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A research note on the potential impact of panel attrition on the relationship between variables

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FORS Working Paper 01-2018

Lausanne, December 2018

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How to cite this document:
Voorpostel, M., Rothenbühler, M., Roberts, C., and Vandenplas, C. (2018). A research note on the potential impact of panel attrition on the relationship between variables. *FORS Working Paper Series, paper 2018-1*. Lausanne: FORS. DOI: 10.24440/FWP-2018-00001

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Acknowledgements
This study has been realized using the data collected by the Swiss Household Panel (SHP), which is based at the Swiss Centre of Expertise in the Social Sciences FORS. The project is supported by the Swiss National Science Foundation.

ISSN 1663-523x (online), DOI: 10.24440/FWP-2018-00001

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SUMMARY

Much research on nonresponse and attrition is concerned with estimating the effect nonresponse has on point estimates. Most substantive research, however, aims to draw conclusions on relationships between variables. How nonresponse and attrition affect relationships between variables has received only marginal attention in the literature. Using data from the Swiss Household Panel (SHP), this study examines the extent to which attrition affects the parameters of multiple regression equations. By comparing models run on the full sample from the first wave of the SHP to the subsample that will continue to participate and the subsample that will drop out in later waves, we assess how coefficients from OLS regressions are affected by the selectiveness of the sample. Our models relating to two well-researched topics, time spent on housework and political participation, produce comparable coefficients for the full sample and the two subsamples in terms of signs and significance, although one coefficient in the model on housework differed significantly in size. Implications for cross-sectional analyses of longitudinal data are discussed.

Keywords: panel study, attrition, nonresponse, bias, OLS regression, covariance

1. INTRODUCTION

Longitudinal data are indispensable to study changes over time. Yet, a major drawback of longitudinal studies is that they not only suffer from unit nonresponse in their first wave of data collection like cross-sectional surveys, but also from attrition from one wave to the next. Dropout from panel surveys decreases the sample size and as a result leads to less precise estimates. A more serious concern is that nonresponse and attrition can potentially lead to bias in survey estimates, causing them to be systematically higher or lower than the true population values of interest. Moreover, longitudinal analyses are based on those respondents who continue to participate in the study, making the analytical sample potentially more selective the longer the life of the panel. This leaves analysts with a persistent threat to the validity of their conclusions. Panel surveys usually provide adjustment weights designed to correct for bias following from attrition, but often the bias cannot be completely corrected (Kreuter et al. 2010).

Most studies on nonresponse and attrition bias focus on the bias in first-order moments, such as in means and proportions (Groves 2006; Sciarini & Goldberg 2016). Systematic error of this nature arises where respondents to the survey differ significantly on a variable of interest from nonrespondents (Stoop 2005), and where this variable correlates with other variables that influence a person's ability or willingness to participate in a survey (or a given survey wave) (Bethlehem 2002; Groves, Presser, & Dipko 2004). Yet much social scientific research using survey data focuses on relationships between variables rather than first-order moments. The extent to which selective attrition affects the relationship between variables has, however, not received much research attention (but see for example, Heggestad, Rogelberg, Goh, & Oswald 2015). Given the popularity of longitudinal data in the social sciences, research into the effects of attrition on conclusions drawn from studies based on them is badly needed. If attrition does affect the relationship between variables, analysts need to be aware that selection effects may have an impact on the development of social scientific theory.

In the present study, we investigate the extent to which attrition in the Swiss Household Panel (SHP) affects the relationship between variables and assess the implications this may have for conclusions drawn from multivariable analyses. We do this by estimating the parameters of OLS multiple regression equations based on all respondents who participated in the first wave in 1999, and comparing them to estimates based on the subsample of respondents still present in 2014 and the subsample that dropped out.

Our study is informative for substantive research using longitudinal data for cross-sectional analysis, which is a common use of such data. In cross-sectional surveys there is only limited information available about nonrespondents. With panel data, we can use the responses to the first wave and compare respondents to later dropouts to get some insight into the ways in which survey nonrespondents differ on substantive variables, and how these variables relate to socio-demographic characteristics. Although we focus on cross-sectional analyses of longitudinal data, our study advances our understanding of the implications of attrition for longitudinal analyses to the extent that it provides insight into the possible selectivity of the part of the sample that is available for such research: the respondents who remain in the panel for a longer period. Our study will help to understand

how the selectivity of the group of loyal panel respondents affects conclusions about relationships between variables at a given point in time. We replicate two well-researched models: one explaining women's time spent on housework and one explaining political participation. These models have been well-documented in the literature, and produce findings that have been shown to be relatively stable over time.

2. BACKGROUND

2.1 SURVEY NONRESPONSE AND ATTRITION: IMPLICATIONS FOR FIRST-ORDER MOMENTS

Nonresponse in surveys is problematic insofar as it is not the result of a random process. Researchers typically rely on survey response rates as indicators of the risk of nonresponse error, but response rates in themselves provide no indication as to whether nonresponse is non-random, and, therefore, likely to bias estimates. Biased estimates occur when variables affecting the likelihood of participating in a survey (e.g. factors relating to contactability such as being employed, or factors such as interest in the survey topic (Stoop 2005)) are correlated with questionnaire variables. As a result, the extent to which nonresponse and attrition cause bias in estimates varies not only from survey to survey, but also within surveys across variables (Groves 2006; Peytcheva & Groves 2009). Lower response rates do not necessarily imply more bias (Keeter, Miller, Kohut, Groves, & Presser 2000; Peytcheva & Groves 2009) and measures to increase response rates do not always decrease bias (Curtin, Presser, & Singer 2000). If nonresponse is not random – i.e. if there are systematic differences between respondents and nonrespondents – this will be reflected in survey (point) estimates that are either positively or negatively biased compared with the true population value (Groves 1989; Groves & Couper 1998).

