

Mode Effects: Same Question, Different Answers – Theory and Experimental Assessment

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In an effort to minimize respondent burden and survey costs and to improve response rates, multi-mode data collection techniques are often used to collect information (*Pintér-Kátay* [2010]). With parallel data collection techniques, however, new methodological challenges are likely to emerge. One of them is the estimation of the so-called mode effects: respondents tend to answer differently to questions depending on the mode of data collection.

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Impact assessment.

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In 2011, the Hungarian Central Statistical Office (HCSO) collected census information from households and individuals using data collection modes of self-administered paper and online questionnaires and face-to-face interviews (*Waffenschmidt* [2011]). This design involved the respondents' right to choose between these three modes. Choosing a mode to respond, however, is usually not random; it is related to the characteristics of the respondent. Differences in information gathered by each mode might be the result of the social desirability bias and the technical features of the different questionnaires, referred to as mode effects. In order to prepare for the methodological challenges raised by this technique, a preliminary experimental study was undertaken to evaluate the presence of mode effects, using data collected in the 2009 census rehearsal. The paper briefly reviews the Canadian and English practice regarding mode effect analysis and describes the key points of the Hungarian study – based on the Canadian practice –, the data reported using the self-administered internet and paper questionnaires and face-to-face interviews, the different characteristics of the respondents and gives a summary on measuring mode effects using the 2009 Hungarian census rehearsal data.

1. Multi-mode data collection and mode effects

With the development and exploitation of modern technology, online (internet-based) questionnaires offer real alternatives to traditional personal interviews and paper-based self-administered questionnaires. National statistical institutes use online data collection as it is considered to be cheaper and quicker than other techniques. Data entry errors can be neglected if data gets directly into a database, therefore data can be made available for analysis shortly after the collection process is complete. Along with hardly deniable advantages, the use of online questionnaires has its own difficulties. Internet response option is not yet available to all respondents due to lower internet coverage or the lack of broadband web access in some areas and respondents are expected to have the necessary computer skills to complete online questionnaires.

To overcome these difficulties, normally multi-mode designs are offered to respondents. The purpose of such design is usually to increase or maintain response rates in surveys while providing a chance to respondents to choose the mode they prefer the most. In multi-mode data collection, however, the so-called social desir-

ability bias might be a priority issue. This is the situation when other people (interviewers) are present during the data collection, some respondents might tend to provide answers they believe are socially acceptable or desirable. In such cases when no interviewer is present and the respondents need to use self-administered questionnaires, the answers for the same questions might be various. Even if the questionnaires and questions are quite similar in each mode, the climate in which the respondent needs to provide the answer can be quite different. In the presence of an interviewer, for example, the respondent can get support on how to interpret a question or which category to choose. Even though similar support is available with self-administered paper questionnaires (printed guide) or self-administered online questionnaires (online guide), the circumstances are technically quite different. In online questionnaires, automatic filtering or automatic adoption to already entered answers is possible. In case of paper questionnaires such automation is not available and usually instructions are provided if questions should be skipped based on previous answers.

All of these social desirability and technical effects arising from differences of data collection techniques are called mode effects. They can be observed when various data collection methods are used to collect survey information. The analysis of these effects emphasizes the importance of measurement. The results of the study could be used to modify questionnaires in order to minimise mode effects, to observe and quantify them as potential errors in the data, or to adjust the collected survey data.

2. Methodology

Mode effects have been brought into focus in the last few years; researchers and methodologists are searching for solutions to handle them. The related research can be divided into two areas: estimation and adjustment. The first one usually covers approaches and experiments with a purpose to find proof that this kind of effect is present in the data. The latter means that if it does exist, a solution is sought to modify or adjust data to remove it.

