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The four year project (2015-19) is a collaboration between the three leading European Research Infrastructures in the social sciences – the European Social Survey (ESS ERIC), the Survey for Health Aging and Retirement in Europe (SHARE ERIC) and the Consortium of European Social Science Data Archives (CESSDA AS) – and organisations representing the Generations and Gender Programme (GGP), European Values Study (EVS) and the WageIndicator Survey.

Work focuses on three key areas: Addressing key challenges for cross-national data collection, breaking down barriers between social science infrastructures and embracing the future of the social sciences.

Evaluating the quality of sampling frames used in European cross-national surveys

Content

Summary

This report addresses the quality of the population registers which are currently being used as sampling frames in countries participating in the four cross-European surveys cooperating in SERISS: the European Social Survey (ESS), the European Values Study (EVS), the Gender and Generations Program (GGP), and the Survey of Health, Ageing, and Retirement in Europe (SHARE). It summarizes what efforts have been undertaken by register authorities to improve and update the registers and presents an inventory of the main problems encountered in the field by survey sampling experts. In addition, it discusses the quality of alternative methods of sampling and possible improvements. Finally, the report reflects on how the major problems in sampling frames affect survey research and how they could be tackled to jointly improve sampling practices.

1. Introduction

Work Package 2 of the Synergies for Europe's Research Infrastructures in the Social Sciences (SERISS) project, "Representing the population", is focused on ensuring that European surveys continue to remain state of the art when it comes to accurately describing phenomena in the population. The aim of most high quality surveys is to be able to draw inferences about a specific population by using probability-based sampling. This is a complex and expensive process in many European countries and the problems are compounded when one moves from national to cross-national surveys since the samples in each country must do justice to national specificity but at the same time be internationally comparative. This work package therefore aims to document and share the best of current practice in order to advance the state of the art and promote future harmonisation. Sampling experts and country teams from the four large cross-national face to face surveys involved in SERISS have put their efforts together to work on this aim: the Survey of Health, Ageing, and Retirement in Europe (SHARE), the European Social Survey (ESS), the Generations and Gender Programme (GGP) and the European Values Study (EVS).

The Work Package report: "Report on the use of sampling frames in European studies" (SERISS Deliverable 2.1, Scherpenzeel et al, 2016) provides the basis for this synergy by clarifying in which countries it would in principle be possible to use a common sampling frame for all studies, in which countries a joint effort to obtain access to the population registers for sampling purposes is needed, and in which countries the construction of an alternative common sampling frame may be considered. However, a true synergy in use of sampling frames demands that the quality standards of all participating surveys are fulfilled. In this report, we will address the quality of the population registers which are currently being used as sampling frames in cross-European surveys. The report is based on three sources: First, an overview of the available literature with regard to quality of population registers in Europe. Second, the data obtained in the expert survey which was used to construct the overview of sampling frames for D2.1. In the survey, we asked the sampling experts in the country teams to indicate what problems and obstacles scientists and survey agencies encounter in using their chosen registers for sampling. Third, a workshop 'Representing the population in surveys' was held within the series of ´SERISS Survey Experts Network´ workshops, in which survey practitioners and researchers exchanged knowledge and discussed challenges in survey sampling. One of the main themes discussed was the quality of the sampling frames used in European and national studies.

The objective of this report is to:

- Give an overview of the known quality problems of population registers in Europe
- Summarize what efforts have been undertaken by register authorities (usually ministries or statistical offices) to improve and update the registers
- Present an inventory of the main problems encountered in the field by survey sampling experts
- Compare the saliency of coverage problems, inaccuracies and other problems in registers for survey sampling in practice
- Discuss the quality of alternative methods of sampling and possible improvements

We first describe the quality criteria which we will use for our evaluation of sampling frame quality in this report. Secondly, available publications about studies of register quality in Europe are summarized to give the state-of-the art of known register problems. This literature overview also describes the efforts undertaken by register authorities to improve the quality of the registers. Next, we describe what survey practitioners and survey sampling experts view as the major problems of the presently used register-based sampling frames, on the basis of our expert survey and the SERISS Survey Experts Network workshop. In the penultimate section of the report we consider briefly some of the quality issues posed by non-register based sampling frames. Although population registers are generally considered the gold-standard for sampling, in some countries the lack of an (accessible) register may mean that non register-based sampling is the only option. In other countries, non-register based samples should perhaps be considered as an alternative if the quality of the available registers is deemed sufficiently low. However, non-register based sampling frames also experience quality issues which must be taken into account, as we address in section 6. The final section of the report discusses the aims of the report as described above and reflects on how the major problems in sampling frames affect survey research and how they could be tackled to jointly improve sampling practices.

