International Journal of Internet Science
2009, 4 (1), 21–33

ISSN 1662-5544

IJIS.NET

The Coverage Bias of Mobile Web Surveys Across European Countries

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Abstract: In recent years, mobile devices are increasingly considered to access the Word Wide Web. Several survey research organizations are about to use this technology as a means of conducting self-administered surveys. Among other advantages it allows survey researchers to overcome the lack of random selection procedures in online surveys since it provides the opportunity to use RDD-like probability sampling of cell phone numbers. However, low penetration rates of smart phones raise concerns that the coverage bias of a mobile Web survey might in fact harm survey estimates considerably. In this paper, we report results of a simulation study on the coverage bias of the mobile Web population across European countries. Based on a subset of the Eurobarometer data we estimate the relative coverage bias of the smart phone population in contrast to the general population. Even though we observed an incline of the mobile Web penetration rates over the course of the past years, coverage biases were still considerably large for socio-demographic variables. Nevertheless, in a few European countries mobile Web coverage biases are already smaller than the coverage biases of the population with traditional landline Internet access.

Keywords: Mobile Web, smart phone, data collection, data quality, survey

Introduction

More and more mobile phones are equipped with mobile Web and data capabilities using data protocols.[1] For 2008, Nielsen Mobile (2008) reported active mobile Internet usage rates among US cell phone owners at 16 percent and at twelve percent in the UK and Italy. However, given the investments of service providers in the respective networks it is assumed that mobile Web will soon become a standard mobile phone application in the general public. In line with this reasoning, Nielsen Mobile (2008) observed an increase of mobile Web usage from 2007 to 2008 and predicted that improved network quality, decreasing costs for mobile Web usage and an increasing distribution of cell phone models like Apple's iPhone, Google's G1 or similar devices will contribute to a wider use of mobile Web access across industrialized countries. In this paper, we will assess the coverage error of socio-demographic variables when using this technology for survey research.

Couper (2008a) identified two major trends in present day survey data collection: the technological trend of using modern information and communication technology (ICT) in survey research and the trend towards self-

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[1]Data protocols are for example GPRS (General Packet Radio Service), UMTS (Universal Mobile Telecommunications System), HSDPA (High Speed Downlink Packet Access) or W-LAN (Wireless Local Area Network).

administration (instead of interviewer administration). As a result of these developments, online surveys have become a standard data collection method (Couper, 2008b; Dillman, 2007). In contrast to telephone surveys and face-to-face interviews, online data collection is self-administered, which decreases possible measurement error due to the presence of an interviewer, e.g. underreporting of socially undesirable behaviors (Kreuter, Presser & Tourangeau, 2008). Also, because of their self-administered character online surveys are a-synchronous (Hancock, Thom-Santelli & Ritchie, 2004) - the researcher's request to take part in a survey and the respondent's actual participation are not necessarily bound to a live interaction. Instead, respondents can answer the survey questions when it best fits their schedule. Also, cost savings of online surveys for scattered populations have been assumed. However, recent studies have pointed out that online surveys require a considerable investment in software tools and programming hours and also yield lower response rates which counterbalances part of the cost efficiency (Bech & Kristensen, 2009).

The use of the mobile Internet for surveys is a natural extension of the present use of online surveys and of the trends towards self-administration and technology use in survey methodology mentioned by Couper (2008a). Mobile Web surveys rely on self-administration since respondents use the key pad (or pointing devices) on their cell phone to enter data themselves and to navigate within the survey without the presence of an interviewer. At the same time it is one of the most advanced applications of ICT in survey research (Fuchs, 2008). Even though, the use of smart phones[2] has several disadvantages for survey research (which will be discussed below, see also Peytchev & Hill, 2008; Zhang, Levinsohn, Olive & Hill, 2008), the use of mobile devices offers a key advantage with respect to the sampling problems of traditional Web surveys: Using mobile phones for administering an online survey provides researchers with the opportunity to use RDD-like random selection procedures (Waksberg, 1978; Gabler & Häder, 2002) in order to generate random samples of mobile phone numbers.[3]

In this paper, we will focus on a crucial data quality issue when conducting mobile Web surveys: coverage error. Given the low penetration rates of mobile Internet devices in the general population, we will assess potential biases arising from the underrepresentation of certain socio-demographic groups in the sampling frame. Given the constraints in terms of cost, accessibility (network coverage) and also familiarity of the population with this technology, the diffusion of this technology is assumed to be still in its infancy (see also Nielsen Mobile, 2008). Similar to Ehlen and Ehlen (2007) who assessed the mobile phone population that abandoned landline telephone service (mobile-only population), we assume that the adoption of mobile devices is biased and restricted to certain subgroups of the general population characterized by socio-demographic properties typically seen in early technology adopters (Yu, 2006). Early adopters of mobile phones are typically young well educated men, who often earn high incomes (see for instance Fuchs, 2002; Arthur, 2007; Blumberg & Luke 2007). Similarly, early adopters of mobile Web technology are assumed to differ from the general population. Since mobile Internet usage requires sophisticated technological competencies, we predict even stronger biases for samples drawn from the mobile Web population. Preliminary results for Germany and Austria support this hypothesis (Busse & Fuchs, 2009; Nicolai, 2009).