2.1. Estimation of mode effects

The literature on mode effect estimation is extensive compared to the topic of mode effect adjustment. Estimation usually starts with the concept of the multi-mode

design. Basically, there are two approaches. One suggests that questionnaires in different modes should correspond as closely to each other as possible, in terms of question wording, instructions and presentation of response choices, etc. A Canadian study (*Grondin–Sun* [2008]) uses this concept in order to minimize mode effects and to facilitate the integration of data received from different response modes. A different approach proposes that in the case of a multi-mode design, one should take advantage of all the potential each mode can offer (*de Leeuw* [2005]). This latter might result in different questionnaire designs. The idea is to use the features of web or paper questionnaires to maximum while give all the support during personal interviews to get the ‘best’ answer from the respondents.

The Hungarian mode effect investigation was based on the Canadian mode effect study as the circumstances of the analyses were quite similar. In the Canadian paper – where internet and paper self-administered questionnaires were compared – mode effect is defined as “any sign that the data reported on internet would have been different had it been reported on paper, whether it be due to the respondent or the internet application as such” (*Grondin–Sun* [2008]). This definition indicates that mode effects are related to both the specialities of data collection modes and the characteristics of the respondents choosing each response mode. Various research projects analyzed the latter. Based on their results, the characteristics of respondents using the internet for data transmission are observed to be different from those choosing other response modes. Internet users usually have more income, higher level of education and belong to younger age groups than other respondents.

The goal of the Canadian study is to detect if mode effect is present in the data collected. The methodology consists of four key parts:

1. Comparison of answers of each question by response mode (results are called *unadjusted differences*). Identifying the questions resulting in the biggest differences;
2. Compiling of variables explaining the preferences of choosing a response mode (for example highest level of educational attainment, age, place of residence, etc.). Using these factors as explanatory variables in a logistic regression model, a predicted probability value to each respondent can be calculated, representing the chance of choosing one response mode over another;
3. Classification of cases into subgroups, based on these probabilities. The probabilities within each subgroup are more resembling, therefore the comparison of the answers within subgroups is a possibility;
4. Matching the proportions by response mode by subgroups. The proportion of respondents by response mode among subgroups is expected to be different. In order to compare the final adjusted data of

the two groups, they must match. Using one of the groups as reference group, the proportion of the other group can be adjusted. Therefore adjustment factors are needed for each subgroup that can be used to standardize the subgroup proportions. As a result, the final *adjusted differences* can be compared to the unadjusted differences. This standardization is carried out by using “1” as a weight for the respondents by first mode (reference group), then by dividing the number of respondents in the reference group by the number of cases of the other group, an adjustment factor is calculated for the other respondents.

Any differences remaining after this adjustment cannot be explained by the explanatory variables used in the regression model. For questions, where the differences significantly decrease, the explanatory power of these factors can be considered high. Therefore any remaining difference can be a sign of the possible presence of mode effects in the data.

2.2. Adjustment of mode effects

Apart from estimation, adjustment of mode effects at the end of the data collection process comes with a purpose to adjust the data gathered by different modes. At a workshop on data collection for social surveys using multiple modes, held in September 2011 in Luxembourg,¹ Gareth James from the UK Office for National Statistics (ONS) presented a draft version of a mode effect study of ONS. According to the plans, mode effect estimation and expectedly an adjustment mechanism will be part of a labour force survey (LFS) web data collection project. This is going to be one of the first studies where mode effect adjustment is explicitly involved. In the study, a dual-frame analogy will be used. It means that respondents will be asked to register themselves at a website. As a result, registered and non-registered household subgroups will be available. With the registration process, contact information and basic details of the households can be collected, therefore the analysis of the non-respondents will also be available at the end of the data collection. In the first phase, face-to-face interviews will be carried out using a random sub-sample of both registrants and non-registrants; that will give the usual LFS data. In the second phase, registrants not participating in the first phase will be evaluated using web data collection. This second leg of the study is for the mode effect comparisons (as non-response will likely to occur, it can also be observed what kind of households typically reject to provide information on internet). The study highlights that

¹ Workshop presentations and papers are available at the ESSnet portal: <http://www.essnet-portal.eu/essnet-data-collection-social-surveys-using-multiple-modes-documents-and-presentation-workshop-septe>

difference in estimates based on information from registrants and non-registrants is attributable to sampling variation or mode effects (*Gareth* [2011]).

The Netherlands also indicated that they are working on their own mode effect study in order to separate selection and measurement effects in social surveys.