The correlates of survey participation or nonparticipation – whether stemming from noncontact or refusal – have been subject to many studies in recent years. In cross-sectional surveys, one generally finds that respondents and nonrespondents differ in relation to household composition, age, social integration, ethnicity, education of sample members, and whether they live in an urban or rural area (Abraham, Maitland, & Bianchi 2006; Groves & Couper 1998; Lynn & Clarke 2002; Stoop 2005). Respondents who drop out from longitudinal studies often share the same characteristics as nonrespondents in cross-sectional studies (Behr, Bellgardt, & Rendtel 2005; Gray, Campanelli, Deepchand, & Prescott-Clarke 1996; Lipps 2009; Uhrig 2008). Like all panel surveys, also the dataset used in this study, the Swiss Household Panel, suffers from nonresponse in its initial wave, as well as attrition between waves. In line with attrition studies based on other surveys (Fitzgerald, Gottschalk, & Moffitt 1998a; Watson 2003; Watson & Wooden 2009), research finds statistically significant differences between respondents participating in the SHP for a longer period and those participating only for the first or a few waves. Specifically, respondents of the SHP who have participated in every wave are more likely to be female, older, married, better educated and home owners. This selective group has mean scores on survey variables that differ from those who dropped out of the study at earlier waves, and hence from the mean of the total sample; they display higher levels of trust, more political

interest and better health (Voorpostel 2010). Hence, first-order moments based on the attrited sample are somewhat biased for certain survey variables in the SHP.[1]

2.2 SURVEY NONRESPONSE AND ATTRITION: IMPLICATIONS FOR THE ASSOCIATION BETWEEN VARIABLES

Compared with studies of the effect of selective nonresponse on proportions and mean parameters, few studies have focused on the effects of nonresponse and attrition on multivariate distribution parameters such as covariances, which are sufficient statistics for a number of parameters widely used in multivariable analyses, including correlations, regression coefficients, and factor loadings (Vannieuwenhuyze 2015). One reason behind this lacuna may be an assumption that even if nonresponse results in a shift in the distribution of a variable (which could cause differences in means between response and population values), it will not necessarily affect how this variable correlates with other variables. Indeed, the few existing studies in this domain suggest that covariances are generally less likely to be affected than means (Gerrits, Van Den Oord, & Voogt 2001; Norris 1987) and that any observed effects are weak (Fitzgerald, et al. 1998a; Goudy 1976). However, if selective attrition affects the presence or absence of outliers in the data, or seriously skews the distribution of a variable, it could affect higher-order moments (Vannieuwenhuyze 2015), and hence, the results of regression and other multivariate techniques.

As explained, mean and proportion parameters can be biased by nonresponse when there is a relationship between response propensity and a survey variable. Two alternative causal models could result in such a relationship – either a direct correlation between the survey variable and the likelihood to respond (the 'survey variable cause model'), or an indirect correlation via a common cause (the 'common cause model'), where a third variable jointly causes participation and the response to survey variables (Groves 2006). For example, if being interested in politics positively influences participation in an election survey, as well as the likelihood to vote, this would lead to the survey data overestimating voter turnout in the population (Sciarini & Goldberg 2016).

To better understand how survey non-response may affect the relationship between variables, we focus on a third source of bias: endogenous selection bias (Elwert & Winship 2014). Endogenous selection bias emerges if the dependent and independent variables, x and y, both influence a third variable, z, known as a collider variable. Conditioning on z would affect the association found between the two variables of interest. Translated to survey non-response, survey participation is the collider variable z, and only analysing respondents to the survey is a form of conditioning on z. If, for example, a higher educational attainment and more political participation separately increase the likelihood to participate in surveys, one might find a different relationship between educational attainment and political interest when only respondents are analysed than if we would have information from the nonrespondents as well. Figure 1 illustrates endogenous selection bias with E standing for level of education, P for political participation and S for survey participation.

[1]The use of weights reduces this bias in estimates based on data from later panel waves.

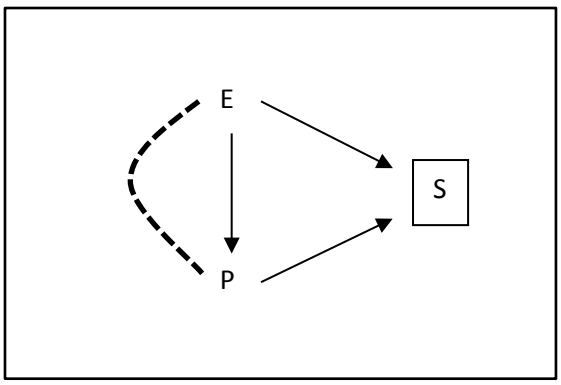

Figure 1. Conditioning on a collidervariable

Figures 2a and 2b further illustrate the idea. If x affects response propensity, where x could be for example years of education (which, as mentioned, is a significant predictor of attrition from the SHP), then if observations for low scores on education are missing (observations within the red circle), the relationship between education and y, say political participation remains unchanged, if political participation is unaffected by attrition among panel members with low education. If, however, both x and y affect response propensity, then the observed relationship between those variables could be affected. This is depicted in Figure 1b: within lower levels of education those with low levels of political participation are especially likely to drop out, and as a result, the slope of the regression line will flatten (the dashed line is the regression line based on incomplete data). When drawing conclusions on how education and political participation are related, we would underestimate the strength of the relationship. The strength of a relationship could also be overestimated. For example, some studies find that men are more likely to trust others than women (Buchan, Croson, & Solnick 2008; Delhey & Newton 2003). It is also well established that men typically participate less frequently in surveys than women (Stoop 2005), but if among panel participants both those with lower levels of trust and men are especially likely to drop out, we may overestimate the true extent of gender differences in levels of trust.

