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Environmental Attitudes, Concerns, and Behaviors Across Survey Modes. Assessing Selection and Measurement Biases in ISSP 2020 'Push-to-Web' Surveys

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ABSTRACT

How much does survey mode matter for predicting environmental attitudes and behaviors? It is essential to consider the influence of survey mode on the measurement of variables, particularly given the increasing popularity of web-based data collection following the Covid crisis. In 2020, several ISSP countries adopted a mixed-mode design, combining web and paper surveys for the Environment IV module. While mixed-mode data collection can reduce mode-specific errors, its success depends on accurately estimating and adjusting for selection and measurement differences between the modes. Failing to do so can increase the Total Survey Error, compromising the accuracy and reliability of the data. In this article, we examine selection and measurement differences in the web and paper modes in the Environment IV data from Switzerland and Finland. Register data are used as a benchmark to estimate selection biases in key socio-demographic variables, and we use these estimates to disentangle mode measurement effects from other sources of error. While we find that age, education, and labor market status account for selection effects across modes, we do not find significant differences in the measurement of environmental attitudes and behaviors across modes once the selection effect is controlled for. Mixing online and paper modes should thus not compromise data quality by introducing measurement biases for environmental variables.

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1. Introduction

Reliable measures in surveys are crucial when assessing attitudes toward various topics of social relevance, such as the environment. Accurate data collection is essential for understanding public perceptions and behaviors. Given the growing complexity of environmental challenges and the importance of understanding the public's perceptions thereof, it is crucial to ensure that surveys employ robust methodologies, as without reliability, survey results could be skewed, leading to misinformed policies and ineffective interventions.

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One important aspect of data quality in this context is related to survey mode, and to the consequences of implementing a mixed-mode design in terms of data quality. Given the challenges that social surveys currently face, such as declining response rates (Beullens et al. 2018; Brick and Williams 2013; de Leeuw et al. 2018) and increasing costs due to more intensive fieldwork efforts (Wolf et al. 2021), it is unsurprising that many countries, including some countries within the International Social Survey Program (ISSP), have shifted away from traditional single-mode, interviewer or self-administered designs. Instead, they are adopting mixed-mode designs that combine modes, such as web and/or paper-based survey administration. While this shift has many advantages including time efficiency and cost (Couper 2000; Bethlehem and Biffignandi 2012), and addresses challenges such as declining response rates (Roberts and Vandenplas 2017), it is important to recognize that each survey mode is also susceptible to mode-specific errors and biases. These can arise from shortcomings in coverage and nonresponse (Dillman and Bowker 2001; Vannieuwenhuyze 2014), even in probability-based samples (as required by the ISSP).

As a consequence, a successful transition to a mixed-mode survey design (including a web mode) hinges on properly estimating the selection bias of the web mode compared to other survey modes (and subsequently correcting for it). In addition to estimating the mode-specific selection effect, it is essential to identify how combining modes affects measurement error in a survey. If measurement differs by mode, the compiling of the measurement errors from different sources can lead to an increase in Total Survey Error (TSE) compared to a single-mode survey. TSE is the sum of all possible sources of error that stem from the difference between the estimates drawn from the responses of a sample to a survey, and the actual values found in the population (Biemer 2010; Couper et al. 2017; Dillman 2017). To quantify the selection errors in each mode, researchers should ideally have access to reliable auxiliary data of the population that allow for the assessment of the accuracy of self-reports in the country-specific surveys against external data (the so-called "backdoor" model for estimating counterfactuals, see Vannieuwenhuyze 2014). It also helps the researcher in estimating self-selection into a mode, and at a second stage, estimating the influence of mode on the variable estimate (the so-called 'mode measurement effect') while controlling for the selection effect (Roberts and Vandenplas 2017). Researchers can make informed decisions about choosing the mode for data collection in comparative surveys like the ISSP only by thoroughly evaluating the representativeness and measurement aspects in both web and paper modes. This evaluation is essential for understanding the benefits and limitations of combining these modes and potentially transitioning toward web-based data collection.

Against this background, we assess non-response and measurement biases in web and paper modes using the ISSP 2020 data of Switzerland (CH) and Finland (FI). The countries offer a good framework for examining mode differences, since they have very similar survey designs, high Internet usage rates,[1] high-quality auxiliary register data, and most respondents filled in the web questionnaire, while about a quarter of respondents answered by paper (CH: 77% web ($N = 3298$), 23% paper ($N = 982$); FI: 75% web ($N = 848$), 25% paper ($N = 289$)). By ensuring that we compare countries with similar survey designs and contexts, such as Finland and Switzerland, we can be confident that any differences we observe in mode selection and measurement are not due to design disparities. Moreover, and as indicated before, we have the advantage of being able to

use register data from these countries as the benchmark for comparing selection bias and nonresponse by mode. Finally, by broadening the scope of analysis beyond a single-country context, we can assess mode selection and measurement effects in two populations. This extends on previous efforts that have examine mode effects in single countries only (Klausch et al. 2015; Hox et al. 2017; Roberts and Vandenplas 2017) and enhances the external validity of our research.

More concretely, in this paper, we aim to clarify two research questions: Firstly, which mode (web or paper) has a lower selection error; and secondly, how much variance can be found in the measurements of selected attitudinal variables related to the environment in the web and paper modes? We will also pay attention to country differences in assessing the mode effects. We will start by reviewing previous research on biases in mixed-mode surveys. In the second part, we discuss the ISSP data in Finland and Switzerland and analyze it from the perspective of selection and measurement differences. While we observe differences in the selection into each survey mode by the respondent's sociodemographic profile, we conclude that the push-to-web design does not provoke significant measurement differences across modes in ISSP environmental variables, once the selection effect is accounted for. We will conclude with some recommendations for mixed-mode data collection in the future.

2. Background

2.1. Web-based data collection in general population surveys

There are many advantages to web-based data collection. Web surveys are considerably less costly than most alternative modes of data collection, and web surveys can be launched quickly since little time is needed between the finalization of the questionnaire and the start of fieldwork. Thus, the web-based collected data are instantly available. Moreover, similarly to other self-administered modes, web surveys suffer less from socially desirable response bias than personal (or telephone) interviews (Heerwegh 2009; Braekman et al. 2020). However, as beneficial as they may be, web surveys, similar to other survey methods, are prone to selection errors unique to this mode, arising from limitations in coverage and nonresponse. Web surveys can suffer from under-coverage, meaning that they are unable to select everyone in a target population because not all members of that population have access to the Internet (Dillman and Bowker 2001). The risk for bias is greater in general population surveys, especially when they are cross-national (such as the ISSP) where comparability across countries and modes is essential. Even if Internet access has grown tremendously across countries and continents during the past decades, significant differences remain, notably by the sociodemographic characteristics of the respondents (Dillman and Bowker 2001; Bethlehem 2010). Web surveys are also vulnerable to self-selection, as not all respondent profiles are equally likely to answer web survey, even if they have access to it (Couper 2000)

Using multiple survey modes has been proposed as a strategy to address these challenges in single-mode (web) surveys. Mixed-mode surveys involve providing or utilizing various modes for different sample members, aiming to enhance overall coverage and decrease non-response rates compared to a single-mode survey. This approach ultimately aims to enhance the survey's external validity (Vannieuwenhuyze and Loosveldt 2013).

