Survey Research Methods (2020)
Vol. 14, No. 5, pp. 499-513
doi:10.18148/srm/2020.v14i5.7619

ISSN 1864-3361
http://www.surveymethods.org

Comparing the participation of Millennials and older age cohorts in the CROss-National Online Survey panel and the German Internet Panel

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Millennials (1982 to 2003) witnessed a set of events during their lives that differentiated them from older age cohorts (Generation X, Boomers, and Silents). Thus, one can also expect that Millennials' web survey participation differs from that of older cohorts. The goal of this study is to compare Millennials to older cohorts on different aspects related to web survey participation: participation rates, break-off rates, smartphone participation, survey evaluation, and data quality. We use data from two online probability-based panels covering four countries: the CROss-National Online Survey (CRONOS) panel in Estonia, Slovenia, and the UK, and the German Internet Panel (GIP). We find significantly lower participation rate for Millennials than for older cohorts and higher break-off rate for Millennials than for older cohorts in two countries. Smartphone participation is significantly higher for Millennials than for Generation X and Boomers in three countries. Comparing Millennials and Silents, we find that Millennials smartphone participation is significantly higher in two countries. There are almost no differences in survey evaluation and data quality across age cohorts in the descriptive analyses, but some age cohort effects in regression analyses. These results suggest that it is necessary to develop new strategies to encourage Millennials' participation in online surveys.

Keywords: age cohorts; break-off; data quality; Millennials; survey participation rates; probability-based online panels; smartphones; survey evaluation

1 Introduction

Strauss and Howe (1991) define Millennials as the cohort of individuals that were born between 1982 and 2003. Millennials witnessed a set of events during their lives that differentiate them from other age cohorts, such as Generation X, Boomers, and Silents (Bowen & Chen McCain, 2015). In particular, Millennials were the first age cohort to have access to the Internet during their formative years (Pew Research Center, 2014). Consequently, they have had the highest exposure to technology across all age cohorts (Hartman & McCambridge, 2011).

Millennials also have a unique set of characteristics that might require to adapt the way of communicating with that age cohort. For instance, Millennials were found to be more independent and self-sufficient than older age cohorts (Williams & Page, 2011). They also use self-service technology, which allows one to reduce face-to-face interactions, more frequently than older age cohorts (Mayock, 2014).

One of the main differences between Millennials and older age cohorts is the style of communication. Millennials' communication skills are of lower quality than those of older age cohorts (Hartman & McCambridge, 2011), with the former having a higher affinity for computer-mediated communication tools (Myers & Sadaghiani, 2010). For instance, a study by the Pew Research Center (2014) in the US shows that 89% of Millennials have a Social Network Site (SNS) profile, compared to 73% of Generation X and about 50% of Boomers. Another study showed that Millennials process website information five times faster than older age cohorts (Kim & Ammeter, 2008).

Due to these differences between Millennials and older age cohorts, one would expect Millennials to behave differently with respect to web survey participation. For instance, Millennials might be interested in different topics and have different levels of interest in sharing their opinions through surveys. Also, they might be affected differently by incentives and attracted by different survey layouts. All these potential differences may affect their decisions to participate in surveys and to break-off during surveys, as well as their survey satisfaction.

While ample research exists that posits age as a potential explanatory variable for survey participation and break-off, only a small portion of this research focuses on web surveys (see, for instance Couper, Kapteyn, Schonlau, & Win-

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ter, 2007; Galesic, 2006; Peytchev, 2009; Revilla, Toninelli, Ochoa, & Loewe, 2016). We argue that researchers should focus specifically on the participation (or break-off) of different age cohorts in web surveys, as we expect to find unique relationships in the case of web surveys, for two main reasons: 1) Millennials have higher Internet literacy and Internet affinity than older age cohorts (Myers & Sadaghiani, 2010) and 2) older people who participate in web surveys may differ significantly from people of the same age who do not participate in web surveys (Peytchev, 2009).

Moreover, most studies on survey participation either include age as a continuous variable instead of studying specific age cohorts, or they were conducted before mobile participation in web surveys became common. However, the possibility of answering especially through smartphones, might differently attract respondents of different age cohorts. For example, Millennials may be more incentivized to participate in web surveys if there is an option to do so via smartphone. This could, in turn, affect the link between age cohort and web survey participation. Optimized survey designs for smartphones could also affect the break-off rate of respondents using smartphones. It follows then that if the prevalence of smartphone use in web surveys differs across age cohorts, the optimization of survey designs may be more successful in reducing the break-off rate for some age cohorts than for others.

One notable exception is the study by Bosch, Revilla, and Paura (2018), which compared Millennials to older age cohorts in terms of different aspects of web survey participation (participation rate, break-off rate, proportion of surveys answered with smartphones, and survey evaluation). Using a dataset of 1,570,301 panelists from the Netquest opt-in online panel from eight countries in Europe, Latin America, and North America, the authors show that Millennials have significantly lower survey participation rates and higher proportions of surveys answered through smartphones than older age cohorts (i.e., Generation X and Boomers). However, they found almost no differences across age cohorts with respect to break-off rate and respondent survey evaluation.

This study builds on Bosch et al. (2018), testing some of their hypotheses on Millennials and older age cohorts, but also extend their research by testing new hypotheses and addressing some of their methodological limitations as follows:

1. While Bosch et al. (2018) rely on data from an opt-in online panel, we use data from two probability-based online panels: the CROss-National Online Survey (CRONOS) panel and the German Internet Panel (GIP). Besides having different selection methods for the panel members, probability-based and non-probability panels often differ in many ways. These differences include the number of survey invitations sent to the panel members (e.g., a probability-based panel may send an invitation every two months while a non-probability panel may send several invitations per month), selection of panelists for each survey (e.g., a probability-based panel usually sends the same survey to all panelists while a non-probability one may send different surveys to panelists based on socio-demographic quotas), fieldwork length (e.g., in a probability-based panel, it may last for one month and in a non-probability one only for a few days), or the target populations (e.g., a probability-based panel often targets the general adult population while non-probability panels conventionally target specific customer-tailored populations). These differences could lead to different results when comparing Millennials to older age cohorts. Thus, it is important to test the robustness of the results that Bosch et al. (2018) obtained in a non-probability panel by examining whether these results hold in probability-based panels.