The adoption of the mobile Web differs considerably across countries. In Japan, for example, mobile phones are commonly used for watching TV and Internet access (Okazaki, 2007).[4] Okazaki (2007) emphasizes the strength of the Japanese mobile data networks as well as "the psychological 'readiness' of people" (p. 670f.) of the Japanese general population that promote the widespread usage of the mobile Internet. In other countries, where predominantly landline infrastructures for TV and Internet exist, mobile Web access is less prevalent. Accordingly, the mobile Web phone tracking by Nielsen Mobile (2008) documented noticeable differences across industrialized countries. Among 16 participating countries mobile Internet usage penetration rate was reported highest in the USA with 16 percent and lowest in Indonesia with 1 percent.[5]

In this paper, we will provide estimates of the proportion of mobile Web users in 28 European countries. Then, we will assess to what extent this group differs from the general population in each country using relative coverage bias estimates (Biemer & Lyberg, 2003). Finally, we will compare the relative coverage biases of the mobile Web population to the respective biases of the traditional landline Internet population. Since the mobile Internet is a more recent feature of cell phone usage and because it requires more sophisticated technological competencies compared to placing mobile telephone calls and sending short text messages, we assume that the mobile Web is still in an earlier stage of the technology adoption cycle. Accordingly, we expect the mobile Web

[2]The term smart phone refers to mobile phones, which offer additional functionality known from personal digital assistants, such as installing programs or touch screen navigation.
[3]For a discussion of mobile Web surveys for event samples where specifically known respondents receive invitations to surveys using their mobile phone numbers see Nicolai, Horst & Burian (2006).
[4]The study conducted by Okazaki (2007) covered the population up to age 40 in rural areas and in the city of Tokyo.
[5]Nielsen Mobile (2008) examined the following countries: US, UK, Italy, Russia, Spain, Thailand, France, Germany, China, Philippines, Singapore, Brazil, Taiwan, India, New Zealand and Indonesia.

population to consist of early adopters to an even larger extent, which will increase the biases for the mobile Web population compared to the overall mobile phone population. Given the fast development in the smart phone and MDA (mobile digital assistant) markets we assume that these biases will soon deteriorate – especially in contrast to the landline Internet population that is developing less dynamically. Accordingly, in this paper we will assess the size and the direction of coverage biases of samples drawn from the mobile Web population compared to samples from the landline Internet population. This shall inform our discussion on the generalizability of survey results based on mobile Web survey data.

Methods

The Eurobarometer study is a face-to-face interview survey conducted four to eight times per year in Europe. This trend study is conducted by the European Commission (see European Commission, 2009 for details). In the most recent wave, the Eurobarometer included the European Union (EU) member states as well as the EU accession countries[6] Turkey, Croatia, Macedonia and the Northern part of Cyprus – 33 countries in total. It used area probability sampling conducted independently in each country. Interviews were predominantly administered face-to-face.

The questionnaire consisted of a socio-demographic module that was constant across waves and a variety of rotating modules plus nonrecurring sets of questions. As part of the standard Eurobarometer socio-demographic questionnaire respondents were asked to report their landline telephone coverage and whether or not they had a personal mobile phone. Also, once a year respondents were asked to report their access to traditional landline Internet and to mobile Web (on household level). It is important to notice that Eurobarometer does not ask for the usage of those Internet devices, but landline Internet and mobile Web access. Thus, using appropriate weighting (see below) this survey provided estimates of socio-demographic variables for the general population as well as for the mobile Internet population and the landline Internet population. Accordingly, we were able to estimate coverage biases induced when using samples drawn from these later special populations. The question on mobile Internet access was administered in one Eurobarometer study in the fall of each year from 2005 to 2009 (with the exemption of 2008). So far, the data for 2009 had not yet been released by the time of the analysis. Thus we had to restrict our assessment to the years 2005 to 2007.

The Eurobarometer group did not report on response rates regularly. However, occasionally non-response rates were published (Gallie & Paugam, 2002). For 2002 Eurobarometer, Gallie and Paugam (2002) reported highest response rates for Germany (75%) and Spain (73%), while lowest response rates appeared in Denmark (36%) and the UK (21%).[7] According to this, non-response varied considerably across countries. Since we could not determine the quality of the data with respect to non-response bias, a comprehensive assessment of generalizability of results was not possible. However, Eurobarometer data included integrated weights that considered unequal selection probabilities due to the sample design[8] and post-stratification weights to adjust the sample to EUROSTAT population data. Since Eurobarometer applied an area probability sampling plan and face-to-face interviews for each country included, the estimated socio-demographic variables based on the weighted full sample are assumed to represent unbiased estimators of the parameters. The weighted data set used in this analysis consisted of N = 81,513 adults (age 18 and over) in 28 countries for three points in time (2005, N = 27,931; 2006, N = 27,931; 2007, N = 25,651).[9] Countries that were not included in all three waves were dropped from the analysis.