These studies are clearly experimental in nature and results are expected to be published in the next two or three years.

3. Experimental estimation of mode effects in the Hungarian census rehearsals

According to the regulation of the Hungarian Population and Housing Census Act (Act CXXXIX of 2009), Census 2011 was carried out using self-administered electronic and paper questionnaires, combined with personal interview technique. As part of the preparation, HCSO conducted its second census rehearsal in 2009, using a two-phase data collection technique. In the first phase, the inhabitants assigned to complete the census rehearsal questionnaire on a voluntary basis, could send their data using either paper or online self-administered questionnaires. In the second phase, interviewers visited the inhabitants not sending their data in the first phase and personal interviews were carried out. Using the data gathered during the rehearsal, HCSO carried out a study of mode effect estimation.²

3.1. Methodological background

The analysis is based on the methodology of the Canadian mode effect study. The model is designed around the assumption that respondents' decision to use a certain response mode is not random. As a consequence, the data gathered by each mode can be compared if the groups are as similar to each other as possible. If the gathered data, by mode, can be examined with the preferences of choosing response mode filtered out, then the filtered differences might be explained by these variables.

The first part of the study examined the relationship between data collected by paper and online self-administered questionnaires. The second focused on data obtained from face-to-face interviews and paper self-administered questionnaires.³ Following

² *Editorial comment.* The study of *Virág Erdei* of this special number covers the Hungarian Census 2011.

³ Three different questionnaires were used in the rehearsal. Questionnaire "A" focused on occupation, "B" on the highest level of educational attainment and "C" on family relations. In order to have a larger sample for the analysis, only the questions that were included in all three types were examined.

the approach laid down in the methodology, the first step in quantifying the mode effect is to compare the results by these three modes and see if there is any difference. In order to remove the preferences of choosing a response mode, explanatory variables for the regression model had to be identified. A detailed analysis of the 2009 census rehearsal, carried out by the HCSO, showed that respondents choosing each mode were different regarding their age, the highest level of educational attainment and economic activity. Based on the results of this analysis and other studies related to mode effects, the following variables were used to explain mode preferences: number of people living at the address, age group, highest level of educational attainment, age of the person responding to the questionnaire, the fact whether the respondent is habitually resident at the address, economic activity and the number of internet subscribers per capita at the settlement.⁴ Using these explanatory variables and the mode as the dependent dummy variable (using “0” for mode “A” and “1” for mode “B”), logistic regression models were built using the appropriate module of SPSS to compare the results of online versus paper self-administered questionnaires and self-administered paper questionnaires versus face-to-face interviews.

3.2. Online versus paper self-administered questionnaires

In the first part of the study, altogether 20 119 self-administered questionnaires were analyzed. 16 894 questionnaires (84 percent) were submitted by post and 3 225 (16 percent) via internet.

Based on the regression variables, predicted probabilities are calculated for each respondent using the logistic regression model. By using “0” for paper and “1” for internet response mode, the higher values indicate higher probabilities of choosing internet. The summary of the model and included variables can be seen in Table 1.

With the adjusted differences available, the comparison with the initial unadjusted results is now possible. Table 3 highlights the variables, where the initial differences couldn't be reduced by the adjustment method. According to these results, the differences are reduced in most of the cases. The initial differences related to the tenure status and other residence questions remain basically unchanged. That means that the difference cannot be explained by the used variables. Similarly, the reduction in the difference of working activity status and the highest

⁴ Data source: GKIE NET Internet Research and Consulting Ltd. – Regional Planning Information System (TEIR).

Even though the definition of mode effect used in this study indicates that characteristics of the respondents should be used only, the last explanatory variable is included to describe the conditions that have an overall effect on preferences (cannot expect high rate of internet respondents if internet coverage is at a low level).

level of educational attainment variables indicated that the whole initial difference is not entirely the result of the difference in the demographic variables used for the analysis. Since the unadjusted differences only slightly changed or haven't changed at all for these questions, it can be assumed that they can indicate the presence of mode effects.