The alternative modes are offered as a solution to recruit members of the population who are not able, or do not want to, respond to the 'original' survey mode. In sequential mixed-mode designs, such as the 'push-to-web' design proposed by the Finnish and Swiss ISSP surveys, respondents are first offered the preferred (web) administration option before offering an alternative mode. It is different from a concurrent mixed-mode design, which entails that several modes are offered to sample members at the same time, or that some sub-groups are targeted with a specific mode in an attempt to encourage their participation (e.g., Mauz et al. 2018). By offering the web option first, respondents are encouraged to answer with the preferred (and less costly) survey mode, thus keeping the overall costs of the fieldwork lower. A major motivation behind the mixing of modes is indeed the potential of reducing the error and cost drawbacks of one mode with the error and cost advantages of the other mode(s) (De Leeuw 2005).[2]

2.2. Mixing modes: opportunities and challenges

Achieving a smooth shift from a single-mode to mixed-mode surveys requires an estimation of how the amalgamation of modes affects data quality. This evaluation is crucial, because while the blending of modes may decrease selection errors, there is a possibility that any reduction could be offset by heightened measurement errors, consequently leading to a higher TSE (Vannieuwenhuyze 2014; Roberts and Vandenplas 2017). This means that the mode-specific measurement errors are compiled and a) contribute to the TSE (and possibly increasing it as a result), and b) confound with the selection errors so that comparisons of estimates between respondents that used different modes can be compromised. Survey errors are conventionally distinguished by their sources (Andersen et al. 1979). Observational survey errors include specification, measurement, and data processing errors while non-observational errors relate to selection, and stem from sampling, coverage, and nonresponse. Measurement error occurs when there are differences in the observed value of a variable and its true, unobserved value. Coverage error emerges from biases in the probability that a member of the population is selected to participate in a survey. Non-response error emerges when a sample member does not have the possibility, or is not willing, to participate in the survey mode that is offered. In case of web surveys, non-response error can also occur when sample members discontinue their survey participation due to technical hurdles they may face when completing the survey (Bethlehem 2010). In the framework of this research, we focus on nonresponse bias among the non-observational errors, and measurement error among the observational ones.

The potential benefits of mixed-mode surveys in enhancing representativeness, saving time, and reducing costs have sparked interest among survey researchers and practitioners in recent years. Despite this, the practical implications of mixing modes on data quality have remained relatively understudied. A growing bulk of literature suggests that the mixing of modes reduces coverage and nonresponse errors compared to single-mode surveys. Sequential mixed-mode surveys starting with the web alternative tend to increase the proportion of web respondents (Holmberg et al. 2010; Tourangeau 2017). Moreover, Millar and Dillman (2011) compared sequential and concurrent web and mail surveys in the United States and found that response rates were higher when

respondents were pushed to answer the web questionnaire compared to offering both mode options concurrently. While the experiment was conducted on a highly Internet-literate population, it suggests that push-to-web surveys do at least not perform poorer in that respect than concurrent web and paper designs. In addition, as for single-mode surveys, the use of multiple reminders and cash incentives helps to attain higher response rates (Millar and Dillman 2011; Tourangeau 2017). Thus, there is mounting evidence that offering the web option as the preferred mode does at least not lower the response rates.

Regarding non-response bias, Klausch et al. (2015) found that offering the web option prior to a follow-up face-to-face interview resulted in a lower selection error in sociodemographic variables compared to alternative mixed-mode designs (telephone or postal mail prior to in-person interview). Similarly, Roberts and Vandenplas (2017) found that sequentially mixing web plus mail surveying reduced nonresponse bias across most sociodemographic variables compared to single-mode mail surveys. Nonresponse bias was also reduced in push-to-web designs compared to mixed telephone and postal mail surveys, but it was, by contrast, increased in over half of the attitudinal variables under analysis compared to the single-mode benchmark survey. Overall, however, the TSE was reduced in all mixed-mode experiments compared to the single-mode design.

As for measurement effects in mixed-mode surveys, two types of mode effects have been identified: one that shifts the distribution of responses, thereby affecting mean and variance across modes, and another one that stems from the process of interpreting and answering questions, for instance when the wording or answer scales differ across modes (Hox et al. 2015). The latter type of mode effect can be significantly reduced by minimizing differences in the way questions are asked across modes, which is the approach taken by the Finnish and Swiss ISSP surveys. Although each mode may be optimized for its own design to minimize measurement error, choosing a uni-mode questionnaire design helps mitigate measurement differences among similar individuals who respond to different modes (Tourangeau 2017). Meanwhile, mode differences in response distribution can be harder to detect and to avoid, especially if respondent selection into mode is not properly controlled for. Since different groups of respondents do not have the same propensity to self-select into a mode, measurement differences across modes are confounded by differences in sample composition. Simply put, it is difficult to disentangle between substantive differences in responses by respondent profile and between methodological differences in measurement across modes. In this respect, Klausch et al. (2013) showed that measurement reliability was higher when mixing self-administered modes (e.g. web and paper) compared to mixing interviewer and self-administration modes. Self-administered modes are less sensitive to social desirability and random response error than interviewer-administered modes. Thus, the size of the additional measurement bias in mixed mode surveys with a web option compared to a single-mode survey seemingly depends to a large extent on whether a uni-mode questionnaire design is used, and whether interviewer and self-administered modes are combined or not.

In sum, researchers must diligently evaluate the effects of mode mixing on a) the composition of the sample, and b) measurement bias in responses. To assess the former, researchers can calculate the relative difference between the characteristics of

respondents to each survey mode and those of the sampling frame. This, however, relies on access to reliable auxiliary data, such as register data, of the sampled population. To estimate the latter, one can calculate the probability of responding to each mode of survey participants based on their sociodemographic characteristics, and then compare survey responses to substantial variables while controlling for the selection effect obtained earlier.

