a web survey for establishments. The data is needed for official statistics. Participation is voluntary and the survey is conducted online. Can you explain to us step-by-step how this request would be handled in your establishment? Please start your description at the time you received the invitation letter and end it when you sent the questionnaire.**	
<u>Questions about the process in general:</u> • Who receives the invitation letter? • Who opens the invitation letter? • Who reads the invitation letter first? • To whom is the invitation letter forwarded? • Has anything changed about the processes as a result of the covid pandemic?	<u>Horizon of expectation:</u> • Path of participation materials in the establishment • Standardization of the response process
<u>Questions about the decision to participate</u> • What was the process of deciding at the time that you would participate in the IAB Job Vacancy Survey? • Which people were involved in the decision? • Is all important information quickly apparent on the invitation letter?	<u>Horizon of expectation:</u> • Persons involved in the participation decision • Context of the participation decision
<u>Questions about answering the questionnaire</u> • **(As you know) the questionnaire contains questions about number of staff, recruitment processes and**	<u>Horizon of expectation:</u> • People involved in answering the questionnaire

employment trends. If you couldn't answer the answers off the top of your head, how did you proceed? • Who is involved in answering the questions? • What positions do these people hold? • Do you sometimes ask colleagues for advice? • How can I specifically imagine these inquiries with colleagues? Do you ask colleagues in your office room or do you call other colleagues? • Do you let colleagues look at the questionnaire? • How do you then forward the login information? • What documents do you use to answer the questionnaire? • Do you estimate some numbers?	• Use of sources • Cognitive processes when answering questions

<u>**Questions about the mode:**</u>
• Do the advantages and disadvantages also play a role for you?
• Can you explain this with your own experience or example?
• **How challenging is it for you to participate in web surveys? Are there any difficulties or concerns?**
• Would it help you to know the mail questionnaire in advance?
• To what extent do you have data protection concerns and if so, what are they?
• Do you have the necessary equipment to participate in web surveys?
  ○ Computer
  ○ Internet connection
  ○ <u>Etc.</u>
	<u>Horizon of expectation:</u>
	• Problems with web surveys
	• Advantages of web surveys
	• Disadvantages of web surveys
	• Influence of the mode on the decision to participate

Module 5: Mode in the participation process

[Questions were adapted to the experimental group the establishment was part of.]

We have now talked in detail about participating in a web survey. Now please imagine that we had contacted you and asked you to participate in the same survey, only this time it was conducted using a mail questionnaire. What would have changed compared to the process just described?	
<u>Questions about the mode:</u> • **What would be the process of sending back the questionnaire? Please also describe who is submitting the questionnaire to the post office.** • **How challenging is it for you to take part in web surveys? Are there any difficulties or concerns?** • How might the mail questionnaire affect your decision-making processes? Do you recall any of mail surveys?	<u>Horizon of expectation:</u> • Problems with mail surveys • Advantages of mail surveys

◦ Length of the questionnaire ◦ Appearance • Do you have data protection concerns about mail surveys? • If several people are involved in answering the questionnaire, how is the questionnaire forwarded?	• Disadvantages of mail surveys • Influence of the mode on the decision to participate

Please imagine again that we have contacted you with a request to take part in the same survey, only this time you can decide whether you take part by mail or web. Which mode would you choose?	
<u>Questions about the mode:</u> • How would you decide whether to participate using the mail questionnaire or the web questionnaire? • **What factors play a role in this?** • **What advantages do web or mail surveys have for you as a respondent?**	<u>Horizon of expectation:</u> • Reasons for choosing one of the modes

Module 6: Participation processes in follow-up quarters (depending on time budget, shorter or longer) [NOT ANALYZED IN THIS PAPER]

[Questions were adapted to the experimental group the establishment was part of.]

Do you still remember your participation in the follow-up telephone survey of the IAB Job Vacancy Survey, in which we asked for the latest figures for the current quarter? **After your participation in the fourth quarter of 2020, we contacted you by telephone in the first quarter of 2021 to ask for a few pieces of information for that quarter. This involved a few questions about vacancies, working hours and number of employees.** **Can you please tell us your impression of the follow-up telephone survey?** **[If no or little recollection of the specific survey: Presentation of the survey (voluntary, from Federal Employment Agency, etc.)].**	
Perhaps you can imagine the scenario: **You participated in our survey a few months ago. Now we contact you by phone and ask for the latest data on vacancies, working hours and number of employees for the current quarter. A colleague of ours would call you unannounced and ask for an update on the information you provided in the web survey. The interview would last about 5 minutes.** **What do you think of this type of follow-up survey? Please tell us your thoughts on this.**	
<u>Questions about the process in general:</u> • Who answers the calls? • Do you make an appointment for the short interview?	<u>Horizon of expectation:</u> • Procedure of the telephone interviews

• What would you say to the following statement? "I answer the questions quickly to get the interview over with." • Are there any experiences you have had that support this perception? If so, what are they?	
Questions about the phone contact: • **How did you perceive the personal telephone contact compared to the mail or web correspondence?** • What role does your impression of the interviewer play in your decision to participate?	
Questions about the decision to participate • What are the coordination processes for the renewed participation decision? • What role does the timing of the call play? • **How do you perceive not being able to determine the time of the interview?**	Horizon of expectation: • Context of the participation decision • Persons involved
Questions about the mode: • What has been your experience with telephone surveys in general? • Do you have any data protection concerns about telephone surveys? • Do the advantages and disadvantages also play a role for you?	Horizon of expectation: • Problems of telephone surveys • Advantages of telephone surveys

Module 7: Effect of the mode change

[Questions were adapted to the experimental group the establishment was part of.]

Please imagine that we had conducted the follow-up survey as a web survey instead of a telephone survey. You would have received another invitation letter with the login information for the web questionnaire. What would that have been like for you?	
Questions about the mode: • What do you think about the survey always being conducted in the same way, i.e., always web and no change to a telephone survey? • Do you base your assessment on your own experience with establishment surveys?	Horizon of expectation: • Advantages of a unified mode • Disadvantages of a unified mode • Influence of the mode on the participation decision

Module 8: Mode preference

<table>
<tr><th colspan="2">Finally, we would like to ask you about your preference. Which type of survey, i.e., web, mail or telephone, is most suitable for you? Could you please also explain the reasons for your decision.</th></tr>
<tr><td>Questions about the mode:
• How does your wish differ between the short follow-up surveys and the comparatively long initial survey?
• What advantages and disadvantages do you see in a telephone survey in general and specifically for follow-up surveys?
• Do you have data protection concerns about telephone surveys?</td><td>Horizon of expectation:
• Mode preference
• Reasons for mode preference</td></tr>
</table>

Module 9 – Information about the establishment

<table>
<tr><th colspan="2">Finally, we have a small question section that revolves around your establishment and the human resource management of your establishment. Can you tell us what the core business of your establishment is?</th></tr>
<tr><td>• How is your establishment structured? To what extent are there different branches or a parent establishment?
• Do you know what type of establishment, e.g., stock corporation or Ltd, your establishment is?
• Which supporting organization does your facility/administrative office have?
• What role does data play in your core business? Can you tell us a little more about this?</td><td>Horizon of expectation:
• Establishment characteristics
• Data affinity of the establishment</td></tr>
</table>

Module 10 – Information about documentation of personnel

<table>
<tr><th colspan="2">The IAB Job Vacancy Survey deals with personnel and hiring data. We are therefore interested in how you handle personnel and hiring data. Can you give us a little insight into how you manage this data?</th></tr>
<tr><td>• To what extent are your personnel administration and hiring processes digitalized?
• How are personnel data stored and managed at your establishment?
• What software do you use?
• Which tasks are performed by external service providers?
• What types of personnel reporting/personnel documentation do you prepare for management or other levels?
• How do you keep track of your employment statistics?
• To what extent is this reporting/documentation digitalized and standardized?</td><td>Horizon of expectation:
• Data affinity
• Digitalization
• Reporting</td></tr>
</table>

- **Module 11: Concluding Remarks**

Thank you very much for this interview! You gave us some valuable suggestions.
Are there any additions or aspects from your side that we didn't address today?
Do you have any questions?
Finally, we would like to ask you to give us your written consent to transcribe this conversation and to evaluate it as part of the accompanying research.
Giving an outlook: Further course of the study, time horizon of the publication of results