For coverage bias considerations variables providing information on marital status, age, age at highest educational degree, gender and type of community were examined. These variables were chosen based on the assumption that they correlate with many substantive variables typically assessed in academic or market research surveys. For each variable, we chose one of the response categories and estimated the relative coverage bias for this subgroup for each country and for each year: For marital status we chose "married", for age at highest educational degree we selected "20 years and older", for gender we made use of the proportion of "male"

[6]The status of a EU accession country requires an official application for membership at the Council of the European Union. Subsequently, applicants will be considered for membership, if necessary, prerequisites or conditions might be imposed.

[7]Response rates were reported for 16 Eurobarometer countries: Belgium, Denmark, Germany, Greece, Spain, France, Ireland, Northern Ireland, Italy, Luxembourg, Netherlands, Austria, Portugal, Finland, Sweden and the UK. Average response rate among these countries was 54 percent (Gallie & Paugam, 2002).

[8]Eurobarometer sampling is based on a multi-stage random selection procedure. On the first stage an area probability sample is drawn considering population size and density of each sample point. For the selection of households in each sample point random route procedure is used. Within household respondent selection is accomplished by means of the last birthday method (TNS Opinion & Social, 2007).

[9]In some countries, younger respondents age 16 and over were surveyed as well. In order to facilitate comparisons across countries these respondents were dropped from the data set analyzed in this paper.

respondents, for age the category “18 to 24 years” was utilized and for the type of the community where the respondent lives we chose “rural”. The relative coverage bias was calculated using the following formula (see Biemer & Lyberg, 2003 and Harrison, 2005 for a detailed discussion):

$$RCB = \frac{N_{nc}}{N} \bullet \frac{p_c - p_{nc}}{P}$$

The first part of the formula refers to the proportion of the population that has mobile Internet access. This proportion was estimated by dividing the subsample not covered by a mobile Internet device (N_{nc}) by the total sample (N) of the weighted Eurobarometer study. In the second part of the formula the relative difference of the estimates for the covered (p_c) and the non-covered (p_{nc}) samples was computed and then divided by the parameter (which in our case was represented by the estimate based on the full sample). The same approach was used in order to estimate the relative coverage bias in the population with access to traditional landline Internet. Again, we estimated the proportion of the population covered by Internet using the respective sub-samples in the Eurobarometer. Also, we estimated the relative difference of the covered and non-covered populations based on the estimates for the respective sub-samples in the Eurobarometer study. In the section *Mobile Web coverage and traditional landline Internet coverage* we will compare the two biases in terms of their magnitude.

It is important to note that we used a simulation approach to determine the relative coverage biases for mobile Web access and traditional landline Internet access. The Eurobarometer data collection is conducted face-to-face providing data from the population with and without mobile Web or landline Internet access. Thus, when using socio-demographic data from the Eurobarometer study that is not prone to mobile Web or landline Internet coverage error we were able to estimate coverage biases of potential mobile Web or landline Internet surveys. This is why we consider our approach a simulation approach.

Since the Eurobarometer study was considerably large and applied an area probability sample we had no reason to believe that coverage error in the Eurobarometer study might interfere with our coverage bias estimates for mobile Web and landline Internet access. However, we were unable to completely rule out the impact of survey non-response in the Eurobarometer study on our coverage bias estimates. In addition, it is important to recognize that the results reported in this paper were based on sample surveys, thus they were prone to sampling error. Accordingly, penetration rates for mobile Internet as well as coverage biases should be considered estimates.

Results

Mobile Web penetration rates

Overall, about one third of the European population was covered by mobile Internet. In 2007, 31% of the respondents asked in the Eurobarometer study reported that they have access to a mobile Internet device.[10] This proportion was up five percentage points from 2005 ($p < .001$).

When looking at the results for the individual countries (Table 1)[11], substantial differences in the mobile Web penetration rates occurred: Luxembourg yielded the largest mobile Internet penetration (49% in 2007) followed by Estonia, Sweden, Latvia and Slovenia (42% each). By contrast, Romania and Bulgaria showed considerably smaller penetration rates (18% each). All other countries exhibited rates between these extremes. Interestingly, there was no clear pattern: Neither income per capita nor mobile phone penetration seemed to correlate with mobile Internet penetration rates. Based on the results, we assumed that mobile Internet coverage was predominantly driven by the activities of the network service providers in the respective markets. However, this needs to be explored in greater detail.

In some countries dynamic developments could be observed from 2005 to 2007, e.g. Ireland +17 percentage points ($p < .001$) or Lithuania +15 percentage points ($p < .001$). In many other countries like Latvia, Luxembourg and Belgium also significant increases of the mobile Web rate were to be noticed. By contrast, there were also countries with only minor increases observed or no raises at all, e. g., Belgium (+3, n.s.) or Hungary (±0).