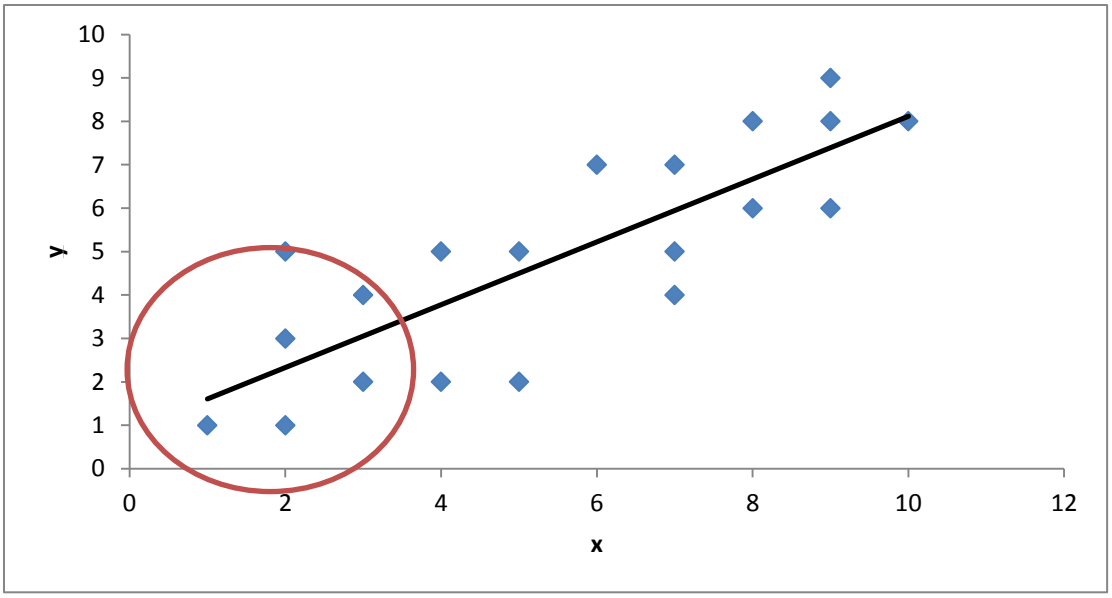

Figure 2a Attrition selective on x

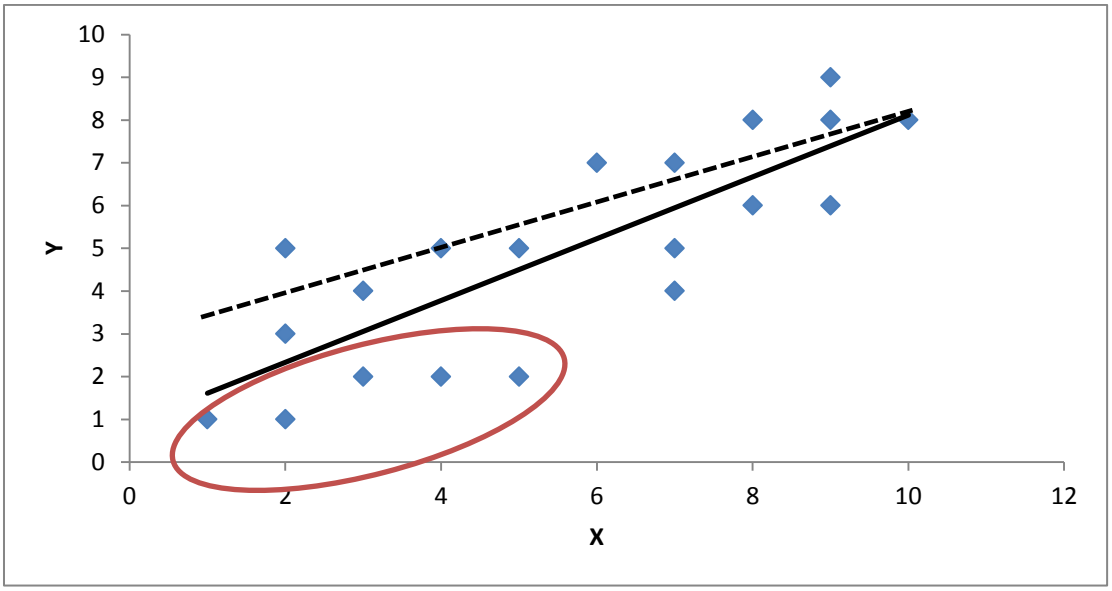

Figure 2b Attrition selective on a combination of x and y

In sum, we explore in this study how bias in some variables – most notably sociodemographic variables – affects how these variables co-vary or correlate with substantive variables, that may or may not be affected by bias themselves.

2.3 EXPLORING THE EFFECT OF ATTRITION ON THE RELATIONSHIP BETWEEN VARIABLES

We address the question of how attrition affects covariances between variables by comparing various models on two substantive research topics: hours spent on housework and political participation. Our approach is the following. To assess the relationship between variables before panel attrition we first estimate OLS regressions on the complete original 1999 sample (the full sample) of the Swiss Household Panel. We then restrict this sample to exclude those who subsequently drop out in later waves and examine whether the relationship between variables changed when the model is based on a selective subsample. We compare the full sample to the selection of respondents who were still

participating in the latest wave available in 2014 (which we call the selective subsample) and the respondents who did not participate in 2014 (the dropout subsample). Because we want to eliminate changes over time as a potential source of differences, we only consider data collected in 1999. Hence, we compare the full 1999 sample and two subsamples in 1999, namely the group that will continue to participate in the panel and the group that will drop out.

We compare the full sample and the two subsamples first by assessing the differences in first-order moments on socio-demographics and on a number of substantive variables. Next, we explore differences in the relationship between variables by estimating identical regression models for the full sample and the two subsamples and comparing the coefficients. Do we come to different conclusions when estimating regression models on the complete sample than when we base the model on a selective subsample, or is the relationship between variables stable enough to yield comparable results? And do coefficients obtained from the selective subsample differ significantly from those obtained from the dropout subsample? Finally, we briefly explore for some coefficients how they are affected when they are estimated on selective subsamples based on participation in waves 2000 to 2014.

Topic 1: explaining time spent on housework

The study of the way housework is shared within households has received much research attention, especially since the 1990s (see for literature reviews Coltrane 2004; Lachance-Grzela & Bouchard 2010). We focus here on the explanations for total time spent on housework that have received most support in the literature: time availability and the gender perspective. According to the time availability approach, the time spent on housework is determined by the availability of time in relation to the amount of housework to be done (Fuwa 2004; Lachance-Grzela & Bouchard 2010). Research shows that women's and men's time in housework is strongly related to time spent in paid employment limiting the time left available for housework, and by the family composition, notably children, increasing the amount of housework that needs to be done (Baxter, Hewitt, & Haynes 2008; Cunningham 2007). For this reason, we include whether respondents are in paid employment and whether there are children living in the household as independent variables in our equation predicting the number of hours spent on housework. The time availability explanation for housework may also partly explain nonresponse, as time availability is likely associated with time spent at home. Individuals who do fewer hours paid work, have children living at home and spend more time on housework can be expected to spend more time at home. Sample members who spend more time at home are easier to contact and hence are more likely to participate in surveys (Stoop 2005).

Based in socialization theory, the gender perspective sees the performance of housework as a symbolic enactment of gender relations (Brines 1994). The more traditional the gender attitudes of the partners are the more traditional is the division of housework. An illustration of gender ideology is research showing that when a woman moves in with a partner, her time spent on housework tends to increase, whereas the man's time decreases (Gupta 1999). Socioeconomic status is also linked to gender ideology (Brewster & Padavic 2000) hence in addition to the partner status as an indicator of gender ideology, we also take educational attainment of the respondent into consideration. These two variables are also

related to nonresponse; single and lower educated individuals are less likely to respond to survey requests (Stoop 2005).