- **Stimulating the conversation**

To keep the conversation going, the following stimuli can be used and adapted. In principle, the interviewer links the first sentence to a statement made by the interviewee and then follows with a question.	
Questions about details • You have often emphasized point X. This seems important to you. Can you elaborate on that? • I have to ask again: This project you have worked on, what exactly is it about? • Earlier you talked about the X ("problems with computers in surveys"). Can you say more about this? • How would you describe the decision to participate?	Horizon of expectation: • Getting the conversation partner to talk
Filling in the blanks • You only spoke briefly about receiving the letter and then got right to answering it. What happened in between? • You said that the letter passed through several hands. Who had the letter in their hands?	Horizon of expectation: • Getting the conversation partner to talk
Completing interrupted passages • Earlier, you briefly alluded to XY. How exactly did this go? • You said that you get a lot of requests. Who are you getting these requests from?	Horizon of expectation: • Getting the conversation partner to talk

Chapter 5

More Clarification, Less Item Nonresponse in Establishment Surveys? A Split-Ballot Experiment[1]

5.1 Abstract, Keywords, Acknowledgements

Abstract: The IAB Job Vacancy Survey of the German Institute for Employment Research collects detailed information on job search and vacancy durations for an establishment's last successful hiring process. The duration questions themselves are burdensome for respondents to answer as they ask for precise dates of the earliest possible hiring for the vacancy, the start of the personnel search, and the decision to hire the selected applicant. Consequently, the nonresponse rates for these items have been relatively high over the years (up to 21 percent). In an effort to reduce item nonresponse, a split-ballot experiment was conducted to test the strategy of providing additional clarifying information and examples to assist respondents in answering the date questions. The results revealed a backfiring effect. Although there was evidence that respondents read the additional clarifying information, this led to even more item nonresponse and lower data quality compared to the control group. Additionally, we observed a negative spillover effect with regard to item nonresponse on a subsequent (non-treated) question. We conclude this article by discussing possible causes of these results and suggestions for further research.

Keywords: questionnaire design, business survey, missing data, cognitive response processes

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5.2 Introduction

Item nonresponse is a common problem in surveys. The failure to collect responses to all survey items reduces the analytic sample size and consequently leads to a reduction in estimation precision and statistical power. It can also lead to biased estimates if the missing values are not missing completely at random (Little & Rubin, 2019). Hence, item nonresponse is an important and impactful source of survey error (De Leeuw et al., 2003). It is often associated with response burden and can be driven by several factors, including questionnaire design (Messmer & Seymour, 1982; Zuell et al., 2015), the cognitive response process (Tourangeau et al., 2000), question wording (e.g., Lenzner et al., 2010), and respondent instructions (e.g., Al Baghal & Lynn, 2015; Smyth et al., 2009), which are well-documented in the experimental household survey literature.

However, experimental evidence on the impact of questionnaire design on item nonresponse in establishment surveys is rare (Bavdaž et al., 2020). Thus, it is often unclear whether design decisions intended to reduce item nonresponse are effective or not, or do more harm than good. As an exception, Ott et al. (2016) experimented with question ordering and showed that asking about personal characteristics at the beginning of an establishment survey questionnaire reduced item nonresponse compared to asking at the end. In another experiment, O'Brien and Levin (2007) showed that using answer prompts reduced item nonresponse in a web survey of establishments. A notable gap in the empirical literature are experiments which test the impact of providing additional respondent instructions and clarifications on item nonresponse in establishment surveys.

In this article, we test whether providing additional clarifying information reduces item nonresponse to three vacancy duration questions affected by high item nonresponse rates in the IAB Job Vacancy Survey. Specifically, we conducted a split-ballot experiment by supplementing the questions with clarifying examples and easy-to-look-up events to aid respondents in providing an adequate response. We tested the hypothesis that providing this additional information would reduce item nonresponse and improve data quality.

5.3 Background

5.3.1 Item Nonresponse in the IAB Job Vacancy Survey (IAB-JVS)

One specific question topic that can be especially burdensome for establishments to answer are those related to job vacancies and vacancy durations, which may require look-up of internal records to identify precise temporal information. Several job vacancy surveys are conducted worldwide to collect this information (e.g., Statistics Canada, 2020; U.S. Bureau of Labor Statistics, 2020b). One example is the IAB Job Vacancy Survey (IAB-JVS) in Germany, which is a large, annual, and nationally-representative establishment survey that collects extensive information about job vacancies, job flows, and search and recruitment processes (Bossler et al., 2020). It is carried out using a concurrent mixed-mode (mail and web) design. The survey includes, among other items, three questions that ask for specific dates concerning the last successful search and recruitment process. In particular, these questions ask for the earliest possible hiring date for the posted position ("At what date should this position be filled at the earliest?"), the date the search started ("When did you start searching for this vacancy?"), and the date the decision was made to hire the applicant ("When did you decide to hire this applicant?").

These specific date variables are frequently used by researchers in conjunction with variables about the recruitment process and the employment biographies of the hired applicant to conduct unique analyses on the structure of the labor demand, the efficiency of search and recruitment methods, and the quality of the resulting job match (e.g., Gürtzgen & Moczall, 2020; Gürtzgen et al., 2019; Rebien, 2019). However, these questions have been facing a disproportionately high share of item nonresponse in recent years (see Table 5.1), ranging regularly between 12 and 21 percent, with a slightly higher share for the search start date than the other two date items, thus compromising the quality and utility of these data.

Table 5.1: Item Nonresponse Rates (in %) for Vacancy Duration Questions in the 2015-2018 IAB Job Vacancy Survey

Year	Earliest hiring date	Start search date	Applicant decision date
2015	17.64	21.01	17.08
2016	13.55	16.99	13.31
2017	13.67	16.86	13.30
2018	12.72	16.03	12.44

5.3.2 Possible Causes of Item Nonresponse for IAB-JVS Vacancy Duration Questions

To get an idea of what might cause item nonresponse in the vacancy duration questions, it is useful to consider the cognitive model of the survey response process (see Figure 5.1, Row 1) proposed by Tourangeau (1984) and Tourangeau et al. (2000) for household surveys and further adaptations by Bavdaž (2010b) and Willimack and Nichols (2010) for establishment surveys. They divide the survey response process into four main components: comprehension, retrieval, judgment and response. Comprehension is defined as "identifying the information sought" (Tourangeau et al., 2000, p. 9) from the question and the accompanying instructions. Retrieval refers to the process of gathering the requested information, which for establishments is strongly linked to the availability of and access to the requested data in their business record systems (e.g., Bavdaž, 2010b; Lorenc, 2007; Willimack

	Comprehension	Retrieval	Judgment	Response
Process	• Interpretation of the question • Identifying the information sought	• Checking business records • Remembering recruiting process	• Estimations based on retrieved data • Evaluation of adequacy of a response	• Mapping response and answer field • Editing response
Possible causes of item nonresponse	• Vagueness of questions • Ambiguity of questions • Presupposition of questions	• Availability of vacancy dates in business records • Events difficult to remember	• Burden of choice between adequate dates • Estimation based on poor information	• Provision of exact dates

Figure 5.1: Cognitive Model of the Survey Response Process (Tourangeau et al., 2000, p. 8; Bavdaž, 2010b, p. 83) and Possible Causes of Item Nonresponse for Vacancy Duration Questions

& Nichols, 2010). The judgment component encompasses judgments and estimations based on the retrieved data and evaluation of the “adequacy of a response” (Willimack & Nichols, 2010, p. 14). Finally, the response component addresses the processes of matching a judgment to an answer field and editing the answer accordingly (Tourangeau et al., 2000, pp. 13–14).