2.3. Sociodemographic predictors of environmental attitudes, concerns, and behaviors

The current literature show that environmental attitudes, concerns, and behaviors largely depend on many sociodemographic factors such as age, gender, education, income, and place of residency, and do so independently from the influence of these background characteristics on mode selection. To understand if (and how) survey mode influences the measurement of environmental variables, it is important to disentangle this effect from the well-known influence of the respondent's sociodemographic profile. Research demonstrates that younger individuals, women, the higher educated, and economically better-off individuals adopt more pro-environmental attitudes and behaviors (Franzen and Vogl 2013; Inglehart 1995; Lee et al. 2015; Stern, Dietz and Kalof 1993). Based on these studies, education, income and, to some degree, also activity status are resources that raise awareness and enable persons to invest in and bear the costs of engaging in pro-environmental behavior, while gender differences have been explained by socio-structural and cultural factors. Age effects vary depending on whether one considers environmental attitudes and concerns, or behavior; although generally, younger people express more concern, older individuals take more pro-environmental action, and moreover it remains unclear whether the effect is due to age, time period, or cohort (Gifford and Nilsson 2014). As for urban–rural differences, traditionally urban dwellers have been thought to be more pro-environment in their attitudes and actions, due to, *inter alia,* the dependence of rural economies on natural resources; yet with the structural changes and increased awareness of recent times, the differences based on residence have started to fade out (Armstrong and Stedman 2019; Huddart-Kennedy et al. 2009). In conclusion, despite the many structural changes in modern societies and the widespread media and public policy attention dedicated to environmental issues, individuals with different socio-demographic profiles continue to have (to some extent) different sensitivities to these issues, and these differences cannot be explained by survey mode alone. In the following empirical part, we will examine how mode mixing affected selection and measurement in ISSP questions on the environment in terms of these key sociodemographic predictors of environmental attitudes, concerns, and behavior.

3. Data and methods

3.1. International Social Survey Program ISSP

The ISSP is a cross-national collaborative project conducting surveys on diverse topics relevant to the social sciences since 1984. Every year, a common questionnaire with a specific thematic focus is fielded. The environment module was fielded for the fourth

time in 2020. In addition to the module questionnaire, a set of background questions containing mainly demographic information is fielded. The ISSP is based on a nationally representative probability sample. Throughout the years, it has usually been conducted as a self-administered paper or face-to-face survey. However, data collection on the Internet has increased in recent years also within the ISSP: in the environmental module of 2020, 12 countries used web-based data collection fully or jointly with other modes, which amounts to almost half of all national surveys included in the cross-national dataset (28 countries).

3.2. Survey design

As mentioned earlier, both the Finnish and the Swiss ISSP 2020 surveys had similar response rates and designs in terms of sampling, survey modes, and use of incentives (see Table 1). Notably, both countries used sequential mixed-mode web plus paper ('push-to-web') design in their data collection that resulted in similar proportions of web versus paper responses. In addition, both countries drew their samples from national registers among any nationals residing in the country. To encourage participation, incentives were offered to participants: in Finland, participation in a lottery was offered, while the Swiss study offered unconditionally prepaid incentives through the choice between a cash or voucher reward. The Finnish and Swiss data collections also had some differences in their designs. The ISSP questionnaire was fielded as a part of a larger national survey in Switzerland (MOSAiCH survey[3]), while it was a stand-alone survey in Finland. The sample was stratified in Switzerland by using a random procedure inside each of the seven NUTS 2-Swiss regions, whereas in Finland, stratification was made by age and municipality. Moreover, the Finnish sample includes persons aged 15–74, while the Swiss sample was drawn among adult citizens with no upper age limit. In order to preserve comparability across the populations, we will only consider adult respondents up to 74 years old in both countries for our analyses.

3.3. Field work

The phases of contact during the fieldwork were similar in the Swiss and Finnish ISSP 2020 surveys (see Figure 1). Postal mail was used as the initial mode of contact, and respondents were invited to answer the survey on the web, on a computer browser or

Table 1. Survey design and outcomes (CH, FI).

	ISSP 2020 Finland	ISSP 2020 Switzerland
Part of larger survey?	No	Yes
Sample population	Residents aged 15–74, any nationality	Residents 18+ years, any nationality
Household	Private only	Private only
Sample source	National register	National register
Stratification	By age and municipality	Regional (7 NUTS-regions)
Field work	21.9.2022–22.12.2022	21.2.2020–13.7.2020
Modes	Web (75%) Paper (25%)	Web (77%) Paper (23%)
Incentives	Yes, lottery	Yes, cash or voucher (10 Swiss CHF)
Gross sample size	2800	10152
Valid interviews	1137	4280
Response rate	41%	42%

Sources: ISSP 2020 Technical reports.

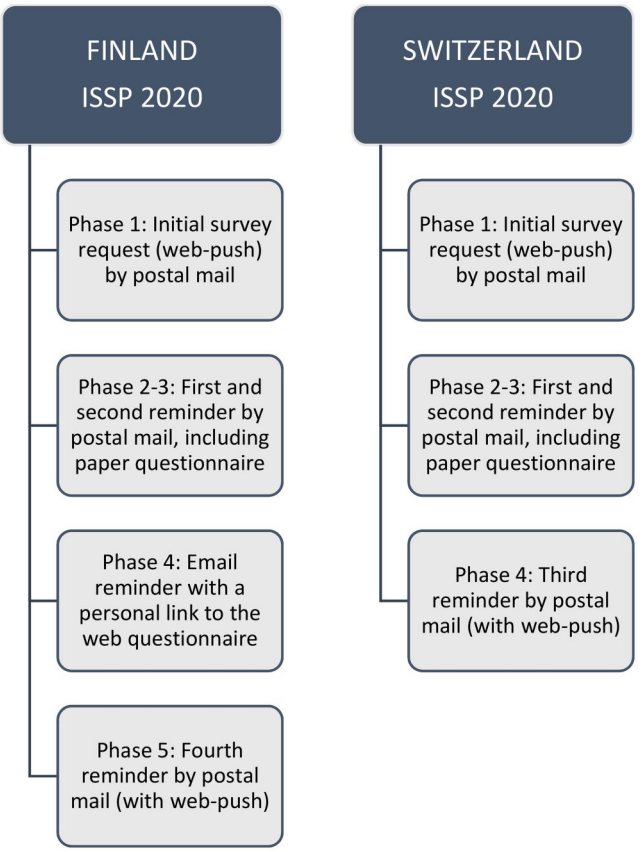

Figure 1. Overview of field work in ISSP Finland and Switzerland. *Sources*: ISSP 2020 Technical reports.

on their mobile phone. The mixing of contact and response modes has been suggested as a way to legitimize the mode of response, and thereby improve the response rates (Dillman and Edwards 2016). In both countries, up to two reminder letters were sent including a paper questionnaire as the alternatively offered mode. The Swiss and the Finnish fieldwork sequences differed slightly, however, after the second reminder in the third contact attempt. The Swiss study used the letter contact mode exclusively, while in Finland, the third contact attempt was done by email. Yet, the final contact attempt is again identical in both countries, with a web-push attempt by postal mail. Altogether, the Finnish recruitment strategy, which included an additional outreach by email, consisted of up to five reminders, while the Swiss survey sent out four reminders at most. In other aspects, the contact and data collection process were nearly identical across the countries.