2. Quality criteria for register based sampling frames

The Work Package report: "Report on the use of sampling frames in European studies" (SERISS Deliverable 2.1) gave a full overview of all sampling frames used across studies and countries, thus bringing together the experiences of all four large SERISS studies. This can serve as a consultation source for survey practitioners and researchers in need of a sampling frame in a particular country or a set of sampling frames across different countries. The overview showed a considerable variation in sampling frames used, from official central population registers, to election or health insurance registers, address listings or geographical databases or random walk procedures (Scherpenzeel et al, 2016). Differences in sampling frames used across countries can lead to country-specific differences in sample quality.

Even among countries that have access to registers for sampling, differences in register quality may affect the comparability of the samples drawn. Possible sources of variation and errors in registers might be under-coverage of some groups, inaccuracies in the sampling frame, duplicate registrations or lack of information to select sampling units with minimum variation of the selection probabilities. Eurostat identified 12 components of quality in administrative register data (Eurostat, 2003): clarity; administrative concepts; coverage; reference time; data freshness; errors in the data; completeness; record matching ability; confidentiality and privacy; compatibility between file formats; comparability of administrative

data in time; envisaged uses of the data. Some of these 12 indicators are source-specific, referring directly to the quality of a particular register. Other indicators are product-specific, referring to the way in which the register is to be used, for example record matching ability (Daas & Fonville, 2007; Eurostat, 2003).

In this report, we use the list of possible sampling frame problems associated with register sampling given below. It has some overlap with the criteria distinguished by Eurostat for the evaluation of the quality of registers and register use in general. However, our list is focused on the register characteristics which in particularly affect the possibility to draw a sample for a survey, with known selection probabilities for all units and covering the population of interest. The Eurostat list was adapted to better reflect this particular aim, partly on the basis of the theoretical framework for the integration of register and survey data given by Zhang (2012) and partly on the basis of the experience of the sampling experts in the four studies involved in WP2:

1. Incompleteness, also called under-coverage: discrepancies exist between the actual target population and the one listed in registers. Specific groups are not covered (for example people in institutions, nomadic groups, foreigners that reside in a country without being citizens of that country, etc.), information on immigration or emigration is misreported or a certain percentage of the population is just not registered, for example because it is not obligatory in the country.
2. Duplicates, also called over-coverage: an individual or a household may appear several times in the register (because, for example, they have a second home, another name, or just by mistake).
3. Out-of-scope: another form of over-coverage: people, households or addresses which do not belong to the population of interest can be listed in the register. With regard to migration, it refers to citizens living abroad most of the time.
4. Inaccuracy, also called unreliability, mainly stems from two different sources (Poulain & Herm, 2013): the first one is mistakes in the record of documentary evidence (such as death, birth, citizenship), which are usually detected if the register is frequently used; the second one is missing self-reported amendments (e.g. change of address, partnership, etc.). Another form of inaccuracy is caused by misclassifications: A woman may be registered as a man, or a person's age may be incorrectly registered for example.
5. Difficulties of access and privacy issues: A lot of time or financial resources may be needed to get access to the register for sample drawing, or access may not be possible at all
6. Lack of auxiliary information in the register: This may mean that the correct selection of sampling units or eligible persons / households is not possible or that more advanced sampling designs are not possible (for example multistage stratified samples). Another lack of information can be that not enough contact information is available in the register to find and contact people. Finally, lack of information about demographics and/or household composition of the persons in the register can make it hard to calculate design weights.
7. Complexity or poor usability of the register and the register information: Problems may arise if the register cannot be handled easily, is not well documented and logically/systematically organised, in a readable format, and if all the information it contains is not coded in a consistent and understandable way.
8. Clustering of sampling units: the register may contain households instead of persons, or building blocks / postal code areas instead of individual addresses.

It should be noted that the register characteristics in this list may have a different concentration between sub-groups of the same population. In a study based in Norway, Falnes-Dalheim and Pedersen (2012) found that addresses of immigrants contained a higher concentration of mistakes than the overall trend: that means that the quality of the register varies between sub-populations within the same country. The under-coverage of certain groups may clearly affect the quality of the samples extracted from registers. Furthermore, certain register characteristics can be problematic for survey sampling although they do not have a large impact on the use of the register for purely administrative and statistical purposed. Poulain & Herm (2013) showed that, for example, the impact of missing self-reported amendments on the demographic statistics that can be produced from the registers is limited as the number of records affected by mistakes is also limited. In contrast, this type of inaccuracies can be more problematic when interviewers in the field encounter many addresses where the registered and sampled inhabitants are no longer resident.

In this report, we focus on the register characteristics which specifically pose problems for survey sampling, according to the survey sampling experts who participated in our expert survey or in our sampling expert network workshop. The report therefore does not constitute an exhaustive overview of general problems and omissions of population registers in Europe.