Interestingly, in a few countries we observed declining mobile Web penetration rates over time. However, the fact that none of these reductions was statistically significant suggests that mobile Web markets were in fact not shrinking. We rather attribute the declining rates in Italy (−1 percentage point) Malta (−2), Germany (−2) and in

[10] Sample weighted to reflect the joint European population represented by the countries considered.
[11] Eurobarometer data weighted to reflect the population in each country.

Cyprus Republic (−4) to the fact that we were estimating penetration rates based on sample surveys which implied margins of error.

Table 1
Proportion Having Access to a Mobile Web, 2005 and 2007 in 28 European Countries

Country	2005	2007	Difference 2007–2005
Austria	32%	32%	0
Belgium	16%	27%	+11***
Bulgaria	9%	18%	+9***
Cyprus (Republic)	25%	21%	−4
Czech Republic	35%	41%	+6*
Denmark	34%	40%	+7*
Estonia	34%	42%	+8*
Finland	34%	39%	+5*
France	24%	25%	+1
Germany	22%	20%	−2
Greece	24%	27%	+3
Hungary	26%	29%	+3
Ireland	17%	34%	+17***
Italy	33%	34%	−1
Latvia	30%	42%	+12***
Lithuania	24%	39%	+15***
Luxembourg	37%	49%	+12***
Malta	20%	18%	−2
Netherlands	29%	36%	+7*
Poland	26%	36%	+10***
Portugal	18%	26%	+8***
Romania	9%	18%	+9***
Slovakia	26%	35%	+9***
Slovenia	37%	42%	+5***
Spain	30%	35%	+5*
Sweden	38%	42%	+4
United Kingdom	32%	36%	+4*
Europe	26%	31%	+5***

Note. Estimates based on 2005 and 2007 Eurobarometer data, $N = 53{,}582$, area probability sample, face-to-face survey, weighted data.
$^{*}p < .05$. $^{***}p < .001$.

As the data given in Table 1 denotes impressive mobile Web rates, it is important to notice that we report mobile Web access rates, instead of mobile Web usage rates. Published mobile Web usage rates are rare, however, Nielsen Mobile (2008) provides mobile Web usage rates for several European countries: Italy was identified as the European country with highest mobile Web usage rate of 11.9% (access in 2007 according to Eurobarometer data: 34%), followed by Spain with 10.8% (access in 2007: 35%), France with 9.6% (access in 2007: 25%) and Germany with 7.4% (access in 2007: 20%). Thus, it should be noted that not everyone who has access to the mobile Internet actually uses it. Accordingly, we assume that mobile Web surveys are in fact prone to even larger coverage biases than the biases reported in this paper (see below).

Differences of mobile Web population and general population

For survey researchers low coverage rates for mobile Internet reported above were not a problem if the covered population would represent the general population with respect to the distribution of key survey variables. Thus, we need to assess the similarities or dissimilarities of the population covered by mobile Internet and the remaining population without mobile Web access. Given the variables in the Eurobarometer questionnaire we looked at socio-demographic variables that were assumed to be correlated to other substantive attitudinal or behavioral variables not available in the data set. For the purpose of this analysis we looked at marital status, age at highest educational degree, age, gender and type of community. In order to simplify the presentation of findings we report overall values for the joint population of those European countries considered in the analysis[12]. Also, we restricted the analysis in Table 2 to 2007 data.

[12]Sample weighted to reflect the joint population in the participating 28 European countries.

Table 2
Socio-Demographic Characteristics of Respondents with and Without Mobile Web Access in Europe (2007)

Socio-Demographic characteristic	Without mobile Web access	With mobile Web access
Marital status		
Married	53%	48%
Unmarried living with a partner	8%	15%
Unmarried never living with a partner	12%	20%
Divorced	6%	5%
Widowed	13%	2%
Other	8%	10%
Total	100%	100%***
Age at last educational degree		
15 and under	30%	12%
16–19	43%	47%
Age 20+	23%	30%
Total	100%	100%***
Gender		
Male	46%	53%
Female	54%	47%
Total	100%	100%***
Age		
18–24	8%	21%
25–39	22%	37%
40–54	26%	28%
55+	44%	13%
Total	100%	100%***
Type of community		
Rural	35%	29%
Small or middle sized town	42%	45%
Large town	24%	27%
Total	100%	100%***

Note. Eurobarometer data 2007, N = 25,651, area probability sample, face-to-face survey, data weighted to reflect the joint European population in the 28 countries considered.
$^{***}p < .001$.

Results suggested noticeable differences of the mobile Web population to the population without mobile Internet access. The mobile Web population across Europe was considerably younger than the remaining part of the population. While 21% of those with mobile Internet access were 18 to 24 years old, the respective value in the group without mobile Web coverage was 8% (p < .001). Also, mobile Web users were more likely to be living in larger municipalities (27% of the mobile Web population vs. 24% of the population without mobile Web, p < .001). Even more pronounced was the gender gap in mobile Web penetration (53% vs. 46%, p < .001). Also, the mobile Internet population was far more educated than the remaining portion of the general population. All in all, the mobile Internet population across European countries consisted of more males, it was younger, better educated, more often residing in large towns and less often married or widowed compared to the population without mobile Web access.