3.4. Analytical strategy

We use selected environmental and sociodemographic variables to assess measurement and selection biases in the Finnish and Swiss ISSP 2020 data (see Table 2). To assess selection effects, we analyze the socio-demographic attributes of survey respondents

Table 2. ISSP 2020 variables and their measurements.

Variable name	Label	Measurement
Environmental attitudes, concerns, and behavior		
Q9a	Impact of climate change for the world	(scale reversed) 1 = extremely good ....10 = extremely bad
Q6	Concerns about environmental issues	1 = not at all concerned ... 5 = very concerned
Q10a	Belief in science for solving environmental problems	1 = agree strongly ... 5 = disagree strongly
Q19a	R's environmental behavior: sort glass for recycling	(scale reversed) 1 = Never ... 4 = Always
Q19b	R's environmental behavior: avoid buying certain products	(scale reversed) 1 = Never ... 4 = Always
Sociodemographic information		
SEX	Sex of respondent	0 = Male 1 = Female
AGE	Age of respondent	Recoded into age-groups; 18-34 years; 35–64 years; 65+ years
EDULEVEL	Education level (ISCED 2011)	Recoded into: 1 = basic education 2 = upper secondary 3 = tertiary education
MAINSTAT	Employment status	Recoded into: 1 = in employment 2 = unemployed 3 = not in labor force
MAINSTAT	Employment status, detailed	Recoded into: 1 = in employment 2 = unemployed 3 = in education, training or military service 4= not in labor force (various reasons)
URBRURAL	Urban-rural residence	1 = rural 0 = urban
nat_INC	Household income, country-specific relative position	1 = median income or higher 0 = below median income

across both modes and compare them to the true population values obtained from national registers. Specifically, we calculate the Absolute Relative Bias (ARB) within each mode and for the entire sample across different population groups based on age, sex, education level, and employment status. The ARB divides the absolute bias by the value of the population, to account for relative differences in the distributions. For instance, a difference of 5 percentage points in a category that accounts for 60% in the population is a smaller bias than a difference of 5 percentage points in a category that accounts for 10%. Put differently, the ARB expresses the difference of the sample in percentages of the value in the population (Eckman 2016; Ochsner 2021), and can take values from −1 to 1 (with a value of 0 indicating no bias). As a second step, we assess mode selection effects in a multivariate setting by estimating the likelihood of selection of survey respondents into the web-mode while controlling for an extended set of respondent characteristics: age, sex, education, main activity status, residence, and income. Estimating the selection effect into survey mode is essential for the next stage of the analyses: to assess mode measurement effects across environmental variables. We estimate responses in selected environmental attitudes, concerns, and behaviors in each mode while controlling for the background characteristics listed above, and the probability of ending up in the web mode (i.e. the selection effect) obtained in the multivariate previous analyses. We aim to detect whether the distribution of responses significantly differ by mode, net of the selection effect. Additional sensitivity analyses were also carried out to confirm the mode measurement tendencies found across the web and paper samples (see Chapter 4.4). The chosen module-specific variables (Environment IV) relate to different aspects of environmental issues that are reflected in people's attitudes, perceptions, and behaviors.

4. Results and discussion

4.1. Preliminary analyses: selection biases by population group and mode

Figures 2(a and b) illustrate the ARB by survey mode and in the full sample, separately for both countries. We find that some population groups are underrepresented in both surveys and modes: these are the youngest and the less educated respondents, as well as those who are active in the labor market (employed respondents in Switzerland, also the unemployed jobseekers). These findings align with the widely recognized

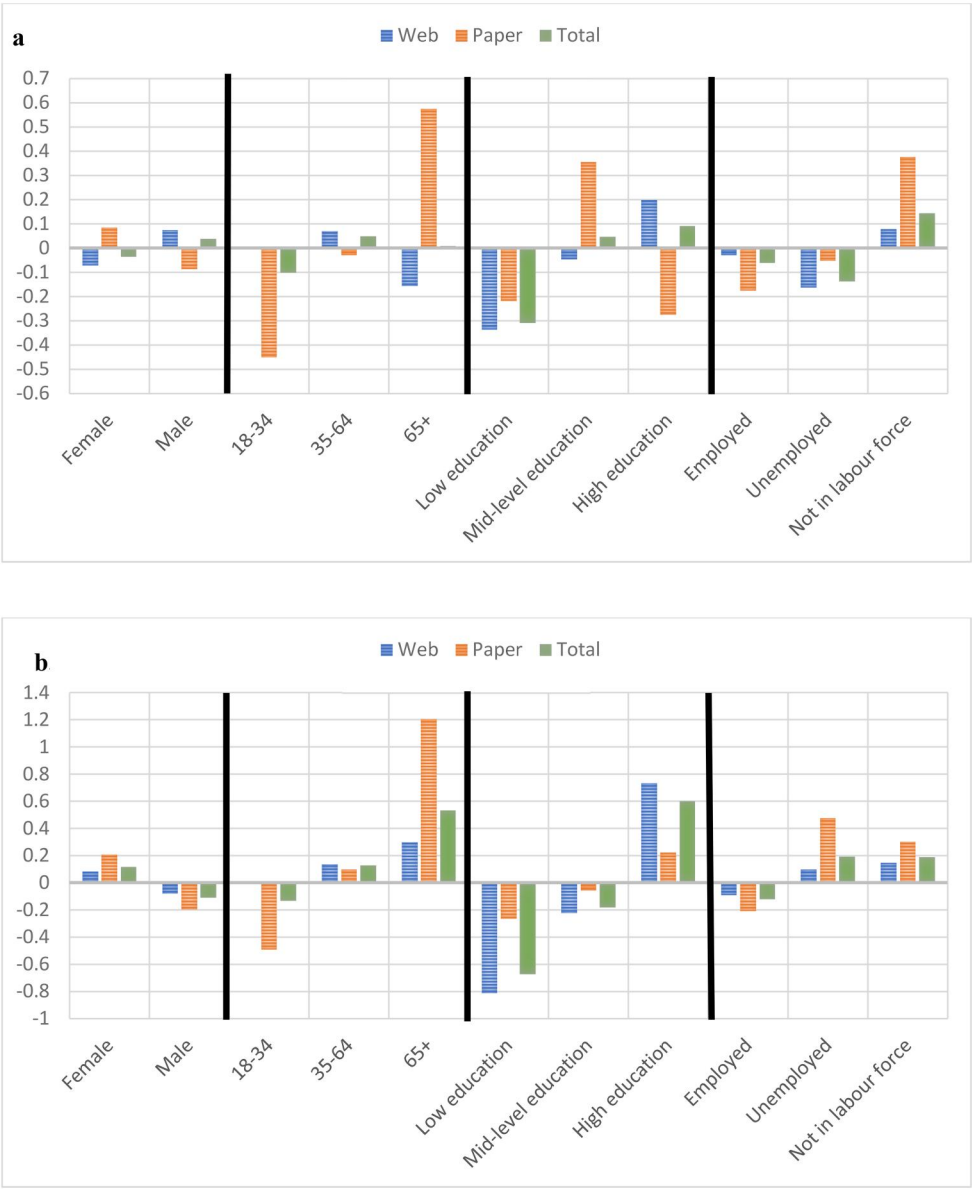

Figure 2. (a) ARB by participant background: ISSP 2020 Switzerland. (b) ARB by participant background. ISSP 2020 Finland.