3. Quality of registers: European figures and strategies of quality assessment

Although published data about the quality of registers are only available for a limited number of countries and are, sometimes, quite outdated, it can be said that the variability in registers' quality in line with what has been found in Scherpenzeel et al. (2016), namely that availability and access to population registers varies by country. In this section, we investigate the quality of registers in the different European countries. Moreover, when information is available, we explore the strategies adopted for the evaluation of the quality of a register. Several strategies can be implemented, and not all of them are directly designed as quality checks. Yet, even indirect assessment may inform users about the quality of the registers.

Overall, Nordic countries are considered to have high quality registers, with timely registration of vital events and frequent quality checks. Minor residual errors are mainly due to migration and to missing self-reported information. It has to be mentioned that Nordic countries are also the most represented in publications concerning quality of registers. In Norway, in order to analyse the determinants of non-contacts, Falnes-Dalheim and Pedersen (2012) adopted an indirect strategy for quality assessment of the register and studied postal returns – that is, letters returned to the sender unopened - of a survey carried out by Statistics Norway. In 2011, Statistics Norway sent a mandatory survey to all 218,000 immigrants (18+) with missing information in the educational registers. The authors then used auxiliary data on the registers to analyse the patterns of postal returns, which reached 10% for this survey – which is quite high, considering that in a study conducted in 2008 (Thorsdalen, 2008) 97.1% of the addresses in the Central Population Register (CPR) were found to be correct. As mentioned before, with this indirect quality check the authors

(Falnes-Dalheim and Pedersen, 2012) were able to show that non-contacts are not distributed equally among the population. In particular, a higher rate of wrong addresses appears to be concentrated among the immigrant population.

In Finland, several activities are undertaken to ensure the quality of the Population Register (PR). The most systematic and repeated measurement of the register quality is the Quality Study (Hokka & Nieminen, 2008). The study is conducted once a year by Statistics Finland and consists of asking people directly whether the information on the register is correct by means of a survey. In particular, questions are included at the end of the Statistics Finland's Labour Force Survey. The main goal of the Quality Study is to assess the quality of the permanent address of a citizen in the PR. The study by Hokka and Nieminen (2008) reported that, in 2007, 98.8% of addresses in the Finnish Population Register were correct.

In Sweden, some studies reported that the registration of vital events such as births and deaths is timely and reliable (Ludvigsson et al., 2016). The report of immigration events is slightly less reliable, with a coverage of 95% of immigration and 91% of emigration (Ludvigsson et al., 2016). This latter figure may lead to over-coverage, which appears to be the largest threat to the quality of the Swedish Total Population Register (TPR) (Bengtsson & Rönning, 2016). A Danish study (Poulsen, 1999) reported that usually 99.2-99.4% of births are correctly reported in the Central Population Register (CPR), and 99.3-99.6% of deaths. Overall, the Danish CPR is considered to be a high-quality register. Unfortunately, we were not able to retrieve more detailed information on the strategy adopted to estimate these figures.

As concerns other Western European states, the situation varies considerably between countries. In the Netherlands, Gerritse et al. (2016) attempted a systematic study of under-coverage of usual residents in the Dutch Population Register (PR). In order to do so, they linked the PR with two other registers: the Employment Register (ER) and the Crime Suspects Register (CSR). By means of a capture-recapture estimation, also known as multiple systems imputation, the authors were then able to estimate the portion of the population missing from the register. The under-coverage of Dutch usual residents has been estimated to be between 0.5% and 1.1% (Gerritse, Bakker, de Wolf, & van der Heijden, 2016); over-coverage, instead, is estimated to affect only 0.2% of the total population (Bakker, 2009; Gerritse et al., 2016).

Although quite outdated, it is worth mentioning a study conducted in the 1980s in Belgium with different purposes, which indirectly allowed the quality of their registers to be established. The 3Bbis survey tested the reliability of data collected via retrospective life history interviews by checking the survey data against reliable administrative data sources (Poulain & Herm, 2013; Poulain, Riandey, & Firdion 1992). The design involved interviewing couples (50 in a pilot study in 1982, 450 in 1988). First, individuals were interviewed individually on crucial events (such as marriage date, date of birth of children, mobility, etc.). After the individual interviews, couples were reunited and interviewed another time: when discrepancies with the individual interviews were found, results were discussed. Finally, the agreed answer was checked against the information contained in the register: again, differences were discussed to find out whether the mistake was in the retrospective answer of respondents or in the registers. As a result, Poulain and Herm (2013) reported that the population register did not record 4% of the migrations reported in the survey; moreover, 20% of children leaving home were unreported in the register. Mistakes in dates of birth of respondents, partners and/or children were residual (Poulain et al., 1992).