Relative coverage biases of mobile Web population

However, neither the small size of the mobile Web population nor its socio-demographic properties alone represent sufficient measures for the coverage problems when surveying the general population using this technology. Instead, we need to compute relative coverage biases for key survey variables in order to assess the bias of survey estimates caused by the lack of coverage in the population accessible by this technology. The relative coverage bias (Biemer & Lyberg, 2003; see methods chapter for details) expresses the size of the error of an estimate as a proportion of its parameter. Again, we consulted five socio-demographic variables introduced in the previous section: age, gender, age at highest educational degree, martial status und type of community.

Overall, the relative coverage bias for the five socio-demographic variables was largest for age (category 18 to 24), followed by the education variable (category age 20 or over at last educational degree). Thus, the estimate for the proportion of young people as well as people with high educational degrees would be heavily skewed in a mobile Web sample, leading to a severe overestimation of these groups when using mobile Web survey methodology. As a result, every survey variable correlated to age or educational degree would be biased as well. Even though, the average relative coverage bias across 28 European countries for the age group 18 to 24 declined substantially from 2005 (0.82) to 2007 (0.69), it was still far too large to be neglected. The reduction of the bias for the educational degree over time was somewhat smaller than for age (from 0.32 in 2005 to 0.28 in 2007), however, the relative coverage bias for education was much smaller from the outset.

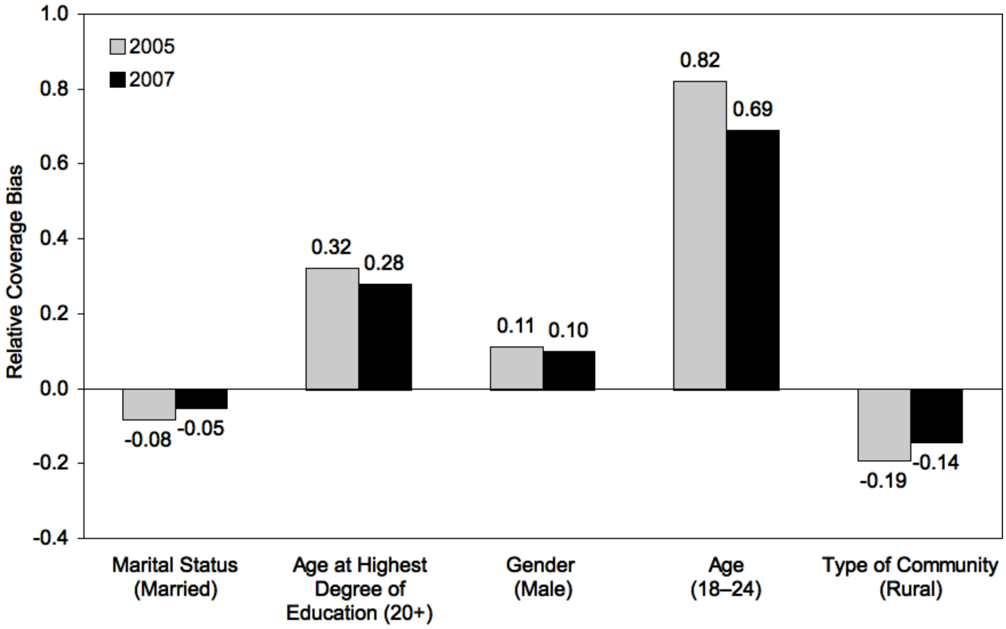

Figure 1. Average relative coverage bias of mobile Web population in 28 European countries (2007) for selected socio-demographic categories.

For marital status and gender the coverage biases were considerably smaller: Married people were slightly underrepresented (−0.05) and males were somewhat overrepresented (0.10) in the mobile Web population. Both biases declined over time; however, they were already on moderately low levels in 2005. The bias for the proportion of people living in rural areas also declined over time (from −0.19 to −0.14). Nevertheless, given its magnitude it still could not be neglected.

The relative coverage biases for the five variables assessed differed considerably across countries. Thus the average values reported in Figure 1 did not fully reflect the coverage problems in every European country. Looking at the average absolute value of the relative coverage bias (neglecting the algebraic signs of the individual bias estimates, see right column in Table 3) the countries differed considerably. While Bulgaria, Slovakia, Luxembourg and Sweden exhibited relatively small average biases (0.15 or smaller = the bias for the socio-demographic estimates on average was 15% or less off the parameter given in the complete data set), Portugal, Romania and Malta showed average absolute relative coverage errors of above .40. In these countries, socio-demographic estimates were extremely off target compared to the parameter. However, it should be noted that the absolute relative coverage bias was larger than 20% in the majority of the countries. As one would expect, mobile Web coverage biases are positively correlated to GDP (0.31) and negatively associated with landline Internet access (−0.38).

When looking at the biases for gender across countries we observed only moderate variability. In sum, about one half of the countries had relative coverage biases for gender smaller that 0.10 while the other half yielded larger values.