phenomenon that surveys tend to attract fewer respondents from younger age groups and individuals with lower levels of education (Nicoletti and Buck 2004; Groves and Couper 2012). The overrepresentation of populations outside the labor force could be explained by the strong presence of retired respondents in this category, as retirement could mean more time available to dedicate to survey participation. Concurrently, retirement coincides with older age and possibly a stronger civic duty to participate in surveys (Groves and Couper 2012). Mode-specific trends in ARB are also apparent, as younger respondents are underrepresented in the paper mode, while the higher educated are overrepresented in the web mode. Concomitant with expectations, age, education, and labor market status account for selection into mode, with each mode attracting certain respondent groups over others. Meanwhile, gender differences in response across modes are small. As for the gross differences between the modes, we generally find higher ARB in the paper mode compared to the web mode. Meanwhile, these differences may relate to the push-to-web design, the lower effect size (N) and the resulting larger variation in the paper respondent group.

In sum, the mixed-mode designs implemented in the Finnish and Swiss ISSP 2020 surveys seem to effectively mitigate potential biases in survey participation compared to single-mode designs. Nonetheless, push-to-web designs still face challenges in adequately capturing responses from younger and less educated populations, despite providing respondents with alternative survey modes. Consequently, while the integration of multiple modes helps to reduce non-response biases, it does not entirely eliminate them. A full overview of the ARB among respondents by survey and separated by mode is available in Online Appendix OA1.

4.2. Selection into the web-mode in ISSP 2020

Before examining mode measurement effects in environmental variables, we estimate the likelihood of selecting into the web mode compared to the paper mode, as predicted by the sociodemographic characteristics of the respondents (see Figure 3, and Online Appendix OA2 for full results). The predictions follow the general patterns regarding mode selection found earlier in the ARB-analyses. Younger respondents and highly educated respondents have a higher likelihood of responding on the web, while the older age groups and respondents with lower education tend to opt for the paper questionnaire. Same conclusions have been made in earlier research on mode selection (Bethlehem 2010; Dillman and Edwards 2016). When it comes to employment status, in Figure 3, we rely on more refined self-reports about respondents' main activity (by contrast to earlier analyses where we compared the labor market status of survey respondents with true population values). Notably, it shows that being outside of the labor market due to enrollment in education, training programs, or military service, significantly and positively associated with a web response in Switzerland. This is probably because most of these respondents belong to the younger age groups that are more likely to respond to the web questionnaire. In addition, income and gender show country-specific patterns. High income is only associated with more web responses in Switzerland, and Swiss women are still less likely to respond with the web mode than men. We speculate that these differences could relate to non-use of the Internet still

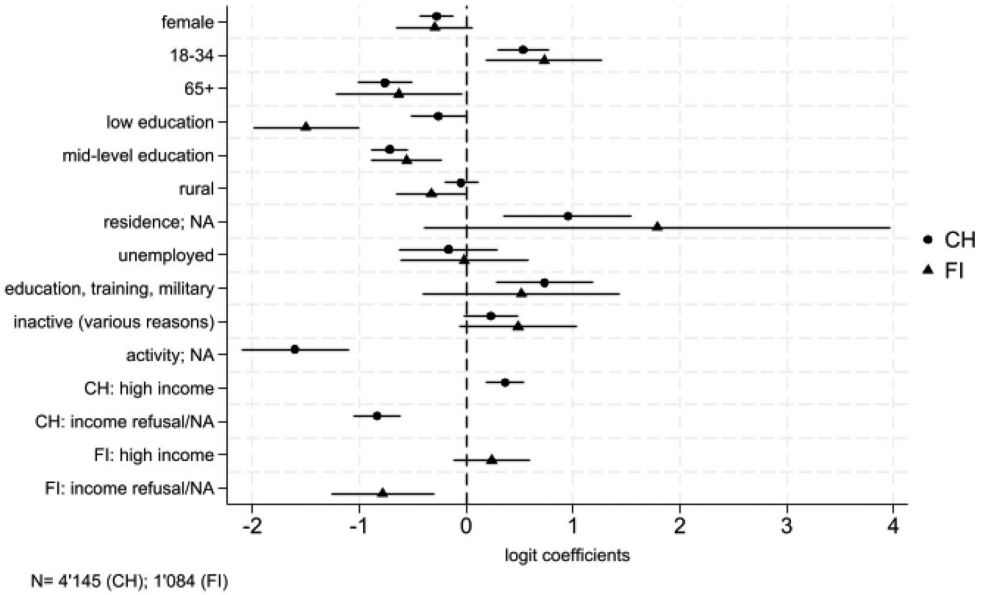

Figure 3. Likelihood of responding by web, by country. *Note*: NA = no answer. Spikes are 95% confidence intervals. Reference categories: age 35–64 years; high education; urban residence; paid employment; lower than median income.

being more widespread among Swiss older women and lower-income groups, compared to the same population groups in Finland, a country that tops rankings on gender and income equality, and that pioneered in the use of digital technologies in public institutions. Finally, our observation indicates that rural respondents do not exhibit a significantly lower likelihood than urban dwellers in responding to the web questionnaire. This observation reflects the extensive Internet coverage and usage rates present in both countries, even within rural areas.

4.3. Mode measurement effects in environmental variables

Having obtained the probability of (self-)selection into mode in earlier analyses, we use this estimation to assess how survey mode affects the measurement of environmental attitudes, concerns, and behavior (see Figures 4–8 and Online Appendix OA3 for full results). The figures display the regression estimates for the predicted environmental attitudes, concerns, and behaviors across the paper and web subsamples, separately for the two countries. Importantly, the models control for the probability of selection into mode, allowing us to test whether the measurement of environmental variables really differs across modes once the selection effect is accounted for. In other words, by controlling for mode selection, we ensure that any mode measurement differences are not confounded by the mode selection differences investigated earlier.