2. While Bosch et al. (2018) focus on Portugal, Spain, and Latin and North American countries, we analyze data from four other countries: Estonia, Slovenia, the UK (the three countries in the CRONOS panel) and Germany (GIP). These countries vary in terms of Internet penetration, smartphone penetration, and the distribution of people across age cohorts. Due to the scarcity of previous research on the response behavior of different age cohorts, we argue that it is crucial to investigate this topic using surveys that are fielded under different conditions.

3. In addition to examining Millennials (1982 to 2003), Generation X (1961 to 1981), and Boomers (1943 to 1960), as Bosch et al. (2018) did, we examine Silents (born before 1943). Even if similar trends are expected for the Silents as for Generation X and Boomers (compared to Millennials), it is important to investigate it empirically and not to mask them by aggregating age cohorts. To the best of our knowledge, there is no research that systematically compares these age cohorts in a web survey setting.

4. We consider different aspects of respondent survey evaluation. Whereas Bosch et al. (2018) focus on one general question on survey evaluation, namely whether the survey was badly done or well done, we consider two questions about respondent's survey evaluation. These questions are whether the respondents found the survey difficult and whether they liked/enjoyed it. We used different questions for two main reasons: 1) data availability and 2) Bosch et al. (2018) did not find any differences across age cohorts for their survey evaluation measure. Thus, it is interesting to test different aspects of survey evaluation.

5. We investigate data quality that was not considered by Bosch et al. (2018). We measure data quality as the rate of non-substantive responses and primacy effects. Indeed, it is very important to consider data quality since it determines how good the conclusions of any study are.

6. We conduct regression analyses to test whether the effect of being in a given age cohort remains when controlling for other confounding variables. In particular, a higher smartphone participation for Millennials could create a confounding effect when directly comparing age cohorts, as done in the descriptive analyses of Bosch et al. (2018). Therefore, it is important to take this into account in the analyses. In our study, we investigate the effect of age cohort on the following dependent variables: participation rate, break-off rate, two survey evaluation indicators (i.e., rate of difficult and enjoyed/liked surveys), and data quality (i.e., non-substantive responses and primacy effects). We use the following control variables: smartphone rate, survey evaluation (except when these are the dependent variables), gender, education, citizenship, employment status, and the countries in which the surveys were fielded (CRONOS only).

2 Hypotheses

Bosch et al. (2018) proposed four hypotheses:

1. Since young adults are considered a hard-to-reach target population for surveys, Millennials' participation rate is expected to be lower than older age cohorts' participation rates.

2. Since Millennials are less effective at filtering out distractions, such as incoming emails or instant messages during the survey, Millennials' break-off rate is expected to be higher than older age cohorts' break-off rates.

3. Since a higher proportion of Millennials uses smartphones than older age cohorts, Millennials are expected to have a higher smartphone participation in surveys than older age cohorts.

4. Compared to other electronic devices, smartphones have smaller screens, which can decrease the visibility of survey contents and lead to longer survey completion times. Thus, Millennials' higher rates of smartphone use may lead them to give a more negative evaluation of web surveys than older age cohorts.

While the authors found evidence in support of the first and third hypotheses, they did not find supporting evidence for the second and fourth hypotheses. However, findings by Peytchev (2009) corroborate the expectation made in the second hypothesis, namely that older respondents have a lower likelihood of break-off in web surveys.

Consequently, we propose the following three hypotheses, that are directly adapted from the ones of Bosch et al. (2018).

Hypothesis 1 The participation rate is lower for Millennials than for Generation X, Boomers, and Silents.

Hypothesis 2 The break-off rate is higher for Millennials than for Generation X, Boomers, and Silents.

Hypothesis 3 The proportion of surveys answered through a smartphone is higher for Millennials than for Generation X, Boomers, and Silents.

We consider different questions about survey evaluation than Bosch et al. (2018) because the authors found no supporting evidence for their hypothesis on survey evaluation and because of data availability restrictions (the CRONOS panel and the GIP did not include a question about the overall survey evaluation). The common questions about survey evaluation available in the CRONOS panel and the GIP ask respondents if they found the survey difficult and if they "enjoyed" (CRONOS panel) or "liked" (GIP) it. Since Millennials are more accustomed to using the Internet (Pew Research Center, 2014) and are able to process website information more quickly than older age cohorts (Kim & Ammeter, 2008), we expect Millennials to find online surveys less difficult. This, in turn, may lead Millennials to enjoy/like survey participation more than older age cohorts. These expectations lead us to the following hypotheses:

Hypothesis 4a Millennials consider web surveys to be less difficult than Generation X, Boomers, and Silents do.

Hypothesis 4b Millennials enjoy/like web surveys more than Generation X, Boomers, and Silents do.

Our last hypothesis is on data quality. Compared to older individuals, younger individuals seem to have a lower rate of high sustained attention (Microsoft Canada, 2015). This fact could result in lower survey data quality for Millennials. However, Millennials are also more familiar with the online environment and the use of both PCs and mobile devices than older age cohorts. This could, in turn, have a positive effect on survey data quality. Following these two lines of argumentation, we expect the opposing effects of these factors (i.e., lower rate of high sustained attention and greater online experience) to counterbalance each other, resulting in comparable survey data quality for Millennials and older age cohorts. Our last hypothesis, therefore, is as follows:

Hypothesis 5 Millennials produce survey data of comparable quality as Generation X, Boomers, and Silents do.

3 Data and method

3.1 Data

In this study, we use data from two different panels to increase the generalizability of our results. Although the panels are comparable in many ways, they also have some key differences.