Using the survey response model as a basis, it is possible to identify potential problems in the components that might prevent establishments from answering the vacancy duration questions in the IAB-JVS (see Figure 5.1, Row 2). With respect to comprehension, establishments might find the concepts of earliest hiring date, search start date, and the applicant decision date to be rather vague. Because the questions are standardized across all establishment types and hiring processes, how establishments comprehend the questions may not correspond precisely to their own recruitment processes. Accordingly, if establishments are unable to map the question onto their specific hiring case and link the survey question to their “business reality” (Bavdaž, 2010b), then item nonresponse could arise. In addition, the concepts may be perceived as ambiguous or vague to respondents. For example, establishments might be unsure whether the earliest possible hiring date refers to the first day when the position was vacant after a dismissal, when a new project was started, or when the funding for the new position became available. Similarly, the applicant decision date could be interpreted in multiple ways: when the supervisor agreed to hire the candidate or when the budget manager agreed to the hire. Another potential problem that could arise is due to presupposition of the questions. For instance, the start search date question assumes that the company has undertaken a formal search for applicants. However, this underlying assumption may be violated if no search for an applicant was necessary (e.g., the position was filled via an unsolicited application without a job posting). Vague and ambiguous concepts and presupposition are common problems that affect respondents’ ability to answer survey questions (Bavdaž, 2010b; Haraldsen, 2013b; Tourangeau et al., 2000; Willimack & Nichols, 2010).

Retrieval of the requested search and recruiting dates is highly dependent on the availability of this information in the establishment's record systems. While professional recruitment software may facilitate retrieval or deduction of the requested dates, establishments without such software would need to search alternative sources, such as proceedings or internal communications (e.g., emails) with applicants, supervisors or other departments, which is a more burdensome proposition that respondents may view as not worth the effort (Willimack & Nichols, 2010, pp. 13–14). If respondents cannot find the relevant dates in their business records, then they would have to rely on their memory or that of colleagues. Such dates could be difficult to recall if the events in question occurred many weeks or months ago or were not highly salient or distinguishable from other human resource activities. In this situation providing respondents with "temporal landmarks" (Tourangeau et al., 2000, pp. 115–117) could guide respondents in their memory process to help them remember (or narrow down) the possible dates.

Possible reasons for item nonresponse to the vacancy duration questions could also occur during the judgment step. Related to the ambiguity of key concepts, respondents may retrieve multiple dates that are considered applicable to the questions. If no additional distinguishing information is provided in the question or accompanying instructions, then it may be difficult for respondents to decide which is the "most appropriate" date (Willimack & Nichols, 2010, pp. 14–15), thus creating a burden of choice that may lead to no answer. If no readily-available date information is found in the business records, then respondents may have to estimate the dates based on vague information or informal communications with colleagues (Lorenc, 2007). This can also be a burdensome and error-prone task that respondents may not be willing to engage with if the respondent was not directly involved in the hiring process, or the recruiting process occurred long ago and the information base is poor (Tourangeau et al., 2000).

Fewer causes of item nonresponse are envisaged during the response step. As dates can be entered either by entering the date into the response field or by selecting the date from a pop-up calendar, the completion process seems less prone to problems of nonresponse. In addition, linking the retrieved dates to the response field seems also straightforward and poses little risk of confusion that may prevent a response.

However, a potential problem could arise if respondents retrieve or remember only a specific week or month rather than the exact date of the event. As an exact date is required in the IAB-JVS, respondents cannot enter their imprecise answer or a date range into the response field, which may lead to either guessing the exact date or not providing a response at all.

5.3.3 Providing Clarifying Information to Reduce Item Nonresponse

To address some of the problems identified above, survey guidelines recommend supplementing complicated questions with clarifying details and examples. For instance, Redline (2011) asserts that respondents could be assisted by providing clarifying information, such as examples or further instructions, to reduce question vagueness, ambiguity, and mapping discrepancies. In their guidelines for establishment questionnaires, Morrison et al. (2010) highlights the importance of instructional information: "Particularly in establishment surveys, the instructions are often very important for conveying the correct specifications or intent of the question..." (Morrison et al., 2010, p. 64). In addition, the Forms Design Standards Manual of the Australian Bureau of Statistics (2010) suggests to use examples to assist respondents for demanding questions, such as open-ended questions. In establishment surveys, it is common to provide these clarification instructions in separate materials or help pages, but there is a risk that respondents do not recognize or consider this additional information when answering the relevant survey questions (Haraldsen, 2013b; Morrison et al., 2010).

In the case of the IAB-JVS, providing clarifying information and examples of milestone events in a general hiring process could reduce item nonresponse by improving respondents' comprehension of the vacancy duration questions and make the concepts seem less vague or ambiguous by guiding respondents toward the intended interpretation of the key concepts. Providing additional information is, however, unlikely to address all potential comprehension problems (e.g., presupposition). With regard to retrieval problems, providing additional clarifying information and examples of milestone events could help respondents find the corresponding event date information in their record systems, or improve their search in other documents (e.g., emails). Even for establishments without a documentation of these vacancy dates, the provided examples could serve as "temporal landmarks" and assist respondents in remembering the hiring process dates in more detail. Additionally, a positive impact of the clarifying information may be expected during the judgment step, where it aids respondents in selecting the most adequate date out of several applicable options and hence reduces the burden of choice. Finally, the response stage could be facilitated if the clarifying information leads to the identification of exact dates, which fit the required format of the response field.

5.4 Data & Methods

5.4.1 Experiment

Based on the previously discussed causes of item nonresponse in the IAB-JVS and clarifying information as a possible remedy for these problems, we experimentally added additional and more specific instructions to each question based on the aforementioned questionnaire design recommendations. These additional instructions included concrete examples of process dates for specific milestone events that the establishment could use and adapt to their own hiring situation. Expert interviews were conducted with substantive researchers and survey methodologists to identify two exemplary milestone dates for each of the asked questions. These exemplifying events are not a comprehensive list of all possible events, but should give respondents an impression of the intended meaning of the questions.

For the earliest hiring date question, a random half of the respondents were provided the following additional information:

"Here you could, for example, enter the following events:

- *Date of a possible project start, in which the new employee should participate*
- *For replacements: Day on which the position is vacant".*

For the start search date question, the treatment group was presented with the following examples:

"Here you could, for example, enter the following events:

- *Date of publication of the job advertisement (e.g., on the homepage, a newspaper or an online job market)*
- *Date of public posting".*

Finally, the applicant decision date question included the following additional information for the treatment respondents:

"Here you could, for example, enter the following events:

- *Date of final approval by the supervisor*
- *Date of the final interview".*

Screenshots of the treated questions, including translations, are provided in Figure 5.2.

As proposed by Couper (2008), the additional information was displayed in italics between the question and the answer box. As it lies within the reading logic (up to down), the information is likely to be noticed and read by respondents. Hence, we overcome the limitation of separate instruction pages (Morrison et al., 2010). This is checked by examining item durations. We also analyze one additional item from the IAB-JVS, which asks for the date the employment relationship began ("When did this employment relationship begin?"). This item was not experimentally treated because it is less affected by item nonresponse than the three experimental items. However, since the employment relationship item directly follows (and has a similar appearance and format) to the three treated items, the treatment effects (if any) are likely to carry over to this item as well. Hence, we investigated a possible spillover effect on this non-treated item. These four questions were not preceded by an explicit introduction explaining reasons or motivation for asking about search and recruiting events.

Treatment group	Control group
35. Zu welchem Termin sollte diese Stelle **frühestens besetzt** werden? *Hier könnten Sie folgende Zeitpunkte beispielsweise eintragen:* • *Datum eines möglichen Projektstartes, bei dem der neue Mitarbeiter mitwirken soll* • *Bei Ersatzeinstellungen: Tag, an dem die Stelle erstmalig unbesetzt ist* Format: tt.mm.jjjj *Translation*: At what date should this position be filled at the earliest? Here you could, for example, enter the following events: • Date of a possible project start, in which the new employee should participate • For replacements: Day on which the position is vacant	**35.** Zu welchem Termin sollte diese Stelle **frühestens besetzt** werden? Format: tt.mm.jjjj Zurück *Translation*: At what date should this position be filled at the earliest?
36. Wann haben Sie mit der **Personalsuche** für diese Stelle **begonnen**? *Hier könnten Sie folgende Zeitpunkte beispielsweise eintragen:* • *Datum der Veröffentlichung der Stellenanzeige (z.B. auf der Homepage, einer Zeitung oder einer Online-Stellenbörse)* • *Datum des öffentlichen Aushangs* Format: tt.mm.jjjj *Translation*: When did you start searching for this vacancy? Here you could, for example, enter the following events: • Date of publication of the job advertisement (e.g., on the homepage, a newspaper or an online job market) • Date of public posting	**36.** Wann haben Sie mit der **Personalsuche** für diese Stelle **begonnen**? Format: tt.mm.jjjj Zurück *Translation*: When did you start searching for this vacancy?
37. Wann haben Sie sich **für diesen Bewerber entschieden**? *Hier könnten Sie folgende Zeitpunkte beispielsweise eintragen:* • *Datum der finalen Zustimmung durch den Vorgesetzten* • *Datum des finalen Vorstellungsgesprächs* Format: tt.mm.jjjj *Translation*: When did you decide to hire this applicant? Here you could, for example, enter the following events: • Date of final approval by the supervisor • Date of the final interview	**37.** Wann haben Sie sich **für diesen Bewerber entschieden**? Format: tt.mm.jjjj Zurück *Translation*: When did you decide to hire this applicant?