One recurrent finding in studies on the division of housework is that women's time spent on housework is more affected by these mechanisms then men's (Baxter, et al. 2008; Kalleberg & Rosenfeld 1990). For this reason, we focus our analysis on time spent on housework by women.

Topic 2: explaining political participation

Research has shown that participation in politics (which includes activities such as voting, lobbying, or protesting) requires resources such as time, money and skills; engagement, such as having an interest in politics, being concerned with public issues and being involved in civic activities; and a network that provides opportunities to become politically involved (Brady, Verba, & Schlozman 1995). We focus on one form of political participation: voting in referenda, which take place in Switzerland several times a year. The variables we include in the model are all related to one or more of these explanations. First, a person's level of education forms an important resource for participation in politics, because it is related to income, social status and also to skills and knowledge that are associated with political participation (Dudley & Gitelson 2002; Verba, et al. 2005). Second, being employed is also a resource as it is associated with an enlarged network and hence social resources. Research has shown that people with a paid job are indeed found to be more politically active (Schlozman, Burns, & Verba 1994; 1999). Attrition studies have demonstrated that politically active sample members are more likely to be loyal panel respondents (Voorpostel 2010). As already mentioned above, being employed and educational attainment are also associated with nonresponse.

Several demographic characteristics are important for political participation and are associated with nonresponse. Women are still found to participate less in formal politics compared with men (Burns 2007; Burns, Schlozman, & Verba 1997). This is found to be related to women's lower access to socio-economic resources (women are less likely to be fulltime employed), and because of women's lower levels of political information, interest and perceived political efficacy. Gender specific socialization may play a role as well (Burns, et al. 1997; Verba, Burns, & Schlozman 1997). Women are more likely to participate in surveys than men (Stoop 2005).

Marital and parental status is also important: married individuals are more politically active than those who are single or divorced (Kingston & Finkel 1987; Voorpostel & Coffé 2012). The presence of children in the household functions on the one hand as a restriction on one's time (Mattingly & Bianchi 2003), but on the other hand provides a source of connection to the wider community, enhancing political interest and participation (Burns, et al. 1997; Sapiro 1982). Also, political participation in the form of voting generally tends to increase with age (Dalton 2006). These demographic characteristics (partnership status, presence of children and age) are all associated with response behaviour as well (Stoop 2005).

Finally, we include volunteering and organizational membership in our models, because civic participation, such as volunteering and membership in organisations, is found to predict political participation and political knowledge (Huckfeldt, Plutzer, & Sprague 1993;

Quintelier 2008). Just like political participation, these activities tend to be more common among loyal panel members (Voorpostel 2010).

3. DATA AND METHOD

3.1 DATA

Data come from the Swiss Household Panel (SHP) (Tillmann et al. 2016). The SHP is an ongoing panel survey that has followed a random sample of households in Switzerland on an annual basis since 1999. The latest available wave of data comes from 2014. Data are collected using computer assisted telephone interviews (CATI). All household members of 15 years and older are interviewed. Although the SHP consists of three samples (the first one started in 1999, the first refreshment sample in 2004 and the second refreshment sample in 2013), we only use the first (1999) sample 'SHP_I' in this study. In the first wave of the study, the SHP_I achieved sample consisted of 7799 respondents from 5074 households. Of these, 2919 (37.4%) respondents (from 2157 households) were interviewed in 2014 and 4880 (62.6%) respondents (from 3549 households) had dropped out (although some of them may have come back to the panel in later waves). A small subset (around 10% of the nonrespondents) was no longer eligible (deceased, institutionalized, or left the country).

We selected all individuals who responded to the individual questionnaire in the first wave and who had no missing values on our variables of interest, with the exception of income, where due to high item nonresponse rates, we use a derived variable with imputed values for households with missing information on income (Lipps 2010). We then constructed three groups: the full sample, the selective subsample that stayed in the panel and the subsample that did not participate in 2014 (the dropout subsample).2 For housework we only present the model for women (full sample n=4125, selective subsample n=1649, dropout subsample n=2476).3 The models on political participation include both men and women but were limited to those respondents who were allowed to vote (full sample n=6202, selective subsample n=2526, dropout subsample n= 3676).

We base our analyses on unweighted data. For the design of our study, that compares respondents participating in 2014 or not on their scores in 1999, no suitable weights are available. The weights that are available for 1999 refer to the complete 1999 sample and do not correct for nonresponse in 2014, and the weights for 2014 refer to the complete 2014 sample. As we look at nonresponse in 2014 in relation to observations in 1999, neither weight is appropriate.

3.2 MEASURES

Women's time spent on housework is measured with an open question: "On average, how many hours do you spend on housework in a normal week?" The presence of children in the household is measured with three dummy variables: one child, two children and three or

[2] We disregard cases that subsequently ceased to be eligible to participate in the panel in this analysis. To test whether nonresponse related to ineligibility mattered for the differences between the subgroups, in additional analyses we excluded respondents who later became ineligible. This did not affect the group comparison. Results are available from the authors.

[3] As expected, the model on housework did not predict men's time spent on housework well (R^2=.09).

more children. Having no children in the household is the reference category. The measure for employment status distinguishes between working fulltime (working more than 90%, the reference group), working a large part-time job (defined as working between 51% and 90%), a small part-time job (between 1% and 50%), and not working for pay, which includes both unemployed and inactive individuals. Age is included in years, and as a squared term to capture the nonlinear effect of age. We further included educational attainment in three categories (primary, secondary and tertiary education), with primary education as the reference group. Civil status was included with dummies for never married and not living with a partner, divorced or widowed, with cohabiting or married as reference group. Income, finally, was based on the logged annual gross household income and was included in quintiles with four dummy variables (the first quintile with the lowest incomes served as the reference category).

Our measure of political participation is based on the question “Let's suppose that there are 10 federal polls in a year. How many do you usually take part in?” The question thus measures the respondent’s participation in referenda, which are at the heart of the Swiss democratic system. As the number of polls a year varies over time, cantons and communes, the SHP does not ask actual participation in a given year, but rather a question measuring a general level of participation that allows easier comparison between individuals. Independent variables were mostly the same as for the model on housework: age, educational attainment, employment status, civil status and presence of children. In addition, we included gender, whether or not the respondent was involved in any volunteering activities, and whether the respondent was a member of any organization.