A Swiss study (Roberts, Lipps, & Kissau, 2013) explores the possibility of using the Swiss Population Register (SRPH - the Stichprobenrahmen für Personen- und Haushaltserhebungen) as a sampling frame. Although there are no figures available, the authors reported that one possible drawback is the under-coverage of certain groups, such as individuals who are not registered as resident (e.g. illegal immigrants) or people that are not actually resident in the place they are registered in. The extent to which this is problematic depends on whether the population of interest includes the potentially missing subjects or not. Moreover, the SRPH is only updated four times a year. In Germany, an overall assessment of the quality of registers is difficult, as there is not a central population register; hence, the quality varies by municipality (Statistisches Bundesamt (Wiesbaden), 2004).

In Southern Europe, where the process of centralization of registers is currently underway and proceeding slowly, the indicators of registers' quality are scarce. In Italy, where local civil registers are used by the Statistical Institute (ISTAT) to draw samples of families, coverage problems have been found mainly due to the definition of family. Indeed, the registers may over-represent virtual families (e.g. families that are registered but that do not actually live together anymore) or underrepresent factual families (e.g. people living together without being recognized as a familiar unit in the register) (Leti, Cicchitelli, Cortese, & Montanari, 2002). The authors also estimated that the bias (in this case, in the estimation of unemployment rate) due to the coverage error may reach up to 5%.

Finally, in Estonia it has been reported that the register may contain an over-coverage of Estonians who moved abroad but did not register their departure (Tiit & Vähi, 2014).

In conclusion, some studies of the quality of population registers have been done in individual countries, showing that the amount of under-coverage varies between countries and between subpopulations within countries. However, we did not find studies at the European level, applying the same quality criteria and same study methods to multiple countries. Furthermore, most studies were conducted by statistical offices, looked at the registers from a purely administrative perspective and hence focused on coverage only. This report focuses on more quality criteria in addition to coverage, in order to evaluate the quality of registers specifically for the use as sampling frames in survey practice. We included questions about quality issues associated with the use of registers for survey sampling in a survey among experts working in large, cross-national survey research programs, and included it as a main discussion topic in a workshop with sampling experts from different fields. The results from these two sources of information are described in the next sections.

4. An expert survey about sampling frames in Europe

4.1. Method

As described in SERISS Deliverable 2.1, titled "Report on the use of sampling frames in European studies" (Scherpenzeel et al., 2016), an expert survey was carried out within the framework of the SERISS work package 2 "Representing the population". The expert survey aimed to construct a comprehensive overview of the sampling frames which are used in the

four SERISS studies (SHARE, ESS, GGP and EVS), to create an inventory of the availability of auxiliary variables in these sampling frames, and to explore the problems encountered in the use of registers as sampling frames in practice. Between the end of April and beginning of May 2016, the researchers who are responsible for sampling and data collection in the countries included in the four large surveys received a questionnaire about the use of sampling frames and auxiliary data in their studies. The questionnaire was programmed as an electronic form and was sent by email to the country teams in each of the four studies, accompanied by an official invitation letter signed by the director of the respective study. The generic version of the questionnaire can be viewed in annex 1 of SERISS Deliverable 2.1, titled "Report on the use of sampling frames in European studies" (Scherpenzeel et al., 2016). Researchers of the country teams were asked in the email and letter to forward the questionnaire to the sampling expert who was responsible for their samples if they were not the experts themselves. This could also be a person at the survey agency to which the fieldwork is assigned.

The questionnaire asked about the name and type of register actually used for the survey purpose, the responsible authority, the register's accessibility for different researchers and organisations, the amount of time it took to obtain a sample from it, the problems encountered, and the auxiliary variables obtainable from it. In addition, questions were included enquiring about other sources for auxiliary data that were used. The data from all questionnaires of the four studies are stored on the SHARE server at the Max Planck Institute for Social Law and Social Policy in Munich. The overview of the use of registers as sample frames in the four SERISS studies can be found in SERISS Deliverable 2.1, titled "Report on the use of sampling frames in European studies" (Scherpenzeel et al., 2016). The results of the questions concerning auxiliary data are presented in SERISS Deliverable 2.5, titled "Report on auxiliary data in available country registers" (Bristle et al, 2016). In the present report, we focus on the answers to the question about the problems encountered in the use of the registers and on answers to the questions concerning the available auxiliary information in the register.

4.2.   Results

We here report on the problems encountered by countries using central or local population registers as their sampling frame, including person registers as well as address registers. Table 1 (adapted from the upper part of table 3 in Scherpenzeel et al, 2016) gives an overview of the use of registers as sampling frames in the four studies. As described by Scherpenzeel et al (2016), 83 completed questionnaires were received, of which 51 reported that some form of person register was used as the sampling frame (42 used a population register and 9 used a different type of person register such as an election register or health insurance register). No use of telephone registers was reported in any of the countries´ questionnaires. In total, 31 reported the use of alternative databases or procedures, such as geographical listings and random route procedures. The use of other methods of sampling than drawing from person registers is most common in the EVS. The EVS fieldwork started in the 1981, about 20 years earlier than the other three studies, when fewer possibilities to use population registers might have existed. Moreover, the EVS covers more countries than any of the other three studies (particularly compared to GGP and SHARE). The questionnaires completed by the EVS teams included 10 countries which were not available for the three other studies and which all indicated to have used another method of sampling

than a person register: Bulgaria, Cyprus, Georgia, Malta, Montenegro, Macedonia, Romania, Serbia, Slovakia and Ukraine.