The CRONOS panel. The CRONOS panel was set up in Estonia, Slovenia, and the UK by inviting respondents (aged 18 years and older) of Round 8 of the European Social Survey (ESS) from September 2016 to February 2017 to participate in seven subsequent online surveys that address a variety of economic, political, and social topics. Respondents who did not have Internet access for private use were equipped with a tablet and Internet access for the duration of the project. In total, the project provided Internet-enabled tablets to 182 panel members. Data collection took place between December 2016 and February 2018. After a short 10-minute welcome survey in December 2016, questionnaires of waves 1 to 6 of the CRONOS panel were fielded with questions that were often adapted from high-standard cross-national surveys. Each questionnaire took about 20 minutes and dealt with different topics. Panel members received an unconditional incentive with their invitation to each wave of the survey (for more information, we refer interested readers to Villar et al., 2018). Recruitment rates, calculated as the proportion of individuals in the gross ESS sample who initially agreed to join CRONOS panel (including hesitant respondents), ranged from about 30% in the UK to about 40% in Estonia and Slovenia (Berzelak, Weber, & Revilla, 2018). In this study, we use data from all seven surveys (i.e., the welcome survey and the six regular waves; CROss-National Online Survey panel, 2018a, 2018b), with 806 panelists in Estonia (260 Millennials, 310 Generation X, 198 Boomers, and 38 Silents), 705 in Slovenia (223 Millennials, 287 Generation X, 165 Boomers, and 30 Silents), and 921 in the UK (213 Millennials, 357 Generation X, 290 Boomers, and 61 Silents).

The GIP. The GIP is part of the Collaborative Research Center 884 "Political Economy of Reforms" at the University of Mannheim. It is based on two probability-based samples of the German population aged 16 to 75 that were drawn in 2012 and 2014. Both samples include on-liners and off-liners (these respondents were equipped with PC-like devices and/or Internet access). In total, 205 off-liners are in the GIP. Panel members are invited every two months to participate in a self-administered web survey dealing with a variety of economic, political, and social topics. Each survey lasts about 20 minutes. For their participation in each wave, respondents receive a conditional incentive. For a detailed methodological description of the GIP, we refer interested readers to Blom, Gathmann, and Krieger (2015). In this study, we use data from six successive waves of the GIP in 2017. These are waves 27 to 32, which took place in January, March, May, July, September, and November (Blom, Bruch, et al., 2017a, 2017b; Blom, Felderer, Gebhard, et al., 2017; Blom, Felderer, Herzing, et al., 2018; Blom, Felderer, Höhne, et al., 2018a, 2018b). Our sample consists of 3,214 panelists (771 Millennials, 1,318 Generation X, 972 Boomers, and 153 Silents). We chose these waves because they overlap the most with those of the CRONOS panel in terms of the fielding period. As per protocol, the data collected by the GIP are made available to the scientific community – via the GESIS Data Archive for the Social Sciences –six months after its collection.

3.2 Analyses

Descriptive analyses. We compare Millennials with Generation X, Boomers, and Silents in different ways using data from the CRONOS panel and GIP (waves 27 to 32). First, we compare Millennials to older age cohorts with respect to the participation rate for each panelist, the break-off rate for each panelist, and the proportion of surveys completed with a smartphone for each panelist. In defining our indicators, we use the following definitions provided in Bosch et al. (2018, p. 361):

- Participation rate for each panelist is defined as the number of surveys he/she started during the period examined, divided by the number of surveys to which he/she was invited during the same time frame.
- Break-off rate for each panelist is defined as the number of times he/she started a survey but did not complete it until the end, divided by the number of times he/she started a survey.
- Rate of surveys completed with a smartphone for each panelist is defined as the number of surveys he/she participated using a smartphone, divided by the number of times he/she started a survey.

It is important to know that the information about the device type available for the CRONOS panel and the GIP differ. For the CRONOS panel, we have information about the device used to answer most questions from wave 2 onwards. Thus, no information on device type is available for the welcome survey and the wave 1. For the GIP (all waves studied), we have similar information to those used by Bosch et al. (2018), i.e., information about the device that was used when the respondents started the survey, without knowing whether respondents switched to another device later.

We compute and report the average of the individual participation, break-off, and smartphone rates, per age cohort, panel, and country.

Next, we compare Millennials and older age cohorts with respect to survey evaluations. The available indicators of survey evaluation in the CRONOS panel and the GIP differ from

the indicators used by Bosch et al. (2018). We focus on the two indicators that were measured in both panels, even though the wording of the questions about survey evaluation differs slightly across the panels. The survey evaluation questions were asked close to the end of the surveys in both the CRONOS panel and the GIP.

In the CRONOS panel, all waves include these two survey evaluation questions, the first measuring survey difficulty and the second survey enjoyment (except wave 5):

- How difficult was it for you to understand and answer the questions in this survey? 1 Not at all difficult; 2 Slightly difficult; 3 Moderately difficult; 4 Very difficult; 5 Extremely difficult.
- How much did you enjoy answering this survey? 1 Not at all; 2 A little; 3 A moderate amount; 4 A lot; 5 A great deal.

In the GIP, the six waves examined include these two survey evaluation questions, which measure survey difficulty and survey enjoyment respectively:

- Did you find the questionnaire difficult? 1 Not at all to 4 Very
- How did you like the survey as a whole? 1 Not at all, 2 A little, 3 A moderate amount, 4 A lot, 5 Very much.

We define the rate of difficult surveys for each panelist as the number of surveys he/she found difficult, divided by the number of times he/she answered this question. In the survey difficulty question, we code a response as "difficult survey" if a respondent chose answer options 3 to 5 in the CRONOS panel or answer options 3 or 4 in the GIP. We report the average of this individual rate of difficult surveys across age cohort, panel, and country. We similarly calculate the rate of enjoyed/liked surveys. In the survey enjoyment question, a response is coded as "enjoyed/liked survey" if a respondent chose answer options 3 to 5 in the CRONOS panel or the GIP. Note that the two survey evaluation questions were not asked in wave 5 of the CRONOS panel. Thus, the rates of enjoyed/liked surveys for the CRONOS panel are only based on six surveys (i.e., the welcome survey and waves 1, 2, 3, 4, and 6). Moreover, difficult and enjoyed/liked rates can only be computed for those who participated in the surveys, which, in turn, could lead to an underestimation of survey difficulty and an overestimation of survey enjoyment.