3.3 METHOD

We first present descriptive statistics for all observations in the first wave (the full sample), the selective subsample and the dropout subsample, to assess the effect of attrition on first-order moments. The variables are presented as means (SD) in the case of continuous variables and frequencies (%) in the case of categorical data. Differences between the two subsamples are evaluated using t-tests or Pearson’s X2 tests as appropriate. The effect of attrition on covariates is assessed using unweighted multiple linear regression models. We estimate the parameters of the models separately for the full sample, the selective subsample and the dropout subsample, and then test whether there is a significant difference between the coefficients from the two subsamples using Hausman tests (Clogg, Petkova, & Haritou 1995). If there is a strong effect of attrition on the relation between variables, we expect to see significant differences between the sizes of the coefficients in the models of the two subsamples. The possible effect of attrition on regression coefficients is further assessed using all possible subsamples still participating in every wave from 1999 to 2014 to investigate how researchers’ conclusions could vary depending on the longitudinal subsample analysed. We illustrate the impact of the definition of the sample under study for the housework model by plotting the unstandardized beta coefficients estimated for the independent variable ‘having three or more children’ for each longitudinal sample. We also visualize the impact of these changes on predicted values of time spent on housework depending upon which subsample is used to perform the analysis. All analyses were performed using the statistical package Stata Version 14.1.

4. RESULTS

4.1 DESCRIPTIVE STATISTICS

The descriptive statistics in Table 1 show that first-order moments differ depending on the sample or subsample from which they are obtained. We first consider the sample of women analysed in the first model.

The women who dropped out of the panel differ significantly from the women who stayed in on almost all the variables included in the model (except in terms of the number of children in the household and age). They perform slightly less housework (16.6±12.5 hours compared with 18.2±11.4 hours for the selective subsample). They are more likely to be single or previously married (24.7% compared with 15.0% for the single group and 16.5% compared with 11.5% for the previously married group) and less likely to be married (58.8% compared with 73.5%); more likely to have completed only primary level education (34.3% compared with 21.7%) and less likely to have completed tertiary level education (11.5% compared with 17.1%); more likely to be in full-time work (24.0% compared with 20.0%) or to be unemployed or inactive (44.7% compared with 37.8%) and less likely to work part-time (10.5% compared with 14.1% for large part-time jobs and 20.8% compared with 28.1% for small part-time jobs); and less likely to be on a high income (51.1% sharing the highest three quintiles compared with 59.2%).

In the second model, for which the subsample analysed consists of respondents with the right to vote in elections, the group of dropouts differs statistically from the group that stays in on all variables in the model. The dropouts participate less often in referenda (6.8±3.5 versus 7.5±3.1 out of 10). They include fewer women (54.8% compared with 59.6%); they are more likely to be older (46.0±17.3 compared with 44.6±12.8), they are more likely to be single (20.9% compared with 13.3%) and less likely to be married (65.1% compared with 77.1%); they are more likely to have no children in the household (66.5% compared with 58.5%); more likely to have completed only primary level education (21.1% compared with 13.0%) and less likely to have completed tertiary level education (20.4% compared with 27.8%); more likely to be unemployed or inactive (36.3% compared with 27.2%) and less likely to have a small part-time job (14.8% compared with 19.4%); and they have overall a lower level of income (51.6% in the highest three quintiles compared with 63.2%). Dropouts are also significantly less likely to do voluntary work (34.7% compared with 43.5%) and are less likely to be active or passive members of organisations (70.5% compared with 79.2%).

Table 1 Descriptive statistics for the full sample, the selective subsample and the dropout subsample for the two models (women's time spent on housework, and voting frequency in referenda)

		Model on housework for women				**Model on voting in referenda**			
		Full sample	Selective subsample	Dropout subsample	p Value for difference between subsamples	Full sample	Selective subsample	Dropout subsample	p Value for difference between subsamples
		(N=4125)	(N=1649)	(N=2476)		(N=6202)	(N=2526)	(N=3676)	
	Range	M±sd or %(n)	M±sd or %(n)	M±sd or %(n)		M±sd or %(n)	M±sd or %(n)	M±sd or %(n)	
Hours housework weekly	0-118	17.2±12.1	18.2±11.4	16.6±12.5	<0.001	-	-	-	
Voting in referenda	0-10	-				7.1±3.3	7.5±3.1	6.8±3.5	<0.001
Women	0/1	-				56.8% (3521)	59.6% (1506)	54.8% (2015)	<0.001
Age	15-91[a]	43.2±16.5	43.7±13.5	42.8±18.2	0.081	45.4±15.7	44.6±12.8	46.0±17.3	0.001
Education					<0.001				<0.001
Primary level	0/1	29.3% (1207)	21.7% (358)	34.3% (849)		17.8% (1106)	13.0% (329)	21.1% (777)	
Secondary level	0/1	57.0% (2352)	61.2% (1009)	54.2% (1343)		58.7% (3642)	59.1% (1494)	58.4% (2148)	
Tertiary level	0/1	13.7% (566)	17.1% (282)	11.5% (284)		23.4% (1454)	27.8% (703)	20.4% (751)	
Working status					<0.001				<0.001
>90%	0/1	22.4% (4924)	20.0% (330)	24.0% (594)		41.5% (2573)	42.1% (1064)	41.1% (1509)	
>50% to ≤90%	0/1	11.9% (492)	14.1% (232)	10.5% (260)		9.3% (575)	11.3% (286)	7.9% (289)	
≤50%	0/1	23.7% (979)	28.1% (464)	20.8% (515)		16.7% (1034)	489% (19.4)	14.8% (545)	
Not employed	0/1	41.9% (1730)	37.8% (623)	44.7% (1107)		32.6% (2020)	27.2% (687)	36.3% (1333)	
Household income	0-2465313				<0.001				<0.001
First quintile	0/1	25.7% (1062)	21.5% (354)	28.6% (708)		24.1% (1493)	18.3% (463)	28.0% (1030)	
Second quintile	0/1	20.0% (824)	19.3% (319)	20.4% (505)		19.7% (1219)	18.5% (467)	20.5% (752)	
Third quintile	0/1	17.7% (732)	19.5% (322)	16.6% (410)		17.7% (1099)	20.2% (509)	16.1% (590)	
Fourth quintile	0/1	18.1% (748)	19.7% (325)	17.1% (423)		19.0% (1179)	21.7% (548)	17.2% (631)	
Fifth quintile	0/1	18.4% (748)	20.0% (329)	17.4% (430)		19.5% (1212)	21.3% (539)	18.3% (673)	
Marital status					<0.001				<0.001