The analyses of the five aspects of environmental attitudes and behaviors show a consistent pattern, with only minor, and in some cases negligible, differences in the measures between web and paper modes. This is supported by the overlapping confidence intervals of the coefficients (predictors) across the web and paper samples. In our

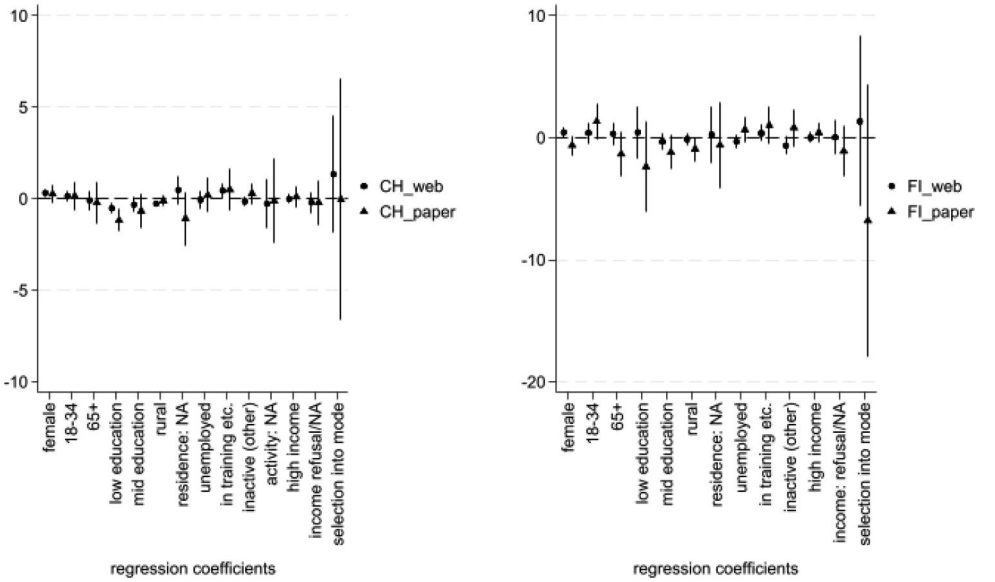

Figure 4. Prediction of climate change attitudes, by country and mode, ISSP 2020. *Note:* $N = 3{,}119$ (web) 899 (paper) in Switzerland; $N = 777$ (web) 263 (paper) in Finland. NA = no answer. Spikes are 95% confidence intervals. Reference categories: age 35–64 years; high education; urban residence; paid employment; lower than median income.

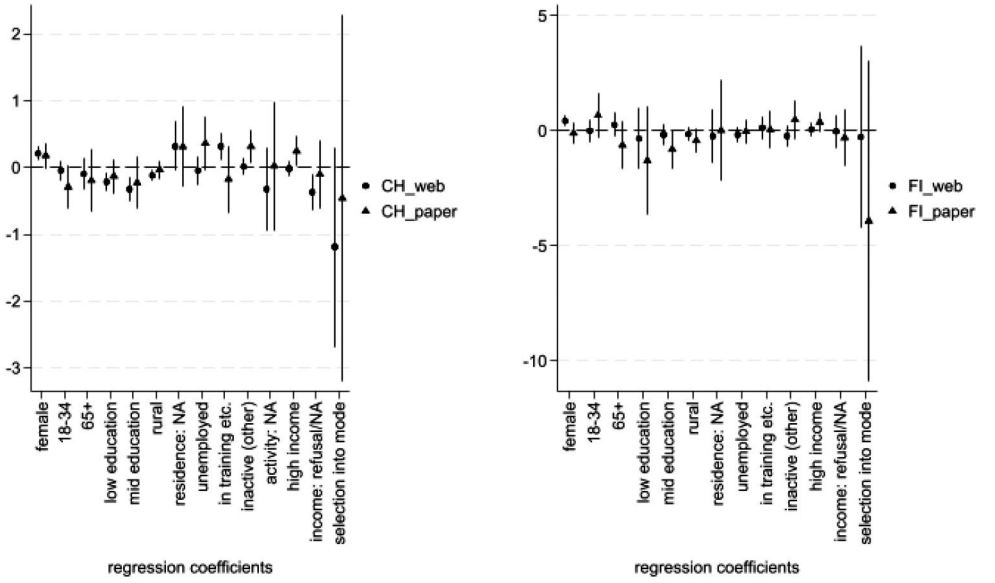

Figure 5. Prediction of environmental concerns, by country and mode, ISSP 2020. *Note*: $N = 3{,}183$ (web) 939 (paper) in Switzerland; $N = 787$ (web) 271 (paper) in Finland. NA = no answer. Spikes are 95% confidence intervals. Reference categories: age 35–64 years; high education; urban residence; paid employment; lower than median income.

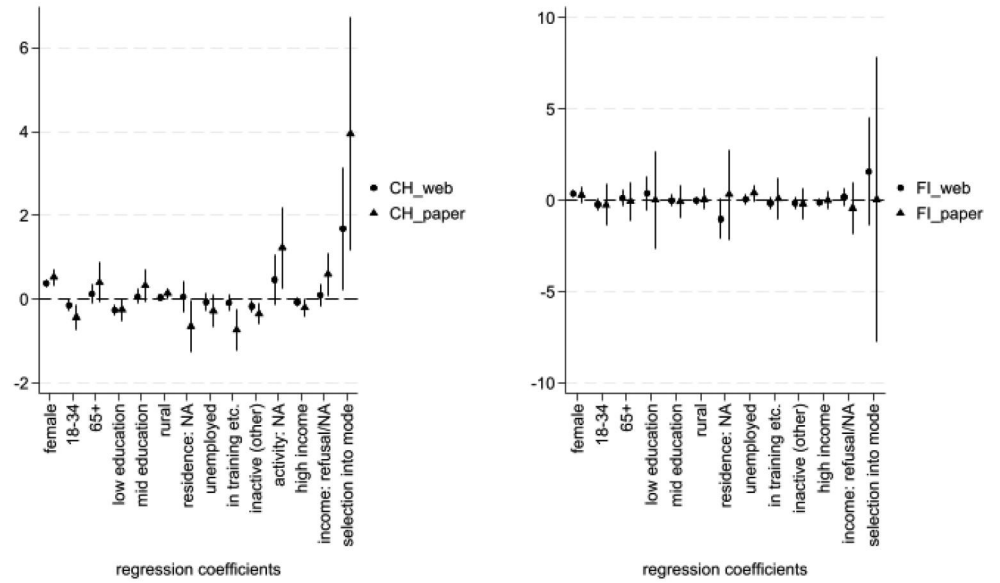

Figure 6. Prediction of belief in science for solving environmental problems, by country and mode, ISSP 2020. *Note:* N = 3,152 (web) 909 (paper) in Switzerland; *N* = 783 (web) 261 (paper) in Finland. NA = no answer. Spikes are 95% confidence intervals. Reference categories: age 35–64 years; high education; urban residence; paid employment; lower than median income.