Finally, we compare Millennials and older age cohorts with respect to data quality. Since we also investigate break-off rate, we focus only on respondents who finished the survey in our investigation of data quality.

We use two indicators of data quality. The first one is the rate of non-substantive responses (i.e., item non-response and "don't know" or "prefer not to answer"). We combine item non-response and "don't know" or "prefer not to answer" into one category because of the relatively low proportion of these response behaviors. We compute the rate of non-substantive responses for each panelist, defining it as the number of times he/she provided a non-substantive response, divided by the number of questions he/she was asked. We report the average of these rates across age cohort, panel, and country. For the sake of simplicity and because data quality is expected to be similar across age cohorts in any of the waves, we decided to focus for our data quality analyses on wave 1 of the CRONOS panel (up to 115 questions) and wave 27 of the GIP (up to 63 questions). Since the questionnaires of the two waves are different, the panels may differ with respect to the level of non-substantive responses. We report the average rates across age cohort, panel, and country.

In addition, we consider primacy effects (i.e., which is the tendency of respondents to select the first option of a response scale). We define the rate of selecting the first answer category for each panelist as the number of times he/she selected the first answer category, divided by the number of questions he/she was asked. We focus on wave 1 in the CRONOS panel and wave 27 in the GIP. Since the questionnaires differ, there might be differences across panels with respect to the level of primacy effects. We report the average rates across age cohort, panel, and country.

All analyses are conducted using Stata version 14. We test the differences between Millennials and the other three age cohorts (i.e., Generation X, Boomers, and Silents) for all the rates calculated and within each panel and country using Z-tests (Stata prtest command). In order to measure the magnitude of the differences, we also compute the effect sizes (Cohen's h).

Regression analyses. To investigate whether the differences observed in the descriptive analyses depend purely on differences due to the age cohort or whether other factors play a role, we conduct a series of Ordinary Least Squares (OLS) regressions. Due to the higher smartphone participation for Millennials, we expect a confounding effect when we simply compare age cohorts with respect to the rates defined previously (see 3.2 Descriptive analyses).

The dependent variables in the regression analyses are participation rate, break-off rate, the two indicators of survey evaluation, and the two data quality indicators. Since the effect of the age cohort is our main interest, the independent variables include dummies for each age cohort, with Millennials used as the reference group. In addition, we include smartphone participation rate as the main potential confounder. We expect that overall, respondents with a higher smartphone participation rate participate less in surveys, have higher break-off rates, and lower data quality. Moreover, we expect survey evaluation to affect participation and break-off rates as well as data quality. These variables are thus also used as independent variables when examin-

ing participation and break-off rates and data quality. More specifically, we expect respondents with higher rates of difficult surveys to participate less, break-off more, and have data of lower quality. In contrast, we expect that, overall, those with higher rates of enjoyed/liked surveys will participate more, break-off less, and provide data of higher quality.

In addition, we expect some socio-demographic variables to create confounding effects. First, since the proportion of women varies across age cohorts, with a higher proportion of women in the oldest cohorts (Worldometer, n.d.), and previous research suggests that gender is associated with higher break-off and/or lower data quality (Peytchev, 2011; Steinbrecher, Roßmann, & Blumenstiel, 2014), part of the differences across age cohorts might be due to gender differences. We thus include a dummy for gender (female = 1) as a control variable. Second, the level of education differs across age cohorts, with Millennials having higher educational levels (Eurostat, 2019), and previous research suggests that higher education is associated with lower break-off and/or data quality (Peytchev, 2009, 2011; Steinbrecher et al., 2014). We thus include a dummy variable for educational attainment (1 = university attendance).

Employment status also varies across age cohorts (OECD, n.d.). and may affect survey participation. More specifically, employed people are expected to have less free time, which, in turn, can increase break-off rate, and reduce data quality. We thus include a dummy variable for employment status (1 = working). In addition, the proportion of migrants per age cohort may differ (Gov.uk., 2018) and being a migrant could reduce survey participation, increase break-off rate and reduce data quality, in particular because of the use of a non-native language in the survey. Thus, we include a dummy variable about respondent's citizenship (1 = Citizen of the country where the surveys took place). Appendix 1 provides some descriptive statistics about these socio-demographic variables. In the analyses for the CRONOS panel, we additionally include dummy controls for Estonia and Slovenia, with the UK being the reference.

4 Results

4.1 Descriptive

Participation rates. In order to test hypothesis 1, which stated that Millennials have lower participation rates than older age cohorts, we compare the average participation rates of Millennials, Generation X, Boomers, and Silents across country, panel, and age cohort. Table 1 shows the results.

As expected, the participation rates are significantly lower for Millennials (between 61.0% and 81.6%) than for the other three age cohorts (between 71.8% and 98.3%), in the three countries of the CRONOS panel and in the GIP. Furthermore, in absolute terms, Cohen's h ranges from 0.12 to 0.63, indicating small to medium effect sizes. These findings support hypothesis 1.

Break-off rates. With respect to hypothesis 2 (the break-off rate is higher for Millennials than for older age cohorts), we compare the average break-off rates across country, panel, and age cohort. Table 2 shows the results.

In Estonia and the UK (CRONOS panel), the break-off rates are significantly higher for Millennials (12.8% and 18.5%, respectively) than for older age cohorts, except for Silents in the UK. For these comparisons, we observe effect sizes ranging from 0.22 to 0.73 in Estonia and from 0.23 to 0.47 in the UK. In Slovenia (CRONOS panel) and Germany (GIP), we observe similar trends, except for Silents in Slovenia. However, the differences are not statistically significant. The effects sizes are also small (maximum of 0.19). Thus, we find support for hypothesis 2 for Estonia and the UK, the countries with the highest break-off rates.