Table 1. Summary of sampling frames used in countries, across the four surveys. The frames were used for the data collection in different years, between 2004 and 2017[1].

	Study				Total
	ESS	**EVS**	**GGP**	**SHARE**	
Population register	14	8	7	13	42
Other register	0	4	0	5	9
Other methods	7	20	3	1	31
Number of respondents[2]	21	32	10	19	82

[1]For the ESS, 11 countries´ questionnaires referred to the sampling frame used for all recent rounds up to the 2016 round, seven referred to all recent rounds up to the 2014 round, and one country (Iceland) referred to the 2012 round. For the EVS, 15 countries ´questionnaires referred to the sampling frame used for all recent rounds up to the 2017 round; another 15 referred to rounds up to the 2008 round; and one country (Hungary) referred to the 2014 round. For the GGP, five countries´ questionnaires referred to the sampling frame used in 2004; one to 2008 and one to 2012. For SHARE, five countries´ questionnaires referred to the sampling frame used for all recent waves up to the coming 2017 wave (for which they were preparing a sample already); six referred to all recent waves up to the 2015 round; five referred to either 2011 or 2013; and one referred to 2004. In each study, two to three countries did not indicate the year of reference. The variation in years referred to within each of the studies reflects the fact that not all countries are always able to participate in each round or wave.
[2] In total across all four studies, 83 country teams completed the expert survey. One respondent did not answer the question about type of sampling frame.

An open ended question was included in the expert survey, accompanied by a textbox in which problems or obstacles encountered during the process of working with the register could be entered. We probed the respondents to think of issues such as coverage, accuracy and timeliness and gave the examples of poor coverage of sub-populations, underrepresentation of the target population, erroneous entries, amount of missing data, and slow updating. The questionnaire routing instructions were to only answer the open ended question about problems if a register was used as the sampling frame, including local and central registers and person as well as address registers. The question should not be answered if a different method was used for obtaining a sample, such as a geographical listing, a database of areas or buildings, maps, or a random walk procedure. Nevertheless, 7 country team experts who had not used a register did denote some problems in the open ended question. The problems they mentioned have not been included in the counts in table 2. They are included in table 3, with a footnote to indicate which country teams it involved.

We present here the results of this expert survey question, according to the list of quality criteria for register based sampling frames presented in section 2. Table 2 shows, across all countries, the frequency with which certain problems were mentioned by the experts of the four different surveys, in reply to the open question about experienced problems in the use of the register. Additional information regarding criterion 5 (access and privacy issues), criterion 6 (lack of auxiliary information) and criterion 8 (clustering of sampling units) is included from the answers to the closed survey questions about access to the register data and the sampling unit /level of information stored in the register. As described above, the questions presented in Table 2 should only be answered if the country teams had used a population or other register as the sampling frame. We excluded from this table the responses of 7 of the 31 respondents who did not use a register but nevertheless filled out

these questions. Consequently, the numbers in Table 2 are based on the 42 respondents in the first and the 9 respondents in the second line of Table 1.

Table 2 shows that, across the four studies, 8 of the 51 country teams which used a register as sampling frame did not mention any specific problem in response to the open ended question. This does not necessarily mean that the registers they used have a higher quality than the other registers included. It can also be related to the question format, as open ended questions are known to induce more nonresponse than closed questions, or to the knowledge of the country team about specific register problems. The cross-country results in Table 2 indicate that the most frequently mentioned problems are inaccuracy of the used register and under-coverage of the target population. The descriptions of register inaccuracy given by the experts often referred to outdated addresses (not keeping track of persons who moved in a timely way) and to persons being registered at another address then where they mostly live, especially in countries or regions where many people have second homes. Under-coverage of the target population seems to be widespread in registers across Europe. In contrast, problems of over-coverage, such as duplicate registrations or out-of-scope registrations, were not spontaneously mentioned as frequent problems in the use of registers for sampling. Six country teams explicitly mentioned obstacles in getting access to the register. Neither lack of auxiliary data nor clustering of units were mentioned spontaneously as problems, likely because these are not the issues that first come to mind when one is asked about obstacles in the access and use of a register. However, we can see a few problems with the availability of auxiliary information on the basis of the answers given to the closed question in which we asked the expert to identify which socio-demographic variables are available in the register they use. Five country teams in total, across all four studies, indicated that no socio-demographic variables were available at all from the register, not even gender or age. Furthermore, we can infer from the answers to the closed question asking respondents to indicate the sampling unit / level of information in the register that clustered units are in fact a frequently occurring register format. It usually refers to address registers, or registers which do not give access to the person data. Since person samples are known to have a higher quality than household or address based samples, the apparent frequency of clustered units indeed constitutes a fifth sampling frame quality problem.