(Table 1 Continued)		**Model on housework for women**				**Model on voting in referenda**			
		Full sample	Selective subsample	Dropout subsample	p Value for difference between subsamples	Full sample	Selective subsample	Dropout subsample	p Value for difference between subsamples
Not living with partner	0/1	20.8 %(859)	15.0% (247)	24.7% (612)		17.8% (1105)	13.3% (337)	20.9% (768)	
Married or cohabiting	0/1	64.7%(2668)	73.5% (1212)	58.8% (1456)		70.0% (4341)	77.1% (1947)	65.1% (2394)	
Divorced or widowed	0/1	14.5%(598)	11.5% (190)	16.5% (408)		12.2% (756)	9.6% (242)	14.0% (514)	
Children in household		-			0.065				<0.001
None	0/1	57.6% (2375)	55.6% (917)	58.9% (1458)		63.2% (3922)	58.5% (1478)	66.5% (2444)	
One	0/1	15.7% (649)	15.7% (259)	15.8% (390)		13.0% (809)	14.3% (362)	12.2% (447)	
Two	0/1	17.5 % (721)	18.3% (301)	17.0% (420)		15.4% (957)	16.8% (424)	14.5% (533)	
Three or more	0/1	9.2% (380)	10.4% (172)	8.4% (208)		8.3% (514)	10.4% (262)	6.9% (252)	
Voluntary work	0/1	-	-	-		38.3% (2373)	43.5% (1098)	34.7% (1275)	<0.001
Membership in organization	0/1	-	-	-		74.0% (4591)	79.2% (2000)	70.5% (2591)	<0.001

Notes. [a]) Age range for political participation was 18-93, [b]) Income range for political participation was 100-650000

4.2 TIME SPENT ON HOUSEWORK

Table 2 presents the results of OLS regressions on time spent on housework. Most of the expected results based on the literature are confirmed: time spent on housework increases with age, but levels off. Women with a tertiary level of education and women working fulltime or more than 50% spend less time on housework. Women with a higher household income also report less housework, and women who live with a partner or with children report more.

Table 2 OLS Regression of various characteristics on time spent on housework by women (complete 1999 sample, selective subsample and dropout subsample)

	Full sample	Selective subsample (participating in 2014)	Dropout subsample (not participating in 2014)	p-value for difference between the two sub-samples
	B (se)	B (se)	B (se)	
Age	0.24 (0.02)*	0.24 (0.02)*	0.24 (0.02)*	0.841
Age squared	-0.01 (0.00)*	-0.01 (0.00)*	-0.01 (0.00)*	0.087
Education (ref. primary level)				
Secondary level	-0.96 (0.38)	-0.14 (0.61)	-1.42 (0.48)*	0.127
Tertiary level	-2.75 (0.53)*	-2.32 (0.78)*	-2.87 (0.74)*	0.598
Working status (ref. fulltime)				
>50% to ≤90%	-0.45 (0.58)	-0.23 (0.84)	-0.42 (0.79)	0.846
≤50%	2.58 (0.51)*	2.45 (0.78)*	3.06 (0.68)*	0.541
Not employed	3.84 (0.48)*	4.96 (0.77)*	3.27 (0.63)*	0.083
Household income (ref. first quintile)				
Second quintile	0.23 (0.52)	-0.76 (0.79)	0.85 (0.68)	0.116
Third quintile	-1.11 (0.55)	-0.82 (0.81)	-1.29 (0.74)	0.678
Fourth quintile	-1.39 (0.55)	-0.77 (0.83)	-1.91 (0.75)	0.292
Fifth quintile	-2.13 (0.55)*	-2.35 (0.82)*	-2.02 (0.74)*	0.766
Marital status (ref. never married)				
Married or cohabiting	7.37 (0.52)*	6.24 (0.83)*	7.85 (0.68)*	0.073
Divorced or widowed	0.84 (0.66)	-0.45 (1.04)	1.27 (0.86)	0.145
Number of children (ref. no children)				
One	3.58 (0.50)*	3.31 (0.75)*	3.65 (0.66)*	0.714
Two	4.63 (0.50)*	4.83 (0.77)*	4.30 (0.67)*	0.595
Three	8.11 (0.62)*	9.66 (0.90)*	6.63 (0.86)*	0.025
Constant	11.44 (0.70)*	11.44 (1.10)*	11.62 (0.91)*	0.897
Number of observations	(N=4125)	(N=1649)	(N=2476)	
R2	0.32	0.33	0.31	
F statistic of model	118.18	49.45	69.95	

*) p<0.01

When comparing the three models the direction of the significant coefficients remains the same and the same coefficients are significant. The only exception is the coefficient for

secondary level of education, which is only significant in the dropout subsample. Yet, this coefficient is not significantly different from the one in the selective subsample. Explained variance is also comparable over the three models. Hence, overall conclusions based on the selective subsample would be the same as the ones based on the full sample.

There is, however, one significant difference in the size of the coefficients between the selective subsample and the dropout subsample, leading to differences in the estimated number of hours spent on housework. Women who have at least three children living at home do 8.1 hours more housework compared with women without children at home in the full sample. This is higher for the selective subsample: 9.7 hours. In the dropout subsample the difference is 6.6 hours, significantly lower. Hence, among women with at least three children, those who remain in the panel perform more housework than those who do not, overestimating the difference in time spent on domestic work of this group as a whole.

To further illustrate how relationships between variables can be influenced by selective attrition, we calculated the same model for selective subsamples of the 1999 sample based on participation in any of the subsequent waves (2000-2014) of the SHP. Figure 3a depicts how the coefficient for women with at least three children in the household varies over the selective subsamples in the panel, whereas Figure 3b shows how this affects the predicted number of hours spent on housework for this group (with all other variables in the models set to the mean value).