Figure 5.2: Screenshots and Translations of the Vacancy Duration Questions, by Treatment and Control Groups

5.4.2 Survey Design

As previously noted, the three treated questions are essential questions of the IAB-JVS survey. These questions belong to the module on the establishment's last successful hiring. Only establishments who reported a successful hiring within the last year are asked to complete this module ("Please think of the last hire of a new employee into a position subject to social security contributions in the past 12 months. If more than one person was hired at the same time, please choose the person whose last name comes first in the alphabet."). Hence, these questions are only presented to a subset of eligible respondents. To avoid tinkering with the main production survey, the experiment was conducted within a separate survey that ran parallel to the main survey in 2019.[2] In contrast to the main survey, which uses a concurrent mixed-mode (mail/web) design, the experimental survey (including both treatment and control groups) was implemented entirely online. Besides this difference, the survey design was very similar to that of the main IAB-JVS survey. The questionnaire and the organization of the fieldwork (corresponding invitation and reminder letters) were the same (for more design details, see Table 5.2).

Table 5.2: Summary of Survey Design

Mailing Date of Invitation Letter	30th September 2019
Mailing Date of Reminder	20th November 2019
Survey Mode	Online
Full Sample	31,905
• *Control*	*15,939*
• *Treatment*	*15,966*
Net Sample (Respondents)	4,414
• *Control*	*2,225*
• *Treatment*	*2,189*
Unit Response Rate (in %)	13.83
Eligible Respondents	1,683
• *Control*	*844*
• *Treatment*	*839*

[2]This analysis is based on a preliminary dataset. The final data will be accessible from mid-2022 at the Research Data Center of the Federal Employment Agency in Germany. The final data set is adjusted for respondents who did not answer items relevant to Eurostat. This exclusion has no substantial impact on the results presented.

The experimental survey used a similar stratified random sampling design as the main survey with industry and establishment size as stratification variables. The sample size for the survey was 31,905. The sample size was chosen according to the projected unit response rate and share of eligible respondents. This calculation led to an expected realized sample of at least 1,750 respondents eligible for the experiment, i.e., a planned eligible respondent sample size of 875 for both treatment and control groups. The planned number of eligible respondents was estimated from a power calculation of a two-sample t-test to detect an effect size of 3 percent on a confidence level of 95 percent.

To improve the efficiency of the sampling design and thus the power of the planned statistical tests, an optimal sample allocation was used. The allocation was optimized towards the historical distribution of item nonresponse in the treated questions. To solve the allocation problem, we applied the method described by Friedrich et al. (2018) to the empirical distributions of the item nonresponse indicators from the previous year's (2018) survey. However, the gain in efficiency due to the optimal allocation over a proportional (to stratum size) allocation was minor, with an average reduction of the expected design effect for the item response indicators of only 0.86 percent. Each sample stratum was split into two approximately equal-sized sets defining the experimental and control groups.

The unit response rate was 13.83 percent. Out of 4,414 responding establishments, a total of 1,683 were eligible for the experiment, with 844 responding from the control group and 839 from the treatment group. There are no significant differences between control and treatment cases with respect to establishment characteristics (see Table 5.3). Hence, the experimental design worked as intended. The item nonresponse rate is calculated by dividing the number of establishments that did not answer the respective question and the number of eligible establishments.[3] As a "don't know" or refusal option was not provided, respondents were forced to answer or skip a question. Each question was displayed on a separate screen and time stamps were used to record the time taken to answer or skip a question. Outliers that took more than 15 minutes to answer or skip the question (N = 6) are excluded from the item duration analysis. All statistical analyses, including two-sample t-tests, account for the survey design.[4]

[3] A small number of break-offs (N = 18) occurred between the branch question, which determines whether the respondent is eligible to answer the treated questions, and the last analyzed question. These are counted as item nonrespondents. Additional sensitivity checks (not reported) showed that excluding these break-offs from the item nonresponse analysis did not substantially change the results.

[4] Weighting to account for unequal inclusion probabilities and unit nonresponse does not change the study conclusions (results not shown).

Table 5.3: Experimental Allocation of Respondents to Control and Treatment Groups, by Establishment Characteristics

Variable	Control	Treatment
Establishment Size		
1-9	544	528
10-19	127	142
20-49	116	118
50-249	50	49
≥ 250	7	2
Industry		
Primary Sector	25	23
Secondary Sector	220	224
Logistics and Retail	163	176
Other Services	422	403
Public Sector	14	13
Industry		
West Germany	687	677
East Germany	157	162
Collective Agreement		
Yes	548	525
No	290	303
Item Missing	6	11
Total	844	839

χ^2-tests showed no significant differences between the control and treatment groups regarding the displayed descriptive statistics

5.5 Results

5.5.1 Item Duration

First, we assess the item durations to check whether respondents in the treatment group likely read the additional clarifying text. Figure 5.3 shows the average item durations for all treated questions by treatment and control group. Additionally, it distinguishes between all eligible participants (upper panel), item respondents (middle panel), and item nonrespondents (lower panel).

Starting with all eligible participants, it is apparent for all three questions that establishments in the treatment group took on average significantly longer to proceed to the next question compared to the control group. This difference is largest for the first question (earliest hiring date: 56 vs. 30 seconds; p = 0.000) followed by the second question (search start date: 29 vs. 23 seconds; p = 0.000) and third question (applicant decision date: 31 vs. 26 seconds; p = 0.063). The pattern for item respondents is very similar to the one for all eligible participants: the treatment group needed significantly more time