Table 3 specifies which country teams in the four studies indicated under-coverage, inaccuracy, access obstacles, lack of auxiliary variables, and clustered units of the registers they used. It also shows the quality issues indicated by the 7 country teams who did not use a register but, despite the questionnaire instructions, answered these questions. The countries marked in blue did not use register in any of the four studies. Duplicates, out-of-scope listings and complexity of use are not included in Table 3 as they were not mentioned by any country team. Under-coverage is mentioned in many countries, but the size of the problem seems to vary a lot: from as little as 2% in Croatia according to the SHARE country team to 15% in Hungary according to the ESS and GGP country teams and even 30% in Israel as reported by the ESS and SHARE teams. These percentages are only examples: Since not all country teams indicated a percentage in their open answer to the question about problems we do not know the true variation across countries. The literature review given in section 3 also indicated that under-coverage problems vary across countries, although published results were available only for a small number of countries.

In addition, the under-coverage might be much higher within a certain subpopulation of research interest in any country. This problem was especially mentioned by the Norwegian country team in one of the studies. The study of Falnes-Dalheim and Pedersen (2012)

described in the literature overview in section 3 showed that although the Norwegian Central Population Register is generally of very high quality in terms of accuracy, the address quality is less good for people with a country background other than Norwegian, i.e. immigrants. Consequently, even when using a highly accurate and accessible person register for survey sampling, researchers requiring representativeness across all population subgroups or interested in particular target groups (for example migrants) can encounter certain quality issues.

Remarks given about access obstacles to the register were frequently given by teams in countries having a local register instead of a central register (Cyprus, Germany, Greece, Italy, Malta, the Netherlands and Switzerland have –at least partially- local registers). This requires getting approval and cooperation from all sampled communities, with each community having the right to refuse, restrict access or demand costs payments. Sampling from local registers can thus lead to a particular quality issue: differential access and differential quality across primary sampling units. The clustered unit problem is present in all countries where no person register is available or accessible and survey researchers have to use address registers or geographical databases. This is the case in at least one of the four studies in Austria, the Czech Republic, Denmark, France, Greece, Ireland, Italy, Lithuania, Montenegro, the Netherlands, Portugal, Serbia, and Spain.

Table 2. Summary of quality issues, across the four surveys, as indicated by the country teams which used a register as sampling frame. Some country teams mentioned multiple issues: these were all counted. The frames were used for the data collection in different years, between 2004 and 2017.

	Study				Total
	ESS	**EVS**	**GGP**	**SHARE**	
Under-coverage	3	0	1	8	12
Duplicates	0	0	0	0	0
Out-of-scope	0	0	0	0	0
Inaccuracy	5	3	3	9	20
Access and privacy	1	0	1	4	6
Auxiliary information					
- Mentioned problem[1]	0	0	0	0	0
- None available[2]	2	0	0	1	3
Complexity / usability	0	0	0	0	0
Clustered units					
- Mentioned problem[1]	0	0	0	0	0
- No person sample[3]	5	2	1	4	12
Other problem	2	2	1	1	6
Sum of all problems[4]	18	16	7	28	69
No problem mentioned	3	2	1	2	8
Total respondents	14	12	7	18	51

[1] "Mentioned problem" means: the problem was explicitly mentioned in the answer to the open ended question about problems encountered in the use of the register.
[2] "None available" means that, according to the answer to the closed question about what socio-demographic variables are available from the register, no information is available about sampling units.
[3] "No person sample" means that, according to the answer to the closed question about what sampling unit is available from the register, no individuals can be sampled from the register.
[4] Sum of all problems: Some country teams mentioned multiple issues: these were all counted.

Table 3. Summary of quality issues across countries, as indicated by the country teams that answered the questions about these topics. Only the issues that were mentioned by at least one country team are listed. Some country teams mentioned multiple issues: these were all counted. The frames were used for the data collection in different years, between 2004 and 2017 (see footnote 2 under Table 1). The rows marked in blue represent the countries in which no registers were used for sampling.