Table 1

*Regression results for online versus paper self-complete questionnaires**

Variables in the equation	B	S.E.	Wald	df	Sig.	Exp(B)
Number of persons living at the address	0.419	0.018	533.938	1	0.000	1.520
Age group	-0.095	0.016	33.730	1	0.000	0.910
Highest level of educational attainment	0.231	0.022	111.831	1	0.000	1.260
Age of the person responding to the questionnaire	-0.019	0.002	98.531	1	0.000	0.981
Fact whether the respondent is habitually resident at the address	0.662	0.142	21.807	1	0.000	1.938
Economic activity	0.034	0.010	11.522	1	0.001	1.034
Number of internet subscribers per capita	2.424	0.231	110.468	1	0.000	11.294
Constant	-3.671	0.207	313.404	1	0.000	0.025

* Sex and marital status were not significant and were dropped from the model.

Note. Model summary: -2 Log likelihood: 15011.606, Cox & Snell R Square: 0.082, Nagelkerke R-Square: 0.139

3.3. Self-administered paper questionnaire versus face-to-face interview

With 46 991 questionnaires available for examination, a larger sample was used for the analysis, in contrast with the previous comparison. 30 097 questionnaires (64 percent) were collected using face-to-face interviews and 16 894 (36 percent) were submitted by post.

In this case "0" was assigned to the respondent using the personal interview mode and "1" was applied for paper respondents. Therefore higher probabilities indicate that respondents were willing to fill out the paper questionnaire by themselves. The summary of this model, and the variables included can be seen in Table 2.

Variables of sex and marital status proved to be significant this time, however, the R-square is lower, compared to the previous analysis. After classifying the respondents into 10 subgroups, the proportions of the personal interview mode were

considered as a reference group, since the proportions were more balanced among subgroups than in the paper reporters.

Table 2

Regression results for self-complete paper questionnaire versus personal interview

Variables in the equation	B	S.E.	Wald	df	Sig.	Exp(B)
Number of persons living at the address	-0.155	0.008	343.155	1	0.000	0.857
Age group	0.106	0.009	129.861	1	0.000	1.112
Highest level of educational attainment	0.205	0.011	380.976	1	0.000	1.228
Sex	0.059	0.021	7.926	1	0.005	1.061
Marital status	-0.072	0.014	26.528	1	0.000	.931
Age of the person responding to the questionnaire	0.015	0.001	244.395	1	0.000	1.015
Fact whether the respondent is habitually resident at the address	-0.384	0.063	36.727	1	0.000	.681
Economic activity	0.012	0.005	5.023	1	0.025	1.012
Number of internet subscribers per capita	-0.369	0.125	8.659	1	0.003	0.691
Constant	-1.397	0.101	190.793	1	0.000	0.247

Note. Model summary: -2 Log likelihood: 54917.847, Cox & Snell R Square: 0.064, Nagelkerke R-Square: 0.088.

Table 3 shows the adjusted and unadjusted differences for this comparison as well. According to the results, we can come to the same conclusion as for the previous analysis. Tenure status and other residence questions seem to be affected by other factors not covered in the logistic regression model. Also, the unadjusted differences for the marital status were not reduced as significantly as for most of the questions. The values for question relating to the economic activity are reduced. However, the unadjusted differences for this question were lower, compared to the online-paper analysis. This might indicate that mode effect related to this question is more characteristic for the online-paper relation or that it is a result of the relatively small sample (“only” 3 225 questionnaires were used, compared to the 16 894 in the second case).

3.4. Results

A summary of the results can be seen in Table 3. It contains all the variables examined in the mode effect analysis (variables resulting in the biggest unadjusted differences).