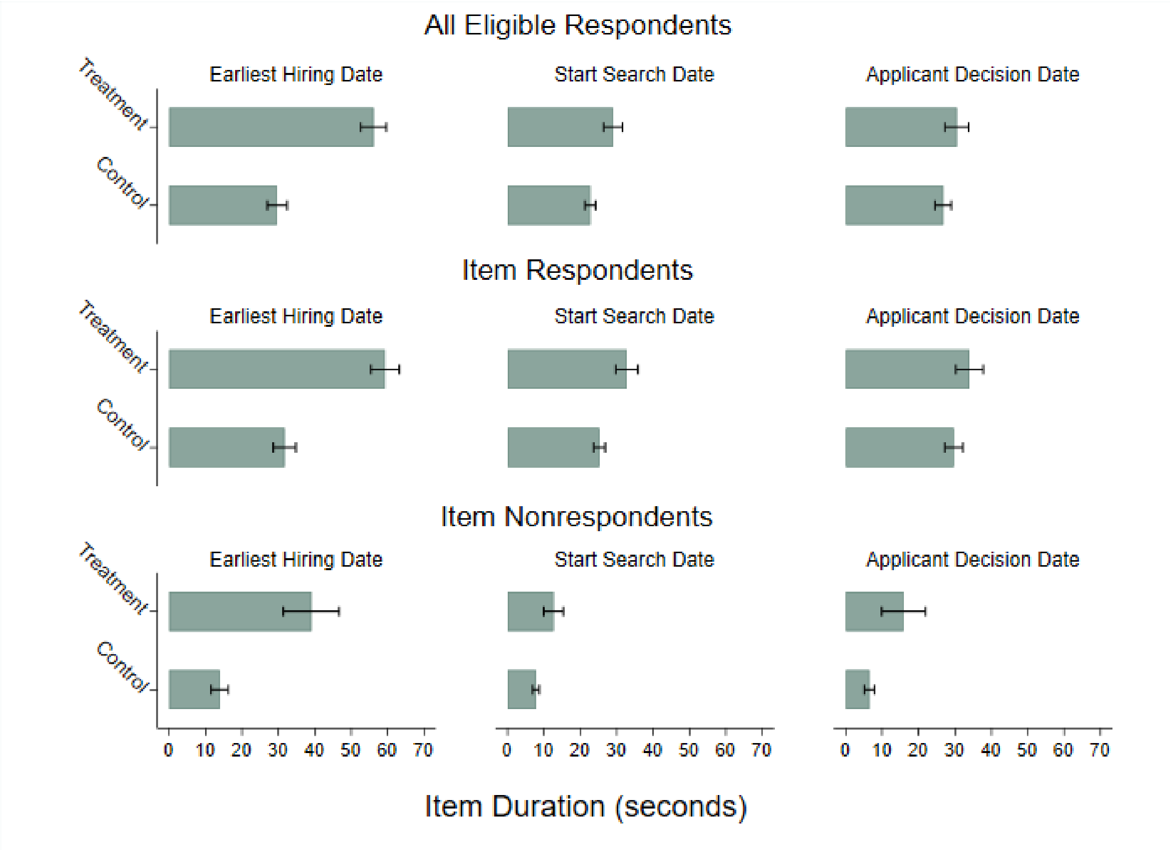

Figure 5.3: Average Item Durations (in Seconds) for All Eligible Participants (Upper Panel), Item Respondents (Middle Panel), and Item Nonrespondents (Lower Panel), by Item and Treatment and Control Groups

than the control group to respond to each of the three items. Hence, we conclude that item respondents in the treatment group likely read the additional information provided.

Item nonrespondents behave in a similar way. First, as expected, they took less time to go forward to the next question compared to item respondents. Secondly, the longer item duration for the treatment group is significant for all three items. Hence, we conclude that the item nonrespondents also likely read the additional information in the treated items.

5.5.2 Item Nonresponse

Next, we analyze the main outcome: item nonresponse. Specifically, we examine the nonresponse rates for the three treated questions individually, along with two summary nonresponse indicators: whether a nonresponse occurred in at least one of the treated questions and whether nonresponse occurred in all three treated questions for a given establishment. Figure 5.4 presents the item nonresponse rate for the three questions and the rates of the two summary indicators.

The results show a consistent pattern: contrary to expectations, item nonresponse is higher in the treatment group than in the control group for all three items. The item nonresponse rates in the treatment group are 15.3 percent, 19.0 percent, and 19.9 percent for the earliest hiring date, start search

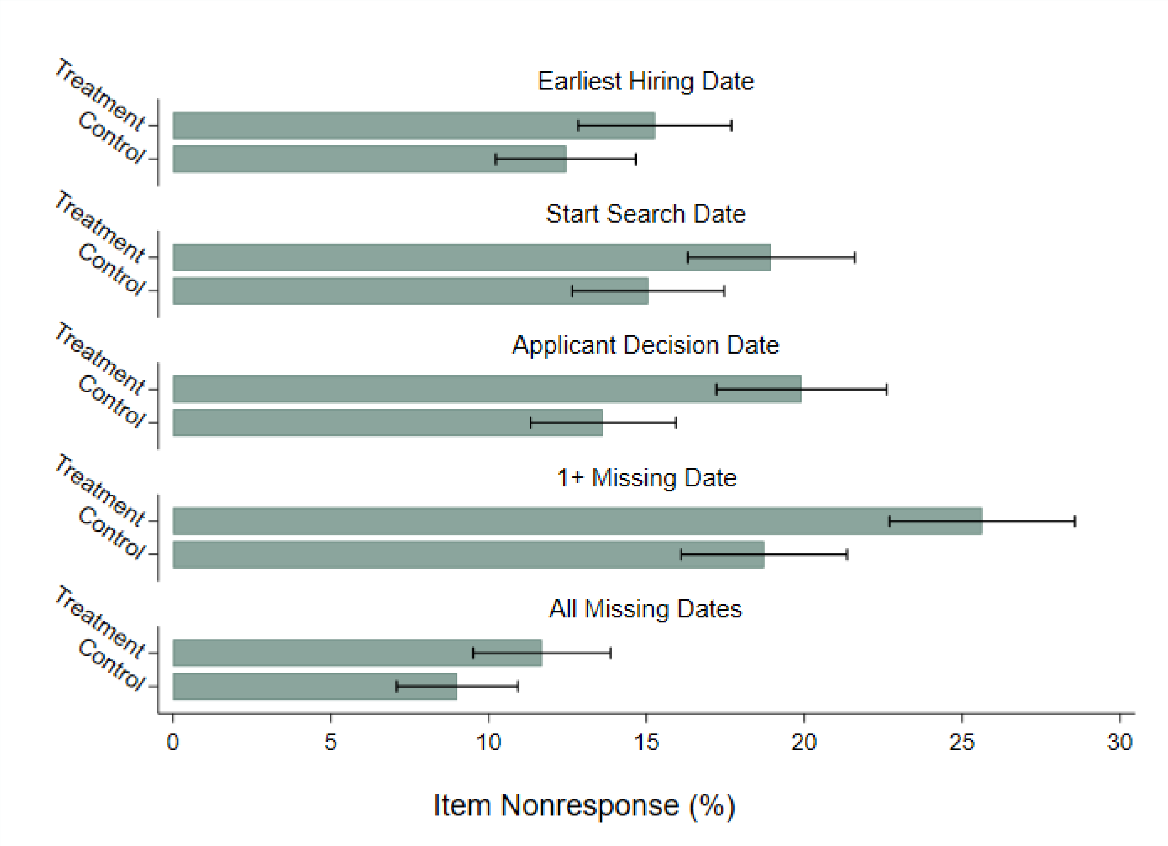

Figure 5.4: Rates of Item Nonresponse (%) by Treatment and Control Groups by Item, At least One Missing Item, and All Missing Items

date, and applicant decision date items, respectively, compared to the respective control group values of 12.4 percent, 15.0 percent, and 13.6 percent. Thus, the item nonresponse rates range from 2.9 to 6.6 percentage points higher in the treatment group compared to the control group. These differences are statistically significant at the 10 percent level for the earliest hiring date and at the 5 percent level for the start search date and the applicant decision date items. In addition, both summary indicators show a negative effect of the treatment on the item response rate. The rate for the indicator of at least one missing item in the treatment group is 6.9 percentage points above the control group and is statistically significant at the 5 percent level. The rate for the all-missing indicator in the treatment group lies 2.7 percentage points above the control group and is significant at the 10 percent level. In summary, providing the exemplifying information to respondents actually led to more item nonresponse compared to not providing this additional information.[5]

5.5.3 Data Quality

Here, we assess the impact of the treatment on data quality. Although it is not possible to assess the accuracy of the dates provided by the responding establishments due to the lack of validation data, it

[5]The negative treatment effect was also observed for several establishment subgroups, including establishment size, industry, region, and collective agreement (results not shown).

is possible to assess the effects of the treatment on other indicators of data quality.