	Quality issue				
	Under-coverage (%)[1]	Inaccuracy (%)[1]	Access and Privacy	Auxiliary information none available	Clustered units No person sample
Country					
Austria		SHARE	GGP	SHARE	SHARE
Belgium		EVS			
Bulgaria	EVS				
Croatia	SHARE (2)	SHARE			
Cyprus					
Czech Republic				ESS*	ESS*
Denmark			SHARE		SHARE
Estonia	ESS, SHARE	SHARE (5)			
Finland					
France	SHARE	SHARE			EVS, SHARE
Georgia					
Germany	SHARE		ESS		
United Kingdom					
Greece					SHARE*
Hungary	GGP	ESS, GGP (15)			
Iceland		ESS, EVS			
Ireland		EVS**		EVS**	EVS**
Israel		ESS (30), SHARE (30)			
Italy	SHARE	GGP, SHARE	SHARE		GGP
Latvia					
Lithuania				EVS*	EVS*
Luxembourg	SHARE	SHARE			
Macedonia					
Malta					
Montenegro					EVS*
Netherlands		ESS*, GGP	SHARE	ESS*	ESS*
Norway	ESS				
Poland		EVS (1), SHARE			
Portugal	SHARE (6)	SHARE			SHARE
Romania	EVS[2]				
Russia					
Serbia					EVS*
Slovakia					
Slovenia					
Spain		ESS			EVS*

	Quality issue				
	Under-coverage (%)[1]	Inaccuracy (%)[1]	Access and Privacy	Auxiliary information none available	Clustered units No person sample
Spain-Girona			SHARE		
Sweden					
Switzerland	ESS, SHARE				
Ukraine					

[1] Percentage of under-coverage of target population or inaccuracy of registrations if mentioned. These percentages were given spontaneously by the country experts in response to the open question about problems, and represent their experience or perception of the amount of under-coverage/inaccuracy.
[2] A combination of an electoral register with a random walk procedure was used.
* Quality issue reported by a country team which did not use a register. The issue referred to a geographical listing/database.
** Quality issue related to the use of a register at the building-address level.

5. A SERISS workshop on sampling

The issue of register quality was discussed at a workshop involving sampling experts from a range of different European countries and representing a range of different interest groups including SERISS partners, national statistical institutes and commercial survey agencies. The workshop, held in December 2016, formed part of the 'SERISS Survey Experts Network'.

The ´SERISS Survey Experts Network´ is a series of workshops thematically based around SERISS work packages. The aim of the workshops is to bring together survey practitioners and researchers (e.g. representatives from national statistics institutes, cross-national European surveys, survey agencies and survey methodologists) in order to facilitate a productive exchange of knowledge and practices in state-of-art survey research, to initiate a discussion on how to tackle specific challenges in survey methodology and data harmonization, and to encourage future cooperation between different organizations. The first of these workshops was titled 'Representing the population in surveys' and conducted within the framework of SERISS Work Package 2. The workshop took place on 8th December 2016 in Munich and was hosted by Munich Center for the Economics of Aging (MEA). Fourteen external sampling experts and 11 SERISS researchers attended the workshop (see Sommer, 2016). To enable exchange between participants, the workshop had an interactive format with a longer discussion session initiated by six short presentations on different areas of sampling-related challenges. The presentations are summarized in Sommer, 2016.

One of the interest groups which was formed at the workshop was devoted to 'Quality of registers', and discussed the main quality issues associated with population registers such as incorrect entries, coverage, the timing of updates, and omissions. It was concluded that a need exists for objective measurements to assess the quality of registers and guidelines on when the quality of a register may not be sufficient for it to be used as a sampling frame. In cases of low quality, the feasibility of alternative methods, including the possible use of dual frames, should be explored. Country-level consortiums could be formed to assess the quality of population registers in their countries. This information could be shared internationally through reports and at conferences. Group participants were interested in future collaboration to set up a list of quality indicators for register data.

Another interest group at the workshop discussed alternative sampling methods for countries where no satisfactory sample frame exists or can be accessed. Although the present report is focused on the quality of population registers as sampling frames, we also shortly address this topic in the next section.

6. Quality of non-register sampling procedures

This report mainly focuses on register based sampling and the problems associated with that. However, as Table 1 showed, 31 sampling experts of the country teams reported to have used a different sampling method, either because their country does not have a population register at all or the existing register cannot be accessed (see Scherpenzeel et al, 2016, for an overview of the existence and use of registers in the different countries). Although it was not explicitly reported by any country team, the possibility exists that in some cases alternative methods were used because the quality of the register was too low to use it for sampling. Since the quality of non-register sampling procedures was also presented and discussed in the SERISS workshop on sampling, we will shortly address this topic here.