Table 3

*Variables included in the analysis, unadjusted and adjusted differences by response mode
(percentage point)*

Variable	Category	3.1. Online versus paper self-administered questionnaires		3.2. Self-administered paper questionnaire versus face-to-face interview	
		Unadjusted differences	Adjusted differences	Unadjusted differences	Adjusted differences
Age groups	–14	7.70	–2.00	–5.50	–0.20
	15–24	3.70	–2.40	–3.20	1.10
	25–34	6.90	2.30	–5.60	–3.00
	35–44	4.10	0.50	–2.00	0.60
	45–54	1.00	1.30	0.20	0.60
	55–64	–6.00	1.00	5.90	1.40
	65+	–17.40	–0.70	10.30	–0.50
Sex	Male	3.40	–0.50	–3.50	–0.50
Nationality	Hungarian only	0.00	–0.50	0.80	0.80
Marital status	Single	12.70	–1.70	–11.30	–3.40
	Married	–2.80	–1.70	7.60	4.70
	Widowed	–7.20	2.70	3.40	–0.90
	Divorced	–2.60	0.60	0.30	–0.50
Economic activity	Working	9.30	5.30	–4.50	–1.30
	Unemployed	–1.10	–1.00	–1.20	–0.50
	Child benefit, maternity leave payment	1.90	–0.10	–1.00	–0.30
	Retired	–21.30	–0.60	14.20	0.80
	Disabled	–1.40	–1.10	0.20	–0.20
	Family provider	0.30	0.10	–0.30	–0.20
	Student	8.10	–1.40	–4.40	3.20
	Child not attending school	3.50	1.70	–3.30	–1.50
Other	0.70	–0.30	0.30	0.10	
Highest level of educational attainment	Primary school or lower	–0.70	1.20	–10.30	–1.10
	Vocational school	–7.40	–3.50	0.90	2.00
	School-leaving certificate	–0.50	–2.90	5.70	1.50
	College, university diploma, PhD, DLA	8.60	5.10	3.80	–2.40

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Variable	Category	3.1. Online versus paper self-administered questionnaires		3.2. Self-administered paper questionnaire versus face-to-face interview	
		Unadjusted differences	Adjusted differences	Unadjusted differences	Adjusted differences
Tenure status	Registered (permanent address)	-2.90	-2.30	8.30	7.90
	Registered (temporary address)	0.60	0.40	-2.50	-2.40
	Unregistered	2.30	1.90	-5.80	-5.50
Have another address	No	-3.50	-2.50	6.60	6.80
	Yes, permanent address	2.50	1.80	-7.20	-6.90
	Yes, temporary address	0.20	0.10	0.50	0.30
	Yes, unregistered	0.60	0.40	0.50	0.20
	Yes, abroad	0.20	0.30	-0.30	-0.50
Is the respondent habitually resident at the address?	Yes	0.40	-0.60	-0.80	-0.10
	No, at other permanent address	-0.40	-0.20	0.10	-0.20
	No, at other temporary address	-0.20	0.00	0.30	0.10
	No, at other unregistered address	0.10	0.50	0.20	0.00
	No, abroad	0.00	0.10	0.30	0.10
Always lived at the address	Yes	6.00	-1.70	-2.40	1.80
Worked last week in December	No	-7.40	-4.90	4.80	0.20

The way the content of the table can be interpreted is the following: the results of tenure status “registered (permanent address)” for the online versus paper self-administered questionnaires, for example, show that respondents choosing internet mode are usually more likely to be registered at their address, compared to respondents using paper form. With the characteristics of the logistic regression model taken into account, this difference slightly decreases, indicating that the used explanatory variables can explain only a small portion of the difference. The decrease is not significant, meaning that possible explanatory variables need to be sought elsewhere.

4. Lessons learned

Even though the regression models were quite weak and the census rehearsals were not designed to serve as mode effect studies, experience was gathered on what is needed for a potential mode effect analysis in the future.

Methodology. In practice, various data collection modes are often used in a design where respondents have the chance to choose the mode they prefer (parallel data collection) or they are approached by different modes one after the other in case of no response (sequential design). As a consequence, the methodology to evaluate mode effects might be very affected by the approach used in the questionnaire design.

An article has been published recently in *Public Opinion Quarterly* (Vannieuwenhuyze et al. [2011]) dealing with the evaluation of mode effects using a mixed-mode dataset with a comparable single-mode dataset present. Methodology for mode effect estimation can differ if only a multi-mode dataset is available and there is no other comparable data or if a multi-mode dataset is available with comparable uni-mode data. There is no ‘gold standard’ methodology at this time for mode effect treatment.