With respect to marital status, the relative coverage bias was considerably smaller in most countries—often it was the smallest of the five biases assessed. Only a few countries showed larger biases of the estimator for the proportion of married people with Romania (−0.25) and Germany (−0.19) being the most severe cases. For the proportion of people in rural communities the relative coverage biases were more pronounced. Greece (−0.53), Romania (−0.40) and eight other countries exhibited biases of 0.20 or larger.

Age (category 18 to 24) was prone to the largest biases in our analysis. Even the smallest relative coverage bias for this variable was 0.28 (in Slovakia). Some countries even showed biases of more than 100% (Germany, Romania, Portugal and Malta). Since the mobile phone and the mobile Web technology were first adopted by the younger populations in most countries, this finding was highly plausible.

For education (age 20 or older at highest educational degree) countries exhibited a wide range of relative coverage biases from 0.01 in Denmark to biases larger than 0.50 in Romania, Ireland, Portugal, Cyprus (Republic) and Malta.

Table 3
Relative Coverage Bias of Mobile Web Population for Five Socio-Demographic Variables (2007) by Country

Country	Marital status (married)	Age at highest degree (20+)	Gender (male)	Age (18–24)	Type of community (rural)	Average bias (of absolute values)
Austria	−0.07	0.23	0.15	0.65	−0.30	0.28
Belgium	−0.02	0.23	0.07	0.57	0.08	0.19
Bulgaria	−0.01	0.03	0.06	0.33	−0.27	0.14
Cyprus (Republic)	0.04	0.76	0.11	0.31	−0.20	0.28
Czech Republic	−0.07	0.24	0.20	0.55	−0.18	0.25
Denmark	−0.07	0.01	0.08	0.63	−0.11	0.18
Estonia	−0.06	0.15	0.07	0.75	−0.02	0.21
Finland	−0.01	0.11	0.07	0.48	−0.20	0.17
France	−0.14	0.15	0.01	0.79	−0.02	0.22
Germany	−0.19	0.14	0.22	10.10	0.00	0.33
Greece	−0.16	0.46	0.02	0.63	−0.53	0.36
Hungary	0.04	0.27	0.09	0.52	−0.34	0.25
Ireland	−0.04	0.58	0.01	0.71	0.02	0.27
Italy	0.08	0.26	0.07	0.67	−0.10	0.24
Latvia	0.00	0.06	0.01	0.66	−0.12	0.17
Lithuania	0.10	0.15	0.06	0.75	−0.16	0.24
Luxembourg	0.01	0.14	0.09	0.43	0.08	0.15
Malta	−0.08	10.25	0.09	10.37	−0.05	0.57
Netherlands	−0.05	0.13	0.14	0.57	−0.08	0.19
Poland	−0.04	0.28	0.08	0.85	−0.33	0.32
Portugal	−0.14	0.60	0.15	10.15	−0.21	0.45
Romania	−0.25	0.57	0.16	10.12	−0.40	0.50
Slovakia	0.04	0.12	0.17	0.28	−0.13	0.15
Slovenia	−0.11	0.26	0.14	0.84	−0.03	0.28
Spain	−0.16	0.28	0.13	0.77	0.04	0.28
Sweden	0.02	0.05	0.14	0.49	0.05	0.15
United Kingdom	−0.03	0.13	0.08	0.77	−0.21	0.24
Average	−0.05	0.28	0.10	0.69	−0.14	0.25

Note. Eurobarometer data, $N = 25{,}651$, area probability sample, face-to-face survey, data weighted to reflect the population in each country.

In sum, the country-specific analysis revealed no clear pattern according to which some countries would always be at the top or at the bottom of the list. Instead, for the five variables we saw a heterogeneous picture: Ten countries (Slovakia, Hungary, Czech Republic, Ireland, Spain, Germany, Greece, Portugal, Romania and Malta) were at some point among the top three with the largest biases and twelve different countries (Bulgaria, Slovakia, Luxembourg, Sweden, Finland, Latvia, Denmark, Estonia, France, Ireland, Cyprus (Republic) and Germany) were among the three countries with the smallest relative coverage biases for one of the five socio-demographic variables. Interestingly, Cyprus (Republic), Slovakia and Germany are among the top three and bottom three at the same time. Among the countries that stood out, Romania should be noted with three appearances on the group with the largest biases and Bulgaria which is three times among the countries with the smallest biases. Even though, in some countries the biases of the mobile Web population were considerably small, overall, in the majority of the countries the magnitude of the coverage biases for key socio-demographic variables in 2007 questions the feasibility of the mobile Internet as a means of administering surveys in the general population.

Mobile Web coverage and traditional landline Internet coverage

For a adequate assessment of the potentials of the mobile Internet for survey research we need to compare the relative coverage biases of the mobile Web population to the relative coverage biases of the population that could be reached using the traditional landline Internet. In order to facilitate such analysis, we used another variable from the Eurobarometer data set which indicated the landline Internet service status of the respondents. As part of the same module on new information and communication technologies, respondents were asked whether landline Internet access was available in their household. This provided us with the opportunity to compute relative coverage biases for the landline Internet population in each country (using the same approach already applied to the relative coverage biases of the mobile Web population) and to compare the size and direction of these biases to the coverage error of the mobile Internet.