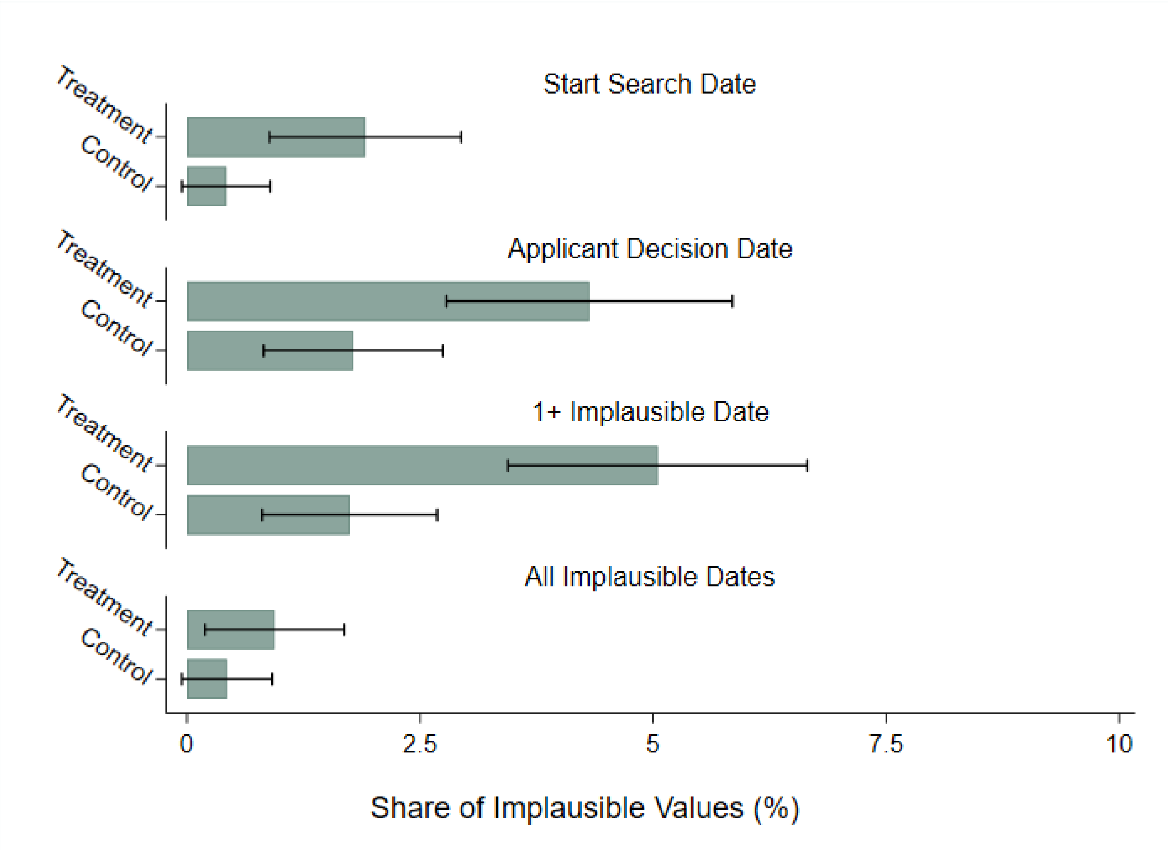

Figure 5.5: Share of Implausible Values (%) by Treatment and Control Groups by Item, At least One Implausible, and All Implausible Dates

The indicator we use is the share of implausible date values defined as dates that occur after the survey completion date. Such dates are by definition incorrect, as the establishments are asked to report on the last completed hiring process. This quality indicator is evaluated for the second and third items only (i.e., the search start date and the applicant decision date). It is not applicable to the first item, as it is plausible that the earliest possible hiring date was originally planned for a future date, but these plans were adjusted later. As shown in Figure 5.5, the share of implausible future dates in the treatment group is 1.5 percentage points higher for the start search item and 2.5 percentage points higher for the applicant decision item compared to the control group. Both differences are statistically significant at the 5 percent level. The negative effect of the treatment is especially evident for the summary indicator of whether at least one answered date lies in the future, where the treatment group is 3.3 percentage points higher than the control group and is statistically significant. No statistically significant effect could be found for the summary indicator of whether all answered dates were implausible between the treatment (0.9 percent) and control groups (0.4 percent). Thus, we conclude that the quality of the responses is poorer when the additional clarifying information is presented to respondents.

5.5.4 Spillover Effects

Lastly, we examine the possibility of a spillover effect of the treatment on the first non-treated item directly following the three experimental items. This question asks for the date the employment relationship began. As it also asks for a specific date, it has a similar appearance and format as the previous three treated items.

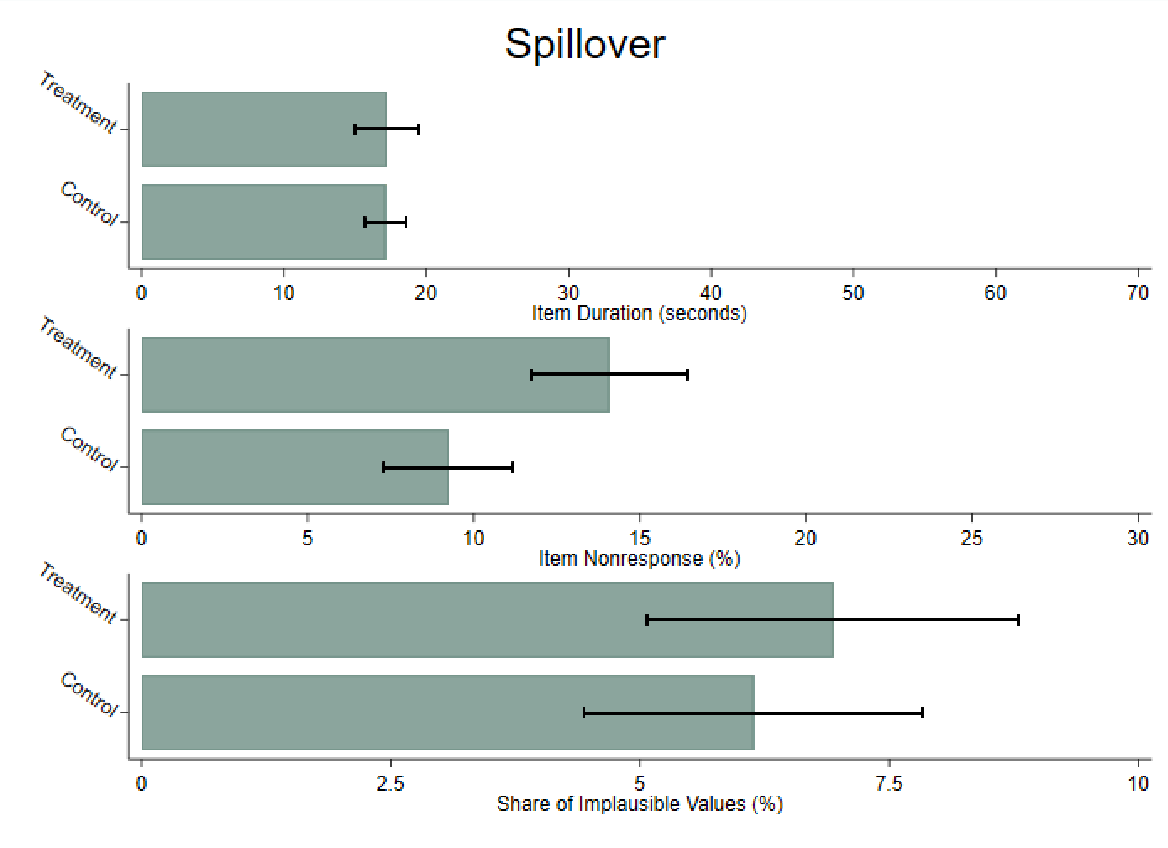

Figure 5.6: Item Duration (in Seconds), Item Nonresponse (%), and Share of Implausible Values (%) for the First Non-Treated Item Following the Treated Items, by Treatment and Control Groups

Figure 5.6 summarizes the relevant outcomes (item duration, item nonresponse, implausible values) for this particular item. Since the question was identical in both control and treatment groups, there is, as expected, no significant difference in response time between the two groups. However, the negative effect of the treatment on item nonresponse observed for the previous three treated items is also observed for this non-treated item. The share of item nonresponse in the control group (9.2 percent) is significantly lower than the share of item nonresponse in the treatment group (14.1 percent). Thus, the effect of the treatment is carried over to the non-treated item with the same question format. We do not find a spillover effect on data quality, as there is no significant difference in the share of implausible values between the two groups. For further follow-up items, no spillover effect was found (results not shown).

5.6 Discussion

Contrary to expectations based on questionnaire design recommendations (e.g., Australian Bureau of Statistics, 2010; Morrison et al., 2010; Redline, 2011) and the cognitive model of survey response (Bavdaž, 2010b; Tourangeau et al., 2000; Willimack & Nichols, 2010), we found that providing additional clarifying information and examples to assist establishments in answering temporal questions related to the process of hiring their most recent employee did not reduce item nonresponse. Instead, this strategy led to a significant increase in item nonresponse. Moreover, there was evidence that the additional information had a negative effect on data quality, as it led to more implausible answers. We also found a spillover effect where the negative effect of providing the additional information on the item nonresponse rate carried over to an adjacent non-treated question. These results clearly rejected our hypothesis that providing the additional clarifying information would overcome possible response problems, reduce item nonresponse, and improve data quality in the IAB-Job Vacancy Survey.