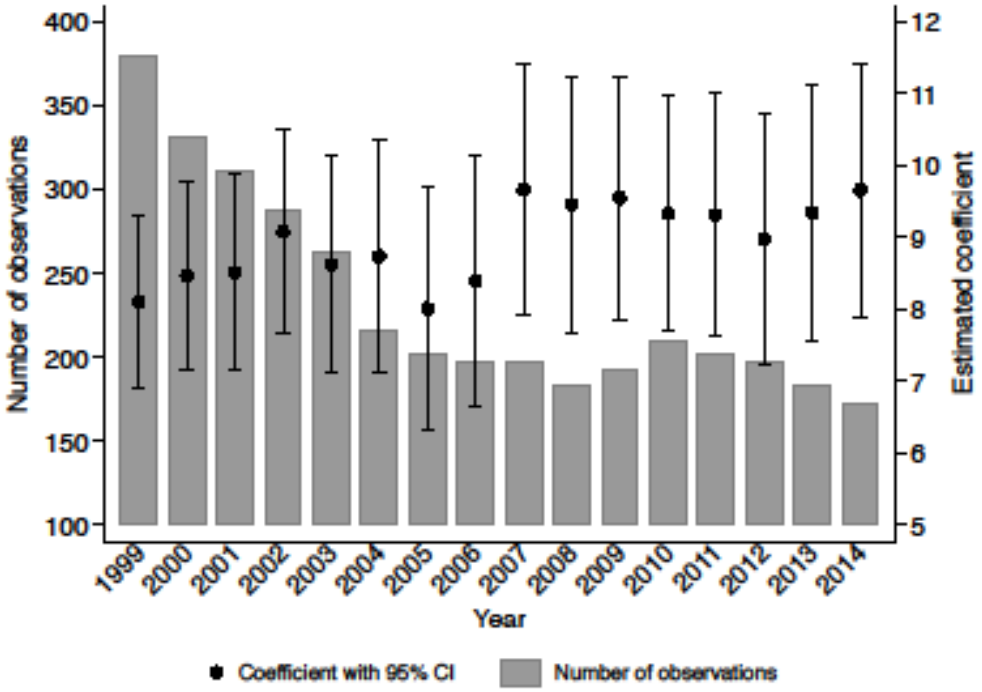

Figure 3a: Regression coefficient for women with at least three children in the household on time spent on housework for subsamples defined by participation in each wave of the SHP. Data from 1999.

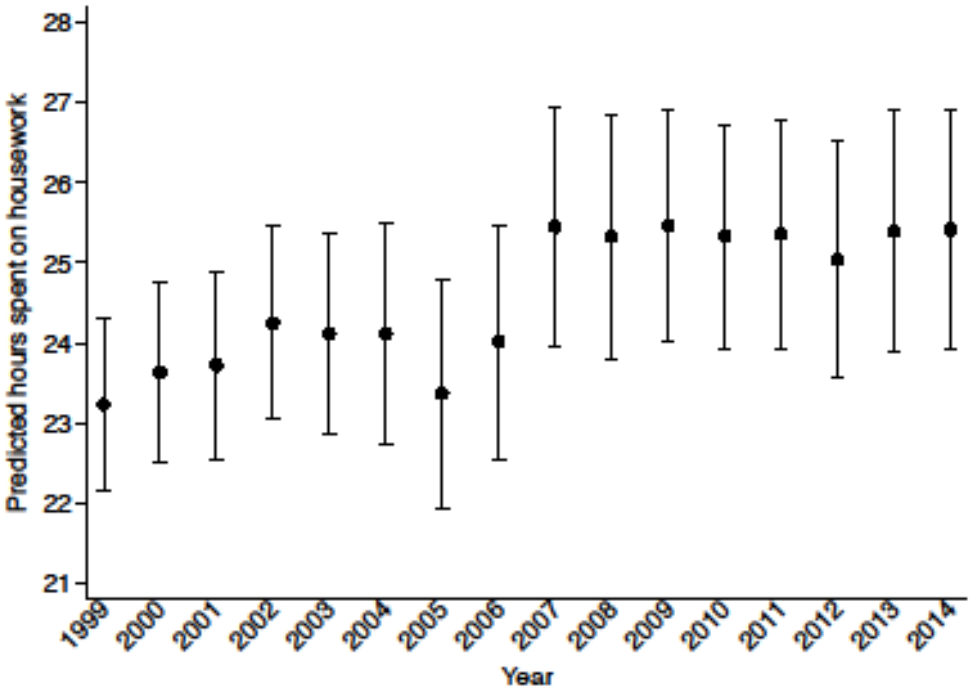

Figure 3b: Predicted hours spent on housework by women with at least three children for subsamples defined by participation in each wave of the SHP. Data from 1999.

Figure 3a shows that as the number of women who live with at least three children in the subsample becomes smaller, the coefficient becomes larger. This illustrates that among women living with at least three children, those performing the least housework in 1999 were most likely to drop out of the panel over time. In fact, the average number of hours spent on housework for the selective subsample with three or more children in the household is 25.6, whereas it is only 19.7 in the dropout group. For the childless women these numbers are much closer, 16.0 and 15.7 hours, respectively (results not shown in the table). As a result, the more selective the sample, the more the time spent on housework by this group compared with the women without children is overestimated (Figure 3b).

Political participation

Table 3 displays the coefficients of the OLS regression model for political participation. In line with the literature, we find that political participation is lower for women than for men and increases with age and level of education; people with a secondary or tertiary level of education participate more frequently in polls compared with people with a primary level of education. However, in contrast with previous findings, we find that political participation is higher amongst people who work part-time or are not employed than among fulltime working individuals. Political participation increases with income. No significant differences were found between married or cohabiting people and single people. As expected, however, voting frequency is lower amongst divorced or widowed people compared with single people. The presence of children in the household does not matter for participating in referenda. Finally, as expected, doing voluntary work and being a member of an organisation has a positive effect on political participation.

Table 3 Results OLS regression of various characteristics on political participation (complete 1999 sample, selective subsample and dropout subsample)

	Full sample 1999	Selective subsample (participated in 2014)	Dropout subsample (did not participate in 2014)	p-value for difference between the two sub-samples
	B (se)	B (se)	B (se)	
Women (ref. men)	-0.45 (0.10)*	-0.64 (0.15)*	-0.41 (0.13)*	0.237
Age	0.05 (0.00)*	0.06 (0.01)*	0.05 (0.00)*	0.431
Age squared	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.993
Education (ref. primary level)				
Secondary level	0.56 (0.11)*	0.26 (0.18)	0.66 (0.14)*	0.100
Tertiary level	1.21 (0.14)*	0.98 (0.21)*	1.19 (0.18)*	0.450
Working status (ref. fulltime)				
>50% to ≤90%	0.55 (0.15)*	0.57 (0.21)*	0.53 (0.22)	0.911
≤50%	0.71 (0.13)*	0.70 (0.19)*	0.72 (0.18)*	0.942
Not employed	0.68 (0.12)*	0.87 (0.19)*	0.54 (0.16)*	0.184
Household income (ref. first quintile)				
Second quintile	0.11 (0.13)	0.33 (0.21)	-0.02 (0.18)	0.212
Third quintile	0.58 (0.14)*	0.55 (0.21)*	0.60 (0.19)*	0.855
Fourth quintile	0.83 (0.14)*	0.80 (0.21)*	0.84 (0.19)*	0.892
Fifth quintile	0.85 (0.14)*	1.02 (0.21)*	0.72 (0.19)*	0.278
Marital status (ref. never married)				
Married or cohabiting	-0.29 (0.14)	-0.29 (0.21)	-0.32 (0.18)	0.923
Divorced or widowed	-0.90 (0.18)*	-1.01 (0.27)*	-0.85 (0.23)*	0.668
Number of children (ref. no children)				
One	0.10 (0.13)	0.09 (0.19)	0.11 (0.18)	0.953
Two	-0.10 (0.13)	0.11 (0.19)	-0.21 (0.17)	0.204
Three	0.29 (0.16)	0.36 (0.22)	0.24 (0.23)	0.700
Voluntary work	0.61 (0.09)*	0.60 (0.13)*	0.58 (0.12)*	0.894
Membership in organization	1.13 (0.10)*	0.99 (0.15)*	1.14 (0.13)*	0.484
Constant	5.52 (0.24)*	6.28 (0.38)*	5.27 (0.31)*	0.046
Number of observations	(N=6202)	(N=2526)	(N=3676)	
R2	0.13	0.14	0.13	
F statistic of model	49.55	21.13	27.73	