Smartphone participation. Hypothesis 3 posits that the proportion of surveys answered through smartphones is higher for Millennials than for older age cohorts. Table 3 shows the results.

In Estonia and Slovenia (CRONOS panel), Millennials have significantly higher smartphone participation rates than Generation X and Boomers, but not higher than Silents. However, the number of observations for Silents is very small in both countries (38 and 30, respectively). It might be the case that these respondents of the Silent age cohort substantially differ from other people in the Silent age cohort. In the UK (CRONOS panel) and Germany (GIP), the number of respondents in the Silent group is higher (61 and 153, respectively). In these countries, the differences between Millennials and Silents are statistically significant, with lower smartphone participation rates for Silents than for Millennials. In Germany, we also find significant differences between Millennials and the other two other age cohorts (Generation X and Boomers) and in the UK, there is a significant difference between Millennials and Boomers. The effect sizes vary widely, depending on the age cohort and the country (e.g., it is up to 1.07 in Germany). Overall, the results support hypothesis 3, namely that Millennials show significantly higher proportions of surveys answered using smartphones than older age cohorts.

Survey evaluation. With respect to survey evaluation, we first investigate the rates of surveys that respondents rated as difficult. Hypothesis 4a posits that, overall, Millennials consider the surveys to be less difficult than Generation X, Boomers, and Silents. Table 4 shows the results.

In the CRONOS panel, we did not find any significant differences across age cohorts for the rate of difficult surveys. This applies to all three countries. In contrast, in the GIP panel, where the overall difficult rate is quite high (25.7%), we found that the average rates of difficult surveys are significantly lower for Generation X and Boomers than for Millennials. The Cohen's h coefficients are small. There is no

Table 1
Average participation rate

		Average participation rate (%)					Cohens's h		
Country	N	Total	M[a]	GenX[b]	Boomers	Silents	M[a]-GenX[b]	M[a]-Boomers	M[a]-Silents
Cross-National Online Survey Panel									
Estonia	806	87.1	81.6	87.9*	91.1**	98.3**	−0.18	−0.28	−0.63
Slovenia	705	83.8	76.0	86.2**	89.2**	87.9**	−0.26	−0.35	−0.31
UK	921	73.5	61.0	71.8**	82.5**	83.7	−0.23	−0.49	−0.52
German Internet Panel									
Germany	3,215	84.9	79.2	83.7**	90.2**	91.6**	−0.12	−0.31	−0.36

The stars in the columns "GenX", "Boomers", and "Silents" indicate a statistically significant difference between Millennials and the respective age cohort.
[a] Millenials [b] Generation X
* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

Table 2
Average break-off rate

		Average break-off rate (%)					Cohens's h		
Country	N	Total	M[a]	GenX[b]	Boomers	Silents	M[a]-GenX[b]	M[a]-Boomers	M[a]-Silents
Cross-National Online Survey Panel									
Estonia	806	7.9	12.8	6.5*	5.0**	0*	0.22	0.28	0.73
Slovenia	705	5.0	7.1	4.2	3.0	8.2	0.13	0.19	−0.04
UK	921	10.3	18.5	10.5**	4.3**	9.0	0.23	0.47	0.28
German Internet Panel									
Germany	3,215	2.2	2.7	2.5	1.6	1.4	0.01	0.08	0.09

The stars in the columns "GenX", "Boomers", and "Silents" indicate a statistically significant difference between Millennials and the respective age cohort.
[a] Millenials [b] Generation X
* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

Table 3
Average proportion of surveys answered using a smartphone

		Average smartphone rates (%)					Cohens's h		
Country	N	Total	M[a]	GenX[b]	Boomers	Silents	M[a]-GenX[b]	M[a]-Boomers	M[a]-Silents
Cross-National Online Survey Panel									
Estonia	806	15.8	23.3	13.0**	9.6**	20.5	0.27	0.38	0.07
Slovenia	705	25.4	37.5	19.1**	17.6**	37.4	0.41	0.45	0.00
UK	921	31.2	44.7	37.1	17.2**	16.3**	0.15	0.61	0.63
German Internet Panel									
Germany	3,215	15.0	31.6	15.5**	3.3**	0.4**	0.38	0.83	1.07

The stars in the columns "GenX", "Boomers", and "Silents" indicate a statistically significant difference between Millennials and the respective age cohort.
[a] Millenials [b] Generation X
* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

Table 4
Average proportion of difficult surveys

		Average difficult surveys rate (%)					Cohens's h		
Country	N	Total	M[a]	GenX[b]	Boomers	Silents	M[a]-GenX[b]	M[a]-Boomers	M[a]-Silents
Cross-National Online Survey Panel									
Estonia	776	14.8	15.0	12.2	16.6	25.1	0.08	−0.04	−0.25
Slovenia	673	20.3	21.0	17.8	20.9	37.4	0.08	0.00	−0.36
UK	865	13.6	14.7	11.5	13.8	20.7	0.10	0.03	−0.16
German Internet Panel									
Germany	3,177	25.7	29.9	25.8*	22.2**	26.7	0.09	0.18	0.07

The stars in the columns "GenX", "Boomers", and "Silents" indicate a statistically significant difference between Millennials and the respective age cohort. Because some respondents never answered the questions on difficult surveys, the Ns are: 776 for Estonia, 673 for Slovenia, 865 for the UK, and 3,177 for Germany.
[a] Millennials [b] Generation X.
* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

significant difference between Millennials and Silents. Thus, the results show no support for hypothesis 4a.

Second, we investigate the proportion of enjoyed/liked surveys. Our hypothesis 4b postulates that, overall, Millennials enjoy/like the surveys more than Generation X, Boomers, and Silents. Table 5 shows the results.