There are at least four plausible explanations for this unexpected finding. First, the response burden and complexity of these questions may have actually increased as more information was presented and needed to be absorbed. Respondents had to read more text and may have felt pressured to look up their records and provide an exact date rather than surmise a response. The additional pressure of providing exact dates may have led respondents to skip the questions entirely. Second, by presenting the additional information, the importance of these questions was implicitly highlighted. Establishments that were unsure about the exact dates of the asked events may have therefore preferred not to answer the question as opposed to giving an uncertain answer. Third, offering examples of two process dates, which are not mutually exclusive, such as the date of publication of the job advertisement on the company homepage and the date of public posting, may have increased the uncertainty of how to answer the questions instead of reducing it. If both of the examples applied to the establishment and the corresponding dates differed slightly, then respondents may not have known which of them they should use. As a result of this confusion, respondents might have simply skipped the item rather than venture a guess. Additionally, as the list of provided examples was not an exhaustive list of all possible scenarios, respondents who did not see an example of their hiring situation may have believed the question(s) did not apply to them. This might have contributed to the higher item nonresponse.

The IAB-JVS vacancy duration questions could benefit from extensive qualitative research to identify the key reasons for item nonresponse. Such an analysis could clarify which component of the cognitive response model is most problematic for respondents and the main contributor of the high item nonresponse for these items. Another contribution of qualitative research could be to gain more insights into the search and recruiting processes of establishments. This information should be used to evaluate the applicability of the questions themselves. If these questions do not apply to the hiring processes in some establishments, then respondents may refuse to answer them rather than give an inaccurate answer, because they do not want to risk providing misleading information about their processes. By taking these qualitative insights into account new questions or clarifying instructions could be developed for collecting search and recruiting durations. Finally, split-ballot experiments, like the one presented here, could show whether these new questions or additional instructions perform better with respect to item nonresponse and data quality.

More generally, future survey experiments, especially those concerning establishment questionnaire design, would benefit from a mixed-method approach, combining experimental evidence with qualitative research to gain insights into the impact of the treatment on response burden and the entire response process. The contribution of qualitative research could be twofold: (1) qualitative pretests could be used to adjust the treatment closer to the needs of the respondent; and (2) qualitative debriefings with item respondents and nonrespondents could shed light on what, in particular, drives the treatment effect (or lack thereof). Specifically, such an approach would enable researchers to compare differences in the cognitive response process for establishments in the control and treatment groups and hence identify the model component(s) which are most affected by the treatment.

In conclusion, this case study showed that providing establishments with additional clarifying information and examples did not reduce, and rather exacerbated, item nonresponse to a set of job vacancy duration questions. Although the rationale for providing additional clarifying details might be well-justified for complex establishment surveys and in line with questionnaire design recommendations, the implementation, as our study showed, can potentially backfire because of increased response burden or other unintended effects. However, without an experiment, such a backfiring effect may not be exposed. Thus, we encourage similar experiments in real-world establishment survey settings where design modifications are considered to facilitate item response. This would also address the notable gap in the empirical literature on questionnaire design effects in establishment surveys.

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Chapter 6

Conclusion

This thesis dealt with nonresponse in establishment surveys, its consequences, and methods to mitigate and adjust for nonresponse. In doing so, this thesis pursued two main goals. First, it advanced the scientific understanding of participation in establishment surveys by providing empirical evidence. As emphasized in the introduction, there is a significant lack of empirical analyses dealing with survey participation processes in establishment surveys. This scarcity is particularly crucial because findings from household and individual surveys cannot be directly applied to the establishment context, and the availability of high-quality publications on this topic in peer-reviewed journals is limited. Second, the papers offered guidance to practitioners for designing their own establishment surveys by presenting reference estimates and blueprints for exploring survey design elements and statistical methods. For these reasons, this work contributes meaningfully to the survey community and facilitates more efficient, accurate, and valid data collection from establishments. In this conclusion, I will briefly summarize the results of each paper and discuss one important implication, focusing on its relevance for future research and survey practice. The final remarks emphasize one common limitation of all my thesis papers and highlight the need for future research in the area of establishment survey methodology and statistics.

6.1 Discussion of the Four Papers

6.1.1 Paper 1: Analyzing Establishment Survey Nonresponse Using Administrative Data and Machine Learning

The first paper (Chapter 2) examined response rates, nonresponse biases, and survey participation patterns in the IAB-Job Vacancy Survey (IAB-JVS) for the years 2010 to 2019. Moreover, it explored the potential of administrative data and machine learning techniques to reduce nonresponse bias in response propensity weighting schemes. The results illustrated a slight decrease in the response rate between 2010 and 2019, with no noticeable trend in aggregate nonresponse bias. While factors such as establishment size and prior survey contacts were negatively correlated with survey participation, establishment age and survey participation in the previous year increased the likelihood of response. There was mixed evidence on the impact of survey topic relevance and workforce diversity, with different operationalizations pointing in different directions. The hypotheses that young establishments with a young workforce are less likely to participate and that establishments with higher wages are less likely to participate were not confirmed. Furthermore, the study demonstrated that using additional administrative data outperforms traditional auxiliary variables in reducing nonresponse bias. None of the 11 modeling approaches, including logistic regression, more flexible regression approaches, single-tree and ensemble tree methods, was outperforming, but ensemble tree methods and regression-based approaches generally yielded better results than single-tree methods. In most evaluations, standard logistic regression performed similarly to the more flexible regression approaches and tree-based methods.

This finding shows that advanced modeling approaches can only improve weighting schemes to a limited extent compared with standard logistic regression. Instead, a more effective approach involves the inclusion of a larger number of auxiliary variables of higher quality. Based on this finding, survey statisticians should focus on developing additional data sources that provide information about both respondents and nonrespondents. For the purpose of effective nonresponse weighting, these auxiliary data should be correlated with the survey variables and the survey participation processes (Little & Vartivarian, 2005). To assist in this effort, survey statisticians can rely on the impact factors of survey participation in establishments, as proposed by Willimack and Snijkers (2013). These factors can guide statisticians in identifying structural information about the establishment and the individual respondents within the establishment, which can be incorporated into the estimation of response propensities. Gathering more auxiliary data on survey participation is crucial not only from a weighting perspective but also for a comprehensive understanding of the general aspects of establishment survey participation. While it may be feasible to capture more establishment characteristics through additional administrative data, such as information on the financial situation or the business structure, collecting data on internal regulations or on the persons responsible for survey requests is a major challenge. Such information are typically not available for nonrespondents in establishment registers. One approach to study the impact of these internal aspects is to concentrate on panel survey participation and gather data on the response process in the preceding wave, which can then be used to examine panel response rates. Similarly, screening interviews could be a promising tool for collecting data on internal regulations and responsible individuals. Future research that quantifies the impact of these internal processes and individuals involved on survey participation in establishment surveys would be of great interest.

6.1.2 Paper 2: The Impact of Mail, Web, and Mixed-Mode Data Collection on Participation in Establishment Surveys

The second thesis paper (Chapter 3) investigated the effects of single-mode web, single-mode mail, sequential web-to-mail, and concurrent mail-web mixed-mode designs on different aspects of participation in establishment surveys. Using a large-scale survey experiment in the 2020 IAB-JVS and qualitative interviews, my co-authors and I analyzed the impact of self-administered mode designs on response rates, nonresponse biases, subgroup participation patterns, cost per respondent, establishment preferences, and participation processes. We found that response rates and aggregate nonresponse biases did not significantly differ across single-mode web, single-mode mail, sequential web-to-mail, and concurrent mail-web mixed-mode designs. However, larger establishments were more likely to participate in single-mode web surveys than in single-mode mail surveys. Additionally, the single-mode web and sequential web-to-mail designs were more cost-efficient per respondent than the concurrent mail-web and single-mode mail designs because expenses for time-consuming data entry, postage, and printing could be saved. Qualitative insights revealed a strong preference for web surveys due to their ease of use, enhanced collaboration within establishments, avoidance of mail dropoffs, and perception as a modern and sustainable way of data collection.