A Hungarian research would also be useful to estimate the presence of mode effects. A study, designed solely for the purpose of mode effect estimation, could provide information about the likely effects of introducing a new data collection mode.

Purpose of the mode effect study. It is also different what researchers or national statistical institutes can use mode effect analysis for: estimation or adjustment. In case of estimation, it can be used as a ‘questionnaire test’ to identify questions being affected by mode effects. If so, the mode effect study can provide feedback and force the process to go back to the questionnaire design phase in order to minimize these effects at the very beginning. Then mode effect analysis can be carried out again until the effect is considered to be negligible enough to conduct a multi-mode survey. If the goal is to adjust data to remove mode effects, the methodology behind their estimation needs to be solid. There are no real examples or practices available on mode effect adjustment at this time.

Explanatory variables. Paradata. Staying with the current methodology (the Canadian approach), additional explanatory variables might be required to compute more exact adjusted differences, based on more sophisticated subgroups. The current analysis made an attempt to use wide range of variables in the regression model, however, most of them proved to be insignificant and therefore were dropped out. The use of larger samples can provide further information on understanding the differences between the results collected by different modes.

As census rehearsals were designed not for mode effect studies in the first place, variables were limited to the gathered data. The Canadian reference shows that additional variables can be entered into the analysis (for example, data about the survey process by which the data are collected). These so-called paradata are to provide information about the data collection process itself. As mode effects are directly linked to the data collection, useful results might be achieved if paradata were available for the analysis.

Sensitive questions. The current analysis was based on data collected from respondents in a voluntary census rehearsal. Since the analysis of mode effects can be the most useful if sensitive questions are present, it should be carried out using survey data containing real sensitive information.

Technical features. Differences in the responses can be the result of the technical implementation of different modes. The internet application used for data entry may have other features than traditional paper form. For this reason, the technical aspects should also be examined in detail. The application used for the 2009 census rehearsal sent messages to the user if no or incorrect answer was entered (format and range checks). Technical information whether the user changed the initial answer due to these warnings is required to measure the effects of such messages. The application, however, had no such feature; therefore the technical aspects could not have been examined. It is not known whether the respondents changed their initial answers as a result of these warnings or at which questions and how often such warning messages popped up. The Canadian study describes that analyzing the effects of pop-up menus and other features of the application can be useful to understand the initial differences in the responses.

5. Final conclusion

The Hungarian Central Statistical Office carried out an experimental mode effect analysis for the first time using the data collected during the 2009 census rehearsal. The mode effect estimation followed closely the methodology used in a Canadian mode effect study. Though the analysis of mode effects was not one of the declared goals of the rehearsal, the aim of the study was to measure if such effects were present in the collected data. According to the results of both the online versus self-administered questionnaires and self-administered paper versus face-to-face comparisons, tenure status and address questions might be affected by mode effects. Other questions, such as marital status or economic activity might be subject to the effect as well. However, based on these results, it is not certain if mode effects for

these questions appear only in certain mode relations or if they are the result of the small sample of internet respondents.

New data collection techniques will nevertheless become more popular in the future since they offer an alternative to traditional modes to motivate respondents to give information. Introducing new data collection modes, however, may require different questionnaire designs and technical implementation; therefore distortion effects might be present in the collected data, especially if different modes are used at the same time. Since mode effects can affect the quality of the collected information, planning such a multi-mode data collection technique requires thorough preparation.

The results of a mode effect study can provide feedback on data quality and can highlight questions that should be treated with attention during the preparations, including questionnaire design and technical implementation.

A twofold analysis can be carried out to test the presence of mode effects in the data. The current study aimed to measure the effects resulting from the different demographic characteristics of the respondent. Analyzing the technical aspect was not possible due to the application used to collect the census test data in 2009.

The data of this study is based on a relatively small sample and contained no real sensitive variables. Relying on the results, general conclusions cannot be drawn. For such inference, further testing and analysis is required, preferably based on different datasets and larger samples.

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