Table 4
Relative Coverage Bias of Mobile Web Access and Traditional Landline Internet Access, Average Bias of 28 European Countries (2005 and 2007)

Socio-Demographic characteristic	Mobile Web		Internet	
	2005	2007	2005	2007
Marital status (married)	−0.08	−0.05	0.06	0.06
Age at highest degree of education (20+)	0.32	0.28	0.63	0.42
Gender (male)	0.11	0.10	0.09	0.07
Age (18–24)	0.82	0.69	0.39	0.39
Type of community (rural)	−0.19	−0.14	−0.23	−0.20

Note. Eurobarometer data, N = 53,582, area probability sample, face-to-face survey, average relative coverage bias across 28 European countries (see method sections for details).

Similar to the relative coverage bias of the mobile Web population we observed declining biases for the population with traditional Internet access (Table 4) except for age and marital status, where no reduction was observed.

Table 5
Relative Size of Coverage Bias in Landline Internet Population and the Mobile Web Population for Selected Socio-Demographic Categories in 28 European Countries (2007)

Country	Marital status (married)	Age at highest degree (20+)	Gender (male)	Age (18–24)	Type of community (rural)
Austria	LI	MOW	LI	LI	LI
Belgium	MOW	MOW	LI	LI	LI
Bulgaria	MOW	MOW	MOW	MOW	MOW
Cyprus (Republic)	LI	LI	MOW	LI	MOW
Czech Republic	LI	MOW	LI	LI	LI
Denmark	MOW	MOW	LI	LI	LI
Estonia	MOW	LI	LI	LI	MOW
Finland	MOW	MOW	LI	LI	LI
France	MOW	MOW	MOW	LI	MOW
Germany	LI	MOW	LI	LI	MOW
Greece	LI	MOW	MOW	MOW	MOW
Hungary	MOW	MOW	MOW	MOW	MOW
Ireland	MOW	LI	MOW	LI	MOW
Italy	MOW	MOW	MOW	LI	MOW
Latvia	MOW	MOW	MOW	LI	MOW
Lithuania	MOW	MOW	LI	MOW	MOW
Luxembourg	MOW	MOW	LI	LI	LI
Malta	MOW	LI	LI	LI	MOW
Netherlands	MOW	MOW	LI	LI	MOW
Poland	LI	MOW	LI	LI	LI
Portugal	LI	LI	LI	LI	LI
Romania	LI	MOW	LI	LI	MOW
Slovakia	LI	MOW	LI	MOW	MOW
Slovenia	LI	MOW	LI	LI	MOW
Spain	LI	MOW	LI	LI	MOW
Sweden	MOW	MOW	LI	LI	LI
United Kingdom	MOW	MOW	LI	LI	LI

Note. Eurobarometer data, N = 25,651, area probability sample, face-to-face survey. LI = relative coverage bias of landline Internet population was smaller than the relative coverage bias of mobile Web population; MOW = relative coverage bias of mobile Web population was equal or smaller than bias of population with traditional Internet access.

When comparing the relative coverage biases for the mobile Web population and the landline Internet population, the biases for the mobile Internet scored well. For education (age 20 or older at highest educational degree) and type of community (rural) the estimates of the relative coverage bias based on the traditional Internet population were considerably larger than the estimates based on the mobile Web population. Also, for marital status (married) the relative coverage bias was smaller for the mobile Web population. In sum, estimates for marital status, education and type of community would be less biased when using the mobile Internet compared to the traditional landline Internet. By contrast, the estimates for age (18 to 24) and gender (male) scored better for the population having landline Internet access. Although in an overall view, coverage biases for the socio-demographic variables assessed are more encouraging for surveys among the mobile Web population than among the landline Internet population, mobile Web biases are still too large for representative surveys.

However, the countries differed considerably with respect to the advantages or disadvantages of the mobile Web population over the traditional landline Internet population. In Table 5 we provide results of a systematic comparison of the biases for the five socio-demographic estimates assessed in this paper for all countries in 2007. The abbreviation LI (= landline Internet) denotes that the bias for this particular variable was smaller for the traditional landline Internet population in a given country. The token MOW (= mobile Web) indicates that the relative coverage bias in the mobile Internet population was smaller than the respective bias in the population with traditional online access or of equal size.

Based on this assessment we have to acknowledge that the relative coverage biases for the mobile Web population were still larger in the majority of the countries. The most extreme case was the Netherlands, where all five biases were smaller in the traditional Internet population (given the high penetration rate of landline Internet access in this country, this result becomes plausible). In three other countries (Austria, the Czech Republic and Portugal), four out of five mobile Web biases were larger compared to the biases in the traditional Internet population. In 13 other countries only two of the five biases were advantageous in the mobile Web population (typically a combination of education, marital status and type of community).