These results are encouraging for survey practitioners, as they suggest that web data collection can be used without compromising the quality of estimates in terms of lower response rates or nonresponse bias. Furthermore, qualitative interviews with respondents indicated that web surveys are less burdensome for conducting establishment surveys, as they streamline internal survey participation processes. Nevertheless, the accompanying qualitative study also highlights the drawbacks of web surveys and the advantages of mail surveys, suggesting that there is potential for improvements in the design of web surveys to further reduce the survey burden and better align with respondent preferences. The importance of a pleasant experience in the web survey is emphasized by a comment (translated from German) in one of the in-depth qualitative interviews: *"First and foremost, the online survey must be convenient for me and take a reasonable amount of time"*. Hence, a critical issue for future research is to further develop and examine web communication and questionnaire design elements that mitigate the disadvantages and enhance the advantages associated with web modes. Potential ideas for improving web questionnaires range from automated confirmation of completion with PDF copies of answered questionnaires, providing respondents with proof of their input, implementing automated chatbots for two-way communication in web surveys, and facilitating the clarification of questions. From a theoretical standpoint, these advanced web design elements should help reduce the burden of survey participation and increase the likelihood of unit response. Future research should examine whether empirical evidence supports the assumption that questionnaires with advanced web features lead to better response rates and lower estimates of nonresponse bias compared with standard web questionnaires. Additionally, it would be interesting to explore to what extent reduced burden from improved questionnaire designs can be effectively communicated in order to convince establishments of the simplified participation before a decision is made in favour of or against participation.

6.1.3 Paper 3: Effects of Replacing Telephone with Web, Mail, and Mixed-Mode Data Collection in an Establishment Follow-Up Survey

The third paper (Chapter 4) examined the influence of a mode design continuation of self-administered single- and mixed-modes (single-mode web, single-mode mail, sequential web-to-mail, and concurrent mail-web) and a mode design switch to computer-assisted telephone interviews (CATI) between the first and follow-up waves. Using a survey experiment, my co-authors and I analyzed the impact of these different mode designs on response rates, nonresponse biases, predictors of survey response, and costs. In the qualitative study component, we shed light on the impact of the mode design switch on response processes, and the impact of CATI and self-administered modes on participation in establishment surveys. Our results demonstrated that in the IAB-JVS follow-up wave, continuing with the same self-administered mode design from the first wave leads to higher response rates for the concurrent mail-web design and the single-mode mail designs compared with a mode design switch to CATI across the waves. A mode design continuation of sequential web-to-mail and single-mode web designs yielded similar response rates as the mode design switch to CATI in the follow-up wave. In addition, the aggregate nonresponse bias estimates did not differ substantially between a mode design continuation and a mode design switch to CATI in the follow-up wave for all mode designs used in the first wave. Survey participation models showed that in all starting mode designs, continuing the mode design led to similar or higher follow-up response probabilities for different groups of establishments (industries, number of employees, decade of foundation) compared with switching to CATI. The results for response rates, nonresponse bias estimates, and predictors of survey participation also hold for the analysis of the cumulative mode sequence from the first and follow-up waves. We found lower costs for the mode design continuation groups compared with the mode design switch to CATI for the follow-up wave, especially for the single-mode web and sequential web-to-mail groups. However, these cost savings in the follow-up wave were rather low relative to the total costs for the entire mode sequence. The costs of the first survey, with a larger sample size and a longer questionnaire, account for most of the costs of the entire mode sequence. In-depth and short qualitative interviews revealed that the mode design switch to CATI is less favored by respondents because of perceived disruptions to their survey participation routines.

These results illustrate that the CATI mode can be replaced by self-administered interviews in the IAB-JVS follow-up survey, with comparable or better response rates and similar nonresponse biases. Furthermore, the study generally showed that the use of a more cost-effective and consistent self-administered survey mode design in establishment panels is feasible with respect to several dimensions of survey participation. However, nonresponse errors account for only one part of the potential errors that impact the validity of the estimates of the statistic of interest. Another important source of error that is influenced by the mode design, especially in a mix involving interviewer and self-administered modes, is measurement error (De Leeuw, 2018). On the one hand, our qualitative interviews suggest that retrieving responses from record systems occurs less frequently and that respondents are more likely to make guesses during telephone interviews, suggesting that CATI modes have a higher risk of less accurate responses. On the other hand, interviewers can guide the respondents in answering the questions and help them provide a valid answer, whereas in self-administered surveys, they essentially have to rely on themselves. Therefore, the impact of the mode design on measurement error, particularly in a longitudinal context, is unclear and poses a significant research gap. Furthermore, it would be highly interesting to expand the analysis of this experiment within the context of the Total Survey Error framework by identifying all sources of error in the final statistic caused by the mode design.

6.1.4 Paper 4: More Clarification, Less Item Nonresponse in Establishment Surveys? A Split-Ballot Experiment

In the fourth and final paper (Chapter 5), my co-authors and I examined the extent to which supplementary information helps to reduce item nonresponse and increase data quality for vacancy duration questions which face high item nonresponse rates in previous years. To evaluate the effectiveness of clarifying information, an experiment was conducted in 2019 as part of an additional online survey of the IAB-JVS. The experimental group received additional information, while the control group did not. The results indicated that respondents in the experimental group spent significantly more time answering the questions, suggesting that they noticed and engaged with clarifying information. Surprisingly, clarifying information actually led to an increase in item nonresponse instead of reducing it. Additionally, the data quality measure was lower in the experimental group than in the control group. Furthermore, there was evidence of a spill-over effect on a non-treated vacancy duration question, which experienced higher item nonresponse in the experimental group.

The puzzling finding that the assistance we designed does more harm than good to respondents in answering these vacancy duration questions requires justification. Since this paper lacks an accompanying qualitative study, we can only speculate on the potential reasons behind this unexpected outcome (e.g., respondents could feel pressured to provide a 100 percent correct answer instead of an educated guess). To counter this shortcoming of unclear mechanisms of interventions, I believe that future methodological research on establishment surveys should make greater use of mixed methods combining qualitative and quantitative evidence, as presented in the second and third papers. Given the complex nature of participation and response processes in establishment surveys and the challenge of capturing the internal routines and characteristics of the individuals involved using quantitative data, purely quantitative approaches can quantify the effects of design and questionnaire elements on survey participation and response, but it is difficult to identify the reasons for the observed effects. In this context, mixed method approaches offer a promising research framework for designing and testing survey elements and uncovering their impact. Particularly, study designs that integrate in-depth qualitative investigations of problematic aspects of survey designs, questionnaires, and potential solutions, large-scale experimental tests of these solutions using quantitative methods, and qualitative debriefings with establishment members can provide comprehensive insights from multiple angles on survey design elements.

6.2 Final Remarks

Apart from the limitations of all papers discussed within each paper, a common limitation of all the studies conducted in this thesis is their exclusive focus on one single establishment survey, namely, the IAB-JVS. Consequently, it remains uncertain whether the findings presented in this thesis are applicable to other establishment surveys with different design elements. Since there are a limited number of other studies it is challenging to determine whether the findings are generalizable or specific to the IAB-JVS. All establishment survey participation factors identified by Willimack and Snijkers (2013) have the potential to interact with design elements, such as survey mode, and yield different outcomes regarding survey participation. Among others, this includes exploring how the findings would differ if the same survey is conducted in another country, administered by a different survey organization, or targeted to a different unit within the establishment. Future research should shed light on whether my findings are specific to the IAB-JVS and whether they hold true for other establishment panels with distinct characteristics. In this context, up-to-date meta-analyses focusing on all establishment surveys, similar to the meta-analyses published by Anseel et al. (2010) and Pielsticker and Hiebl (2020) on specific subgroups of establishment surveys, would be highly desirable.

In total, this dissertation contributes to and enriches the sparse literature on survey participation, and thus the data collection methods used in establishment surveys. I conclude this dissertation with the wish for more studies investigating data quality and methodological approaches for establishment surveys and hence a more comprehensive base for design choices, supporting the quote from Snijkers et al. (2013) already used in the introduction: *"The field of business surveys needs more documentation describing practices (practices that both do and do not work), case studies, pilots, and experiments to identify and isolate best practices. So, we encourage the readers to do more research and to share the results with colleagues around the world."*

6.3 References

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