No significant differences are found in the three countries of the CRONOS panel. In the GIP, there is only one significant difference, namely between Millennials and Boomers, with Millennials showing a significantly higher rate of liked surveys (49.3% vs. 43.8%). The effect sizes are small, even in the GIP, where we found the significant difference. Thus, the results do not support our hypothesis 4b.

Data quality. In order to test our last hypothesis, which states that Millennials provide data of similar quality as older age cohorts, we use two indicators of data quality: non-substantive responses and the proportion of times respondents selected the first category out of all their answers (primacy effects). Tables 6 and 7 present the results.

Only two significant differences are found with respect to non-substantive responses. These differences are for different age cohorts and have different directions, with Boomers having a lower proportion of non-substantive responses than Millennials in Slovenia and Silents having a higher proportion of non-substantive responses than Millennials in Germany. The effect sizes are small, with a maximum absolute value of 0.34 in Slovenia. With respect to primacy effects, no significant differences were found and the effect sizes are very small, with a maximum absolute value of 0.08 in Slovenia. Thus, data quality, as measured here, does not differ across age cohorts in the different countries, which supports hypothesis 5.

4.2 Regressions

Finally, we also ran some regression models to investigate the effect of age cohort on participation rate, break-off rate, survey evaluation, and data quality, computed as explained in section 3.2.1. We controlled for several variables, such as smartphone participation rate, that we expected to be the main confounders . Table 8 displays the standardized beta coefficients and indicates the coefficients that have a p-value lower than 0.05 and 0.01. In what follows, we discuss the results in the respective order of our hypotheses.

First, the adjusted R^2 values are quite low, which means that our models did not explain much of the variance of the dependent variables. However, our goal is not to explain these dependent variables, but to study the effect of being in different age cohorts.

Next, in both panels, the three dummies corresponding to the age cohorts have significant effects on participation rate. The size of the coefficients increases from Generation X to Boomers, but then decreases for Silents. Thus, we found some supporting evidence for hypothesis 1.

In both panels, the three dummies corresponding to the age cohorts have significant effects on break-off rate. As expected, we observe negative coefficients for Generation X, Boomers, and Silents. These results support hypothesis 2.

With respect to survey evaluation, the dummies for Generation X and Boomers have no significant effect in the CRONOS panel, but they have significant negative effects on both indicators in the GIP (whereas we expected positive ones). The dummy of Silents has a significant effect on the difficult rate in the CRONOS panel, but no significant effect in the GIP. For the GIP, these results provide partial support for hypothesis 4b but no support for hypothesis 4a. In contrast, for the CRONOS panel, no support for either hypotheses was found.

Analyzing data quality, we find that in both panels, the

Table 5
Average proportion of enjoyed/liked surveys

		Average enjoyed/liked surveys rate (%)					Cohens's h		
Country	N	Total	M[a]	GenX[b]	Boomers	Silents	M[a]-GenX[b]	M[a]-Boomers	M[a]-Silents
Cross-National Online Survey Panel									
Estonia	776	68.4	71.4	66.7	68.2	63.4	0.10	0.07	0.17
Slovenia	673	93.1	92.8	93.0	93.1	95.6	−0.01	−0.01	−0.12
UK	865	78.1	75.4	79.0	80.5	70.4	−0.09	−0.12	0.11
German Internet Panel									
Germany	3,183	45.7	49.3	45.0	43.8*	45.9	0.09	0.11	0.07

The stars in the columns "GenX", "Boomers", and "Silents" indicate a statistically significant difference between Millennials and the respective age cohort. Because some respondents never answered to the questions on enjoyed/liked survey, the Ns are: 776 for Estonia, 673 for Slovenia, 865 for UK, and 3,183 for Germany.
[a] Millennials [b] Generation X.
* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

Table 6
Average proportion of non-substantive responses

		Average non-substantive responses (%)					Cohens's h		
Country	N	Total	M[a]	GenX[b]	Boomers	Silents	M[a]-GenX[b]	M[a]-Boomers	M[a]-Silents
Cross-National Online Survey Panel									
Estonia	704	3.5	2.0	3.6	4.6	5.0	−0.10	−0.15	−0.17
Slovenia	522	3.7	1.8	3.6	4.9	9.1*	−0.11	−0.18	−0.34
UK	652	1.7	0.9	2.0	1.7	3.0	−0.09	−0.07	−0.16
German Internet Panel									
Germany	2,834	3.2	4.5	3.6	2.1**	1.7	0.05	0.14	0.17

The stars in the columns "GenX", "Boomers", and "Silents" indicate a statistically significant difference between Millennials and the respective age cohort.
[a] Millennials [b] Generation X
* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

Table 7
Average proportion of times the first answer category was selected

		Average rates select 1st category (%)					Cohens's h		
Country	N	Total	M[a]	GenX[b]	Boomers	Silents	M[a]-GenX[b]	M[a]-Boomers	M[a]-Silents
Cross-National Online Survey Panel									
Estonia	704	22.9	22.8	22.1	23.4	27.4	0.02	−0.01	−0.11
Slovenia	522	23.3	21.7	24.1	23.2	25.0	−0.06	−0.04	−0.08
UK	652	24.4	24.6	23.9	24.6	25.1	0.02	0.00	−0.01
German Internet Panel									
Germany	2,834	17.9	17.1	18.1	18.2	17.7	−0.03	−0.03	−0.02

The stars in the columns "GenX", "Boomers", and "Silents" indicate a statistically significant difference between Millennials and the respective age cohort.
[a] Millenials [b] Generation X
* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

Table 8
All regression models in both panels (standardized beta coefficients)