The most common non-register sampling procedures are address listings or enumerations, in which the interviewers generate a sampling frame by listing or collecting addresses within a selected geographical area, or random walk procedures in which the address listing and selection is integrated with the interviewing process. Non-register samples obtained with these procedures can be considered probability-based samples under the condition that the interviewer instructions for address listing and selection are very clear, strict and understandable and that all interviewers fully comply with these instructions in the correct way. However, survey practice has shown that such procedures are difficult to control and give a certain freedom to interviewers to deviate from instructions, either purposely or through misunderstanding. The interviewers can influence sample selection by substituting the selected households with households which are easier to contact or more cooperative. They may also influence the initial sampling frame compiled during the listing stage by, for example, following a different route than prescribed. Recent studies have shown that address listing procedures and random walk procedures result in sampling bias and violations of the equal probability assumption (see for example Hoffmeyer-Zlotnik 2003, Eckman and Kreuter, 2011 Eckman 2013, Menold, 2014, Bauer 2014, Bauer 2016). In addition, the gross sample is not as clearly defined before the fieldwork as in a register-based sample and proper response rate calculations are more difficult. Several experimental innovations were discussed at the SERISS workshop on sampling, such as the use of easily accessible geodata, a spiral sampling technique on the basis of google maps (Nelaj, 2017), and True Random Route sampling and J-Section Sampling (Bauer, 2017). In general, there is a demand for testing these innovations and estimating their impact on sample quality.

7. Discussion: The main obstacles for register sampling

In this report, we addressed the quality of the population registers which are currently being used as sampling frames in cross-European surveys. The aim was to make an inventory of the main problems encountered by sampling experts in the field who have to draw samples from these registers, using a list of literature-based quality criteria. Are under- and over-

coverage the main problems for survey sampling in practice as they are for administrative and statistical use? Or are survey sampling and fieldwork more strongly affected by inaccuracies in address registrations, lack of auxiliary information or clustered units? What other problems are experienced in the use of registers? We focused on the register characteristics which particularly affect the possibility to draw a good quality probability sample for a survey, according to the survey sampling experts who participated in our expert survey or in our sampling expert network workshop. The report therefore does not constitute an exhaustive overview of general problems and omissions of population registers in Europe.

The survey we conducted among the sampling experts of the country teams in the ESS, EVS, GGP and SHARE gives an indication of which problems in population registers are most salient for survey sampling. We defined a list of eight quality criteria to categorize the answers given by the sampling experts to an open ended question about register problems. These criteria were: Incompleteness (or under-coverage); over-coverage (consisting of out-of-scope cases and duplicates); Inaccuracy; difficulties of access and privacy issues; lack of auxiliary information; complexity or poor usability; and clustering of sampling units. The top five most frequently mentioned quality problems across all countries teams that used a register for sampling looks as follows:

1. Inaccuracy (mentioned 20 times)
2. Clustered units (answer chosen 12 times)
3. Under-coverage (mentioned 12 times)
4. Access and privacy / Other problem (both mentioned six times)
5. No auxiliary information available at all (answer chosen three times)

Neither under-coverage in general, nor the subcategories out-of-scope registrations and duplicate registrations, were mentioned by any of the respondents. Complexity of the registers was not mentioned explicitly as an obstacle either. Remarkably, inaccuracy seems to be a more general problem of registers across Europe than under-coverage, at least in the view of the survey practitioners who draw samples from these registers. This might, however, also reflect the larger impact of inaccurate addresses on fieldwork and response rates. Under-coverage of the target population might be a more significant problem for the data users and analysts than for the survey agencies and country teams responsible for the data collection. The clustered units problem in registers is, in many cases, related to the problem of access and privacy: Many person registers do not allow researchers and other parties to access the person data. Addresses are considered less sensitive data than person data and are therefore more often available for sampling purposes.

The access and privacy obstacles were understandably less present in those countries where the register had been used for sampling. The open ended question which was posed only if a register had been used might therefore underestimate this problem. Scherpenzeel et al (2016) have shown that in ten countries, population registers are known to exist but are not used as a sampling frame by any of the country teams of the four large European surveys. In addition, access obstacles are generally present when a country has local registers instead of central registers. Sampling from local registers leads to a particular quality issue: differential access and differential quality across primary sampling units. These results indicate that the problem of not getting access is in fact one of the largest problems of survey sampling in Europe.

Finally, five of the sampling experts of country teams reported that no auxiliary information about their sampling units was available at all in the register they used. In contrast, most other sampling experts indicated at least some auxiliary variables. A large variation exists in the available information across registers, and the type of users that is allowed to access that information: An extensive description of the auxiliary data in available country registers can be found in Bristle et al (2016).

The quality issues associated with the use of registers for survey sampling were reported by the country teams which used a register as a sampling frame. Almost 40% of the country teams had not used any kind of register, however, but applied alternative methods of sampling. There are many quality issues associated with non-register sampling procedures, as was also discussed at the SERISS Survey Experts Network workshop in December 2016. Several innovative techniques have been proposed to improve these procedures, but they still need to be tested and evaluated in practice. At this moment, register based probability sampling of person units is, as before, considered to be the best sampling basis for scientific studies and the only way to harmonize sample composition in a cross-country study. To achieve that aim, however, open access to all existing person registers in Europe for survey sampling needs to be put on the agenda of national statistical offices, ministries and European statistical institutes.

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