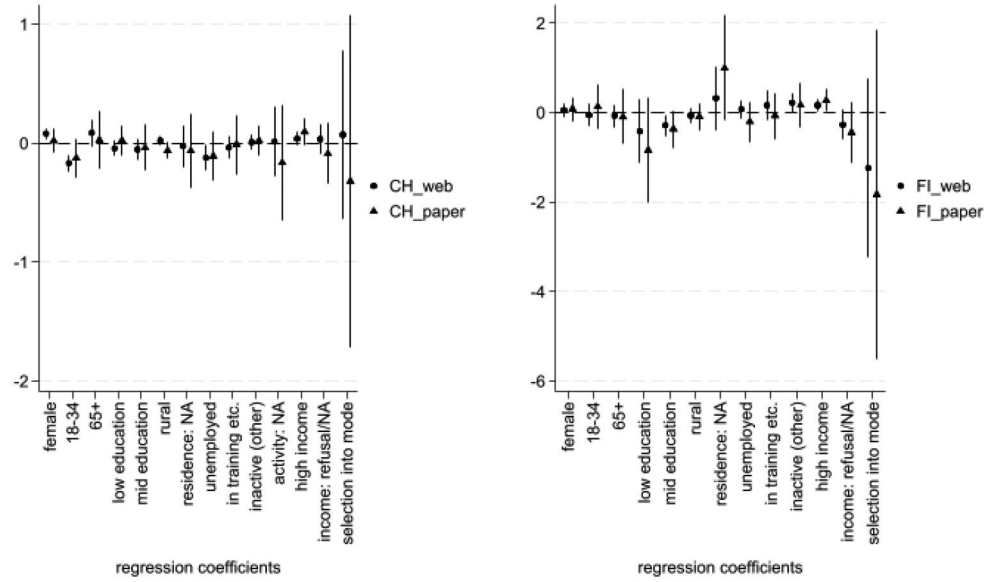

Figure 7. Prediction of recycling behavior, by country and mode, ISSP 2020. *Note:* *N* = 3,188 (web) 922 (paper) in Switzerland; *N* = 794 (web) 275 (paper) in Finland. NA = no answer. Spikes are 95% confidence intervals. Reference categories: age 35–64 years; high education; urban residence; paid employment; lower than median income.

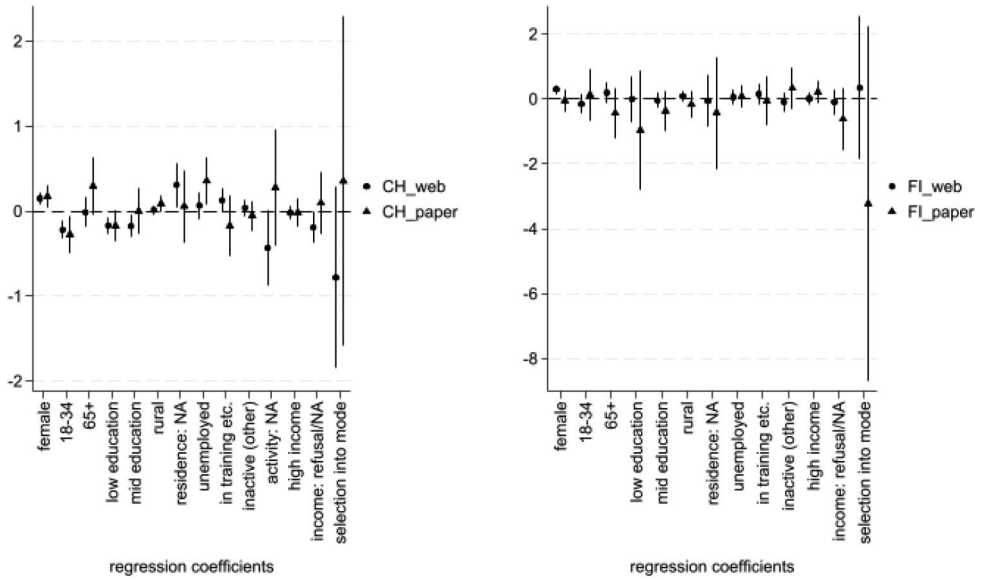

Figure 8. Prediction of consumption behavior, by country and mode, ISSP 2020. *Note:* $N = 3{,}193$ (web) 922 (paper) in Switzerland; $N = 798$ (web) 273 (paper) in Finland. NA = no answer. Spikes are 95% confidence intervals. Reference categories: age 35–64 years; high education; urban residence; paid employment; lower than median income.

analysis, we find tendencies of (non-significant) mode measurement differences in the associations between predictors and outcomes for a few key demographic variables. These variables, including respondent gender, education, and type of main activity, were also identified as sensitive to mode differences in earlier analyses on selection. Specifically, for belief in science for solving environmental problems (Figure 6), environmental concerns (Figure 5), and the impact of climate change (Figure 4), gender is the only variable that shows weak mode measurement differences in both Finland and Switzerland. Education and type of activity, on the other hand, show different patterns only in the Swiss data. For environmental behaviors, the same variables show similar (non-significant) patterns across modes. While gender predicts recycling behavior in Switzerland (Figure 7), and consumption behavior in Finland (Figure 8), the influence of gender does not significantly differ between the web and the paper samples for the two behaviors. Moreover, age and education predict recycling and consumption behaviors only in Switzerland (and mode differences remain non-significant). Meanwhile, we observe strong multicollinearity in the Finnish paper sample, influencing the effect of (low) education in the Finnish data (see OA6). In this regard, it is noteworthy that the low educated group in the Finnish paper sample is particularly small ($N = 46$). As a result, the education coefficient is likely to be less stable in this sample, and readers should be cautious when interpreting the substantive effect of education on measurement in the Finnish data.

To conclude, while different tendencies emerge regarding the associations of key demographic predictors with environmental outcomes of interest in the web and paper samples, the differences between the modes are not statistically significant. Additionally, in all the regression analyses on environmental outcomes by sociodemographic predictors (OA3),

the control variable that assesses selection into mode is never statistically significant. Therefore, the real effect of these different patterns of associations should be contextualized, as the confidence intervals of the web and paper estimates overlap for the sociodemographic characteristics under consideration. In other words, there is minimal evidence of increased measurement error resulting from mixing of modes in the 2020 ISSP Finnish and Swiss surveys. At least based on the Finnish and Swiss experience, examining environmental attitudes, concerns, and behaviors in the ISSP 2020 push-to-web surveys will not substantially differ between the modes once the different probability of selection into the survey mode is taken into account. This is reassuring for researchers concerned that mixing web and paper modes might compromise measurement equivalence and the ability to obtain reliable estimates of respondent attitudes and behaviors. Clearly, in the Finnish and Swiss push-to-web experiences, mode measurement effects are minor to inexistent, and the different survey administration strategies will not alter the substantive conclusions drawn from using the ISSP Environment IV data to study the environmental attitudes and behaviors of the population.