Independent variables	Particip.[a] Rate	Break-off rate	Non-subs.[b] rate	Select first rate	Difficult Rate	Enjoyed/liked Rate
Cross-National Online Survey Panel						
Generation X	0.15**	−0.10**	0.14**	0.04	−0.04	0.00
Boomers	0.20**	−0.14**	0.17**	0.07*	0.01	0.02
Silents	0.13**	−0.07**	0.16**	0.09**	0.09**	−0.03
Smartphone rate	−0.07**	0.07**	−0.06*	0.11**	0.06**	0.03
Difficult rate	−0.03	0.03	0.02	−0.05	-	-
Enjoyed rate	0.08**	−0.05*	−0.05*	0.07**	-	-
Female	0.04*	−0.02	0.05*	0.03	0.02	0.02
University	0.07**	−0.05*	−0.05*	−0.00	−0.10**	−0.01
Work	−0.06*	0.02	−0.01	−0.02	−0.03	−0.00
Citizen	−0.03	−0.00	0.08**	−0.02	0.06**	0.04*
Estonia	0.25**	−0.03	0.16**	−0.06*	0.04	−0.14**
Slovenia	0.20**	−0.09**	0.19**	−0.07**	0.14**	0.22**
Number of observations	2,299	2,299	1,867	1,867	2,299	2,299
Adjusted R^2	0.1134	0.0337	0.0715	0.0303	0.0441	0.1010
German Internet Panel						
Generation X	0.07**	−0.05*	−0.05*	0.03	−0.07**	−0.09**
Boomers	0.19**	−0.09**	−0.15**	0.06*	−0.14**	−0.09**
Silents	0.10**	−0.04*	−0.10**	0.03	−0.03	−0.02
Smartphone rate	−0.03	0.04*	0.07**	0.01	−0.02	−0.01
Difficult rate	0.10**	0.02	0.25**	−0.31**	-	-
Liked rate	−0.20**	−0.04	−0.09**	0.15**	-	-
Female	−0.01	0.03	0.07**	−0.10**	0.17**	0.13**
University	0.02	−0.02	−0.07**	−0.09**	−0.04*	−0.05**
Work	0.02	−0.01	−0.03	0.08**	−0.04*	0.02
Citizen	0.05**	−0.01	−0.03	−0.03	−0.04*	−0.03
Number of observations	3,134	3,134	2,827	2,827	3,134	3,140
Adjusted R^2	0.0569	0.0087	0.0920	0.0890	0.0443	0.0257

The standard errors of the standardized beta coefficients (obtained using the command "stdBeta, se" in Stata) are between 0.02 and 0.03 for the CRONOS and are all 0.02 for the GIP.
[a] Participation [b] Non-substantive responses
* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

three age cohort dummies have significant effects on the rates of non-substantive responses. However, the directions of the effects differ across the age cohorts. In the CRONOS panel, we consistently observe positive effects, but in the GIP, we consistently observe negative effects. In terms of the rates of selecting the first answer category, Boomers have a significant effect in both panels and Silents have a significant effect in the CRONOS panel. The signs of the significant coefficients are positive in both panels. These mixed results might be linked to the two opposing effects (i.e., lower rates of high sustained attention and higher online experience) that we expected to counterbalance each other. It seems that depending on the situations (e.g., countries or panels), one of the two expected effects might be larger than the other, or vice versa, so that they do not counterbalance each other. All in all, there is little support for hypothesis 5.

Smartphone participation rate has a significant effect on all the dependent variables, except for the enjoyed/liked rates in the CRONOS panel and on the break-off and non-substantive responses in the GIP. While the difficult rate has no significant effect in the CRONOS panel, it has a significant effect on participation rate and the two data quality indicators in the GIP. The enjoyed/liked rates have a significant effect on participation rate, break-off rate, and the two data quality indicators in the CRONOS panel, as well as participation rate and the two data quality indicators in the GIP. Finally, the four sociodemographic variables included as controls show some significant effects. This also applies to the

country dummies in the CRONOS.

5 Discussion and conclusion

In this study, we used data from two online probability-based panels—the CRONOS panel in Estonia, Slovenia, and the UK (all seven surveys) and the GIP in Germany (waves 27 to 32). Building on Bosch et al. (2018) and adding our own contributions, we investigated whether Millennials differ from older age cohorts in terms of participation and break-off rates, smartphone participation, survey evaluation, and data quality. Table 9 presents the exact hypotheses tested and states whether we found supporting evidence for the respective hypothesis in the descriptive analyses and the regression analyses.

As expected, the participation rate is significantly lower for Millennials than for Generation X, Boomers, and Silents, while the break-off rate is higher for Millennials than for older age cohorts in three out of the four countries. The proportion of surveys answered through smartphones is significantly higher for Millennials than for Generation X and Boomers in three countries. When comparing Millennials to Silents, it is significantly higher in half of the countries. Regarding survey evaluation and data quality, not many differences were observed across age cohorts in the descriptive analyses.

Moreover, Generation X, Boomers, and Silents have significant effects on participation, break-off, and non-substantive responses rates in both panels. As for the rate of selecting the first answer, Boomers (both panels) and Silents (CRONOS) have significant coefficients. Regarding difficult and enjoyed/liked rates, there is only one significant effect in the CRONOS panel (Silents on difficult rate). But in the GIP, both Generation X and Boomers have significant negative effects on the two rates.

Overall, we find supporting evidence for our first three hypotheses on participation, break-off, and smartphone rates. However, we find only little supporting evidence for the remaining hypotheses on survey evaluation and data quality. The results are quite mixed and depend on the type of analyses, the panel and/or country.

These results are in line with Bosch et al. (2018), who found support for the differences in participation rates and smartphone participation rates, but not for survey evaluation, even though we used different indicators. In this study, we also found some support for hypothesis 2 on break-off rates, but not for all countries. This suggests that the differences across age cohorts are quite similar in both studies, despite the fact that Bosch et al. (2018) focused on non-probability online panels and we study probability-based online panels, that differ in important ways, including the number of survey invitations sent and the length of the fieldwork.