*) p<0.01

When comparing the models estimated on the full sample and the two subsamples, again, we see mostly comparable results. With one exception, the same coefficients are significant and their associations are in the same direction. The explained variance of the different models is comparable as well. Hence, also for voting frequency, conclusions based on the selective subsample would be the same as for the complete sample. The only one exception concerns the effect of secondary level of education, which is not significant

anymore when only considering the selective subsample, although the coefficient is not significantly different from the coefficient in the dropout subsample. This is a consequence of the attrition of people with a primary level of education with low levels of political participation (the average level of participation of respondents with a primary level of education in the selective subsample is 7.0 and only 6.1 in the dropout subsample), weakening the effect of education on voting frequency.

5. DISCUSSION

We set out to explore the extent to which selective attrition affects the relationship between variables in a long running household panel study. As expected, we found that attrition leads to more significant biases in first-order moments (means and percentages) than in regression coefficients. Whereas the body of literature on the effect of nonresponse on the relationship between variables is small, the findings so far suggest that relationships between variables are less affected by nonresponse than first-order moments (Gerrits, et al. 2001; Goudy 1976; Norris 1987). Our results give further support to these findings. Moreover, our findings show that when researchers interested in longitudinal analyses limit their analytical sample to respondents who remain in the study for a long time (the "fully longitudinal respondents"), they should be aware that this sample becomes increasingly selective, and that this can occasionally influence the conclusions drawn from multivariable analyses.

We showed that, in line with other studies on attrition (Fitzgerald, Gottschalk, & Moffitt 1998b; Watson & Wooden 2009), the respondents who continue to participate in the panel are more likely to be female, older, higher educated, living with a partner, and higher earners. The full 1999 sample, although itself selective to some extent, more closely resembles the population of reference than the selective subsample of respondents who stay in the panel over time. Nonresponse adjustment weights may correct for bias in some variables but not necessarily for all (Kreuter, et al. 2010).

When studying relationships between variables rather than first-order moments, the consequences of nonresponse bias due to attrition of the sample seemed limited in the two models we presented. The amount of variance explained by each of the models was unchanged, and the overall relationship between the independent variables and dependent variables was unaffected. When looking at the number of hours women spend on housework, and the frequency of participation in referenda by the population with voting rights, OLS regression coefficients have the same sign and level of significance leading to the same general conclusions, whether the models are based on the full sample or on a selective subsample. Nonetheless, it is important to note that in some cases the size of the effects was affected by selective attrition. In the models on time spent on housework, as the sample became more selective, the group of women with three or more children in the household became increasingly smaller and scored much higher on time spent on housework compared with women without children. This is the result of the fact that within this group especially women who performed less housework dropped out at a higher rate. For the models on political participation, in the selective subsample we did not find that individuals with a secondary level of education voted more frequently in referenda compared with those with a primary level of education, as we did in the full sample. Among individuals with a primary level of education especially, those who voted less frequently dropped out at a higher rate than individuals who voted more often.

Theory on nonresponse has suggested various mechanisms behind participation in surveys. For example, sample members may cooperate with a survey request because they see it as a civic duty. This would be more likely among individuals who adhere more strongly to social norms on contributing to the common good, and hence, who are also more likely to be engaged in activities such as volunteering and voting (Groves, Singer, & Corning 2000).

These kinds of activities tend to be more common among higher educated groups (Dudley & Gitelson 2002). When assessing nonresponse in cross-sectional surveys, there may be information on the educational level of nonrespondents available, but rarely on their civic engagement. Nonresponse analysis as a result is then based on educational level, with the assumption that it may partially serve as a proxy for civic engagement. We show with our model on political participation that the higher response propensity among individuals who show more civic engagement is not captured by educational level alone, but rather by a combination of education and, in our example, political participation.

An advantage of our study is that we were able to use information on future dropout from the panel and hence could use data about subsequent nonrespondents from the first wave of participation. This approach has some limitations, however. First of all, we do not have information on the sample members who did not participate in the first wave of the panel. Hence our full sample is not completely unbiased. Moreover, as we used information provided by the respondents in the first wave, we did not take into account any changes in subsequent waves that may have been associated with later dropout. Also, as the reason for dropping out of the panel is unknown for a substantial part of the nonrespondents, it is possible that the (albeit relatively minimal) observed impact of attrition on the relation between variables would be less if ineligible cases were excluded from the analysis. Another limitation of using information provided in the first wave from specific subsamples is that none of the available weights provided to SHP data users were appropriate for the purposes of our analyses. Hence, we were not able to assess whether adjustment weights had the potential to correct any changes in relationships between variables following panel attrition. Also, we only presented the results from two research topics concerning specific subsamples. This of course does not allow us to make generalisations about how other models on other substantive topics might be affected by panel attrition. We advise data users carrying out cross-sectional analyses on the attrited sample surveyed at later waves to conduct similar analyses as those presented here to assess the extent to which nonresponse bias may affect their research conclusions. Data users carrying out longitudinal analyses using only respondents who participate frequently could also benefit from adopting such an approach as a preliminary step to help diagnose the potential for endogenous selection bias in their conclusions about causal relationships over time.

Future research should focus on the effect of nonresponse adjustment on the relationship between variables and on whether nonresponse adjustments correct for the biases we found in the size of the effects. Another avenue for future research is the study of how selective attrition affects longitudinal data analyses directly.

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