4.4. Additional analyses

Using a split-sample approach to test mode measurement effects is sensitive to sample size. This is especially relevant to consider in surveys where respondents were "pushed" to answer the web questionnaire, leading to more web than paper responses in the survey, and consequently, more variation in the paper sample. An alternative way to test mode measurement differences is by analyzing the full sample and interacting the predictors with the response mode (see Online Appendix OA4). The analyses reveal very few cases where survey mode moderates the relationship between the respondent's sociodemographic profile and their environmental opinions. The older, unemployed, and high-income respondents on the web tend to report less concern for the environment, and low-educated respondents report fewer negative perceptions about climate change, especially on the web. Yet overall, significant interactions between survey mode and key sociodemographic predictors (net of the mode selection effect) in relation to environmental variables are limited and restricted to particular variables and respondent groups. Nonetheless, these results underline the importance of always controlling for survey mode when researchers compare environmental attitudes and behaviors between respondent groups in mixed-mode surveys.

In previous analyses, we tested mode measurement differences in environmental variables and confirmed the absence of substantial mode measurement effects. To assess if the same conclusions hold for variables from other domains, we test mode measurement differences in selected core ISSP social and political variables, including Top-Bottom self-placement, trust in national Parliament, social trust, and redistribution attitudes (see Online Appendix OA5). We find that the results for these variables follow similar patterns as the environmental variables. While mainly education and the type of main activity (but also gender and income for redistribution attitudes) show certain mode-specific tendencies, these differences do not cross the threshold of statistical significance. In short, mode measurement differences are weak whether we consider environmental variables or other respondent attitudes in the ISSP 2020 data. Although

our research focuses solely on environmental variables, this finding remains significant and suggests that mode measurement effects may not be specific to particular topics. Therefore, they may also be minimal in other domains, such as political and social attitudes. This challenges the idea of 'heterogeneous mode effects' (Liedl and Steiber 2023), which have been observed notably when comparing interviewer-led modes with self-completion. It appears that concerns about mode measurement effects across attitudinal and behavioral variables may be less pronounced when mixing self-administered modes, provided that appropriate precautions are taken in the analysis (i.e., controlling for selection effects).

5. Conclusions

This research has examined selection and mode measurement effects in two 2020 ISSP surveys with a similar push-to-web design: Finland and Switzerland. By assessing selection bias and mode measurement differences in environmental variables in the Finnish and Swiss contributions to the ISSP 2020, two main conclusions can be drawn. Firstly, we have found that each mode attracts certain respondent groups over others, which highlights the importance of offering the alternative mode in sequential mixed-mode designs (in this case, the paper option), as a way to compensate for the shortcomings of coverage in the principal mode of data collection (in this case, the web mode). Education, age, and labor market status emerge as the crucial variables that differ in coverage by mode and would strongly benefit from a mixed-mode (web and paper) design as opposed to offering one mode only. In Switzerland, non-response bias among women and low-income earners also decreases from combining web and paper modes in data collection. These differences highlight the strong potential of push-to-web surveys in offering high-quality data collection at a lower cost than other survey modes, without neglecting the benefit of the paper mode in improving coverage and decreasing non-response. Second, while conducting a mixed-mode survey could potentially compromise measurement equivalence across the modes, we find little evidence of substantial differences in the measurement of a range of environmental variables, once the mode selection effect is properly controlled for. Most of the differences in environmental attitudes, concerns and behaviors vary by respondent characteristics, but not by the mode of administration. This is encouraging news for ISSP data users conducting research with the ISSP environmental variables, and likely also for other attitudinal and behavioral variables, as the substantial results of their research seem not to be confounded by additional error from mixing modes. It remains, however, advisable to be cautious before concluding that mode measurement effects should not be substantial in any survey context. Researchers who are concerned about potential mode measurement effects in variables collected with mixed-mode surveys should strive to compare data collections with similar design across modes.

In the Finnish and Swiss ISSP 2020 surveys, respondents were offered the paper option only at later stages of the fieldwork (with a reminder). Nevertheless, in principle respondents self-selected into their preferred mode, which could be argued to lead to biases in the estimates. Hence, it is prudent to approach comparisons between the representativeness of web and paper samples with caution when juxtaposed against the sample frame. However, ISSP data collections implement measures to counteract biases resulting from self-selection.

For instance, they utilize probability sampling during recruitment, enabling researchers to maintain control over the process and mitigate potential biases. Nevertheless, the potential of using experimental frameworks for testing mode selection differences should be explored as a future avenue of research. Another limitation of our research is the lack of information on mode preferences or experiences that would allow us to explore additional covariates to estimate mode selection effects and, consequently, entirely meet the assumption that the sociodemographic characteristics that we use in the analyses fully capture the mode selection effect (Vannieuwenhuyze et al. 2014). In this regard, future research should, whenever possible, explore the potential of using both back- and front-door modeling to assess mode selection (and the following measurement) biases.

Despite the limitations, our study indicates that push-to-web data collection is a promising avenue for future ISSP data collections. This approach offers a potential means of upholding the ISSP's high-quality standards while accommodating the evolving survey landscape marked by declining response rates, resource constraints, and shifts in respondent behaviors. However, the benefit of mixed-mode (web and paper) surveys hinges on the possibility to estimate the mode selection effect and account for it in analyses of relationships between variables. Once the selection effect is controlled for, the mixing of modes bears very little influence on the measurement of environmental variables and their substantial relationships with respondent characteristics. Researchers interested in exploring the environmental attitudes, concerns and behaviors of the population by using the push-to-web ISSP 2020 data can remain confident that these data collections continue to adhere to the high quality-standards that the ISSP survey is known for.

Notes

1. Internet use: Finland 93%, Switzerland 96%, according to the International Telecommunication Union (ITU 2022).
2. Nevertheless, incorporating an additional mode incurs fixed costs that directly impact the overall expenses of the survey. For instance, the switch to web surveying entails the development and implementation of the IT infrastructure, whose costs will add to the (cheaper) variable cost of web surveys (Vannieuwenhuyze 2014).
3. MOSAiCH is the 'Measurement and Observation of Social Attitudes in Switzerland' survey that has, since 2005, focused on the Swiss population's values and attitudes toward a wide range of social issues.

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Informed consent of human participants

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