This study has some limitations. First, the number of participants from Silents is much lower than for the other age cohorts. This is particularly problematic in the CRONOS panel, since this group was very small in some countries (less than 40 respondents). Second, although both panels are comparable in many ways, they also differ in crucial ways. For instance, the CRONOS panel was recruited at the end of a face-to-face interview while the GIP was recruited directly. Also, the CRONOS panel only lasted for about one year, while the GIP has been undergoing since 2012. Therefore, it is difficult to disentangle the country-specific differences from the panel-specific differences. Moreover, the use of two instead of one panel somewhat limited the indicators that could be used for survey evaluations and data quality. Furthermore, we cannot (fully) separate generation effects from age/ageing effects or (precisely) identify the reasons for differences between our study and the study by Bosch et al. (2018). Indeed, both studies differ with respect to several aspects, in particular, the type of panel (probability-based vs. non-probability panel) and countries.

Further research that overcomes these limitations would be useful. In particular, we encourage researchers to compare probability-based and non-probability panels within the same country to disentangle the effect of panel type and country. Future research could also look at differences across countries by, for instance, using multilevel analyses or study interactions between age cohort and other respondent characteristics (e.g., education level).

In summary, our study provides useful insights and has some practical implications for web survey research. Indeed, although Millennials are heavy Internet users, their participation in online panels seems to be lower and their break-off rates are higher. This could be related to the fact that Millennials prefer sharing their opinions in other ways (e.g., in social networks) than surveys. They may also be less interested in the topics of the surveys or the way in which surveys are currently implemented. Further research to understand why these differences arise is needed. However, our results suggest that Millennials are more likely than other age cohorts to use smartphones to participate in surveys in several countries. Thus, we should make sure that surveys are fully optimized for smartphones if we want to increase their participation and commitment to online panels. However, optimizing the surveys for smartphones seems to be insufficient, since the two panels studied here use optimization for smartphone respondents but still have lower participation rates for Millennials and higher break-off rates in several countries. Therefore, the development of new strategies to involve Millennials in online survey participation is very much needed. Research employing new measurement strategies, facilitated by the steady increase of smartphone usage, might help in achieving this goal. For instance, allowing respondents to use voice recording (Lütters, Friedrich-Freksa, & Egger, 2018; Revilla, Couper, Bosch, & Asensio, 2020) or images (Bosch, Revilla, & Paura, 2019) in answering web

Table 9
Summary of the results

Hypotheses	Support descriptive analyses	Support regression analyses
H1: The participation rate is lower for Millennials than for Generation X, Boomers, and Silents.	Yes	Yes
H2: The break-off rate is higher for Millennials than for Generation X, Boomers, and Silents.	Yes, in Estonia and UK	Yes
H3: The proportion of surveys answered through a smartphone is higher for Millennials than for Generation X, Boomers, and Silents.	Yes, except for Silents in Estonia and Slovenia and Generation X in UK	Not tested
H4a: Millennials overall consider the surveys to be less difficult than Generation X, Boomers, and Silents.	No	No
H4b: Millennials enjoy/like the surveys more than Generation X, Boomers, and Silents.	No	Partial in GIP
H5: Millennials produce data of comparable quality to Generation X, Boomers, and Silents.	Yes	No

survey questions might help to engage Millennials. Furthermore, the development of gamification strategies (Keusch & Zhang, 2017) may also help to motivate Millennials to participate in future web surveys.

Acknowledgements

The authors are grateful to Annelies Blom and the members of the Z1 project (University of Mannheim) for collecting and providing the data of the German Internet Panel (waves 27 to 32). We also acknowledge financial support by the German Science Foundation through the Collaborative Research Center 884 "Political Economy of Reforms" at the University of Mannheim. We also thank the two anonymous reviewers and the editor for their helpful comments on a previous version of the paper.

Data Availability Statement

The CRONOS data used in this study are available online: https://www.europeansocialsurvey.org/data/download_cronos.html. The GIP data used in this study are available to the scientific community via the GESIS Data Archive for the Social Sciences. For ethical and data protection reasons, some of the data, such as respondents' age for building the age cohorts and paradata, can only be accessed at the Onsite Data Access (ODA) facilities of the GIP Secure Data Center (SDC) located at the Collaborative Research Center 884 "Political Economy of Reforms", University of Mannheim, B6 30-32, 68159 Mannheim, Germany.

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Appendix
Tables

Table A1
Proportion of female, panellists with university degree, panellists working, and panellists with the citizenship of the country where the surveys took place, for each country and panel.

	CRONOS			GIP
%	Estonia	Slovenia	UK	Germany
Female	56.7	54.2	55.5	49.1
University	37.7	25.6	35.9	29.0
Work	71.5	62.8	58.8	64.0
Citizen	90.6	98.7	93.7	97.0

Table A2
Regression models without controlling for possible confounders (standardized beta coefficients)

Independent variables	Particip.[b] Rate	Break-off rate	Non-subs.[c] rate	Select first rate	Difficult Rate	Enjoyed/liked Rate
Cross-National Online Survey Panel						
Generation X	0.15**	−0.12**	0.14**	0.02	−0.06[a,*]	−0.00
Boomers	0.23**	−0.17**	0.16**	0.06*	−0.01	0.01
Silents	0.13**	−0.07**	0.15**	0.10**	0.08**	−0.04
No. obs.	2,432	2,432	1,878	1,878	2,314	2,314
Adjusted R^2	0.0414	0.0214	0.0267	0.0078	0.0117	0.0004
German Internet Panel						
Generation X	0.09**	−0.01[a]	−0.07*	0.07[a,**]	−0.08**	−0.08**
Boomers	0.20**	−0.05*	−0.19**	0.07**	−0.14**	−0.10**
Silents	0.11**	−0.02[a]	−0.11**	0.02	−0.03	−0.03
Number of observations	3,215	3,215	2,834	2,834	3,177	3,183
Adjusted R^2	0.0296	0.0011	0.0255	0.0027	0.0112	0.0056

The standard errors of the standardized beta coefficients (obtained using the command "stdBeta, se" in Stata) are between 0.01 and 0.03 for the CRONOS and are all 0.02 for the GIP.
[a] Effects that are significant in this model but are not anymore when including the control variables, or vice-versa.
[b] Participation [c] Non-substantive responses
* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$