Interestingly, for ten countries (Bulgaria, Hungary, France, Greece, Italy, Latvia, Lithuania, Ireland, Poland and Slovakia) we estimated three or more favorable estimates for the mobile Internet population with Bulgaria and Hungary being the ideal cases where all five coverage biases for the socio-demographic variables assessed were beneficial in the mobile Web population. In France, Greece, Italy, Latvia and Lithuania the mobile Internet population allowed better estimates of four out of five socio-demographic variables. With the exemption of Greece, in this group the only variable that could not be estimated favorably using the mobile Internet population was age (18 to 24).

Discussion

The results presented in this paper suggest that it is too early to use mobile Web surveys as a mode of data collection in the European general population. The mobile Internet penetration rates, ranging from 18% in Romania and Malta to 49% in Luxembourg, were still too low in 2007 to justify the use of this technology for survey data collection in the general population. The average mobile Web penetration rate in Europe was 31% in the general population. Even though, in some countries the relative coverage biases have dropped over the course of the past years and were reasonably small in 2007 (and thus, would allow for samples with moderate coverage biases), for most countries the discrepancies of the mobile Web population and the general population were far too large at this time. It is important to notice that there are considerable differences concerning the magnitude of relative coverage biases calculated for different socio-demographic variables. Overall, Bulgaria seems a country quite applicable for conducting mobile Web surveys with an average coverage bias of only 0.14. Nevertheless mobile Internet surveys in Bulgaria would still suffer from highly biased estimates for age and type of community. In sum, age (with average across all countries of 0.69) and age at highest educational degree (0.28) are prone to the largest biases in Europe. However, it should be noted, that for some countries the relative coverage bias for estimates of key socio-demographic variables were relatively smaller in the mobile Web population than in the population with traditional landline Internet access. This is especially true for Bulgaria and Hungary where the relative coverage bias is advantageous for every variable considered in our analysis and also for several other countries where three or more biases are smaller in the mobile Web population than in the landline Internet population. Whether this will become true for more or even all European countries in the future needs to be monitored closely.

Also, we have to acknowledge that the mere coverage of the population with a new technology does not imply that all respondents who have access to the mobile Internet are actually capable and willing to use it in order to take a survey. Lack of technological sophistication or expensive payment plans may hinder potential respondents to actually use the mobile Internet when asked to do so in a survey – even though they might have this technology at their disposal. Thus, non-response bias may add considerably to the mean square error of mobile Web survey estimates. However, with the exemption of the Research Triangle Institute's experimental mobile Web panel (Zhang et al., 2008; Peytchev & Hill, 2008) we lack experience whether respondents are willing to take surveys using their mobile Web device. Even though respondents in the RTI panel agreed to take part in the mobile Web panel and received extensive incentives, on average only 65 of the 92 participants took part in the panel surveys (personal communication Andy Peytchev). Based on the experiences from landline telephone surveys using probability sampling without pre-notification of respondents (Link & Mokdad, 2005), non-response might be even more severe when sending respondents an unheralded text message on their mobile device to participate in a mobile Web survey.

Like traditional Web surveys, mobile Web surveys are a-synchronous in their interactional structure: The researcher poses a survey invitation to the potential respondent and he or she chooses the optimal point in time for answering the questions. Thus, mobile Web surveys offer the opportunity to make respondents aware of a survey invitation even if they are not at home. Accordingly for the completion of the survey respondents can choose a point in time that fits their schedule and their need for privacy or their need for a quiet, undisturbed setting. However, it is not yet clear whether the accessibility of potential respondents and the a-synchronous character of mobile Web surveys actually translates into high response rates.

In addition to its a-synchronous character, another potential advantage of mobile Web surveys arises from the fact that researchers can make use of RDD-like methods to randomly generated mobile phone numbers and, thus, invite random samples from the mobile phone population to their surveys. Even though, at this time the relative coverage biases for estimates based on the mobile Web population are far too large, we speculate that mobile Internet penetration will increase over time and eventually will reach the same high rates as mobile phone usage. Once we have reached sufficient high coverage, using the mobile Internet for survey research provides the opportunity to benefit from both, the advantages of self-administered online surveys and of random selection procedures. Today, for traditional landline Internet surveys researcher make use of actively recruited access panels using RDD telephone samples or other probability samples for the recruitment (Göritz, 2007). This procedure requires extensive resources and is time consuming. If we could conduct cross sectional studies using RDD samples of mobile phone numbers in order to invite random samples to our mobile Web questionnaire (either by text message or multi-media message), we could overcome a serious disadvantage of traditional landline online surveys.

Given the fact that - at least in some countries - the relative coverage biases of the mobile Web population are smaller compared to the biases in population with traditional landline Internet access, a more detailed methodological assessment of this new technology as a survey mode seems justified. However, whether it will be used eventually to collect survey data in the general population remains to be seen. Mobile Web methodology needs to demonstrate a particular advantage in terms of cost or the mean square error (preferably both), before it will be adopted as a method of survey data collection.

Acknowledgements

Support by a grant from the German Research Foundation (DFG) to the first author (Ref # FU 389/16-1) is gratefully acknowledged.

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