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(Optimal) governance of research support by "Survey Methodology"

Marek Fuchs

Abstract

Survey research is an integral element of modern social science. The infrastructure in terms of research institute, surveys, conferences and journals has greatly improved over the past 20 years and recently several initiatives have gained momentum even on a European level. This development has brought about the need for an integrated theoretical concept in order to assess and evaluate the quality of surveys and survey estimates. In our view, survey methodology is an interdisciplinary body of knowledge and expertise that describes the "science of conducting and evaluating surveys". It is a theory-driven empirical approach to assess the quality of survey research. Thus, it applies the principles of survey research to the development and assessment of this very method. Even though surveys have been conducted in a highly professional manner for decades, survey methodology offers the opportunity to use a universal theoretical approach when planning and assessing surveys and also a joint terminology. Both, the integrated theoretical concept and the joint terminology foster the professionalization of survey methods and stimulates methodological research on the improvement of survey methods.

One key element of survey methodology is the total survey error framework. It shall be described in greater detail below (section 1). Afterwards we will discuss some limitations of this concept (section 2) and mechanisms ad organizational issues in order to promote the use of this concept (section 3).

1. The total survey error framework

The quality of a survey statistics such as a mean, a percentage or a correlation coefficient is assessed by multiple criteria: The timeliness of reporting, the relevance of the findings, the credibility of researchers and results, and finally the accuracy and precision of the estimates. While timeliness of reporting and the credibility of researchers and results are rather soft indicators that require qualitative assessments, the accuracy of a survey statistic is an objective quantitative quality indicator. It is determined by the survey estimate's distance to or deviation from the true population parameter. If, for example, a survey would aim to determine the average household income in a certain population, any deviation of the sample estimate from the true value - that we would have gotten if all members of the target population have provided income data without error - would decrease accuracy. By contrast, the precision of a survey estimate is determined by the size of the margin of error (or confidence interval) and thus by the standard error. The standard error is a function of the sample size, of the alpha error and of the variance of the measure in question. Accuracy and precision offer an integrated view on the quality of a survey estimate. While the precision is discussed in almost every introductory statistics text book, the accuracy is not always considered to the same extent when evaluating the quality of a survey estimate. Instead, most survey researchers are used to determine the margin of error or the standard error in order to assess the quality of an estimate. The accuracy of the estimate is considered less rigorous and also determined less often explicitly. In survey methodology, accuracy and precision are treated as equitable concepts. However, given the lack of attention for the accuracy of an estimate we focus on this facet in the following paper. In the remainder of this paper, we use the total survey error framework (e.g., Biemer and Lyberg 2003) for an integrated discussion of a survey estimate's accuracy.

There are two types of survey error that harm the accuracy of a survey estimate: variable or random error and systematic error. While random errors are assumed to cancel out each other - i.e., a negative deviation of the measurement from the true value would be compensated by a positive deviation - systematic errors shift the sample estimate systematically away from the true value - e.g., because of a certain question wording, all respondents in a survey would report a higher number of doctor visits than actually occurred in a given reference period. For linear estimates (like means, percentages and population totals) it is save to state that an increase in the random error leads to an increased variance while a rise in any systematic error results in an ascended bias of the estimate. Using this terminology one can state that the accuracy of a survey estimate is affected by either an increase of the bias or by a rise of its variance.

In a traditional view, the driving factors or sources of those survey errors are differentiated into two groups: sampling error and non-sampling error. Non-sampling error would then be further differentiated into coverage error, non-response error and measurement error. A theory-driven modern approach differentiates observational errors and non-observational errors. While observational errors are related to the measurement of a particular variable for a particular sample unit, non-observational errors occur when an incomplete net sample is established that is supposed to represent the target population. Following this path Groves and colleagues (2004) group the sources of error into two assemblies: The first class of error sources applies to the representation of the target population by the weighted net sample ("representation"). The second class of error components adds to the total error by affecting the edited survey responses obtained from a respondent ("measurement"). This extension of the traditional total survey error concept gives room for a detailed analysis of the mechanisms considering several sources of error at the same time including possible interaction effects.

1.1 Total survey error components affecting representation

(1) Before a sample can be drawn a sampling frame is necessary that allows access to the members of the target population. The completeness of this frame and the possible bias of its composition cause misrepresentations of the population by the sample. If a group is underrepresented in the frame – e.g., individuals who own mobile phones as their only communicative device are missing from traditional RDD sampling frames because they do not have a landline telephone number – the socio demographic or substantive characteristics of this group are not considered when computing the survey statistic. This causes a lack of accuracy of the survey estimate since some groups might be underrepresented in the frame (e.g. Blumberg and Luke 2007) and subsequently in the sample drawn from the frame (=coverage bias).

(2) Once a frame is available one needs to draw a random sample: a simple random sample, a stratified sample, a cluster sample, or more complex sample designs (Kish 1965; Lohr 1999).

Based on this sample the standard error is computed by taking the square root of the division of the variance in the sample and the number of cases in the sample. The standard error is then used to compute the confidence limits and the margin of error - both are indicators for the precision of the estimate. The sampling error depends heavily on the design of the sample: For a fixed number of sample cases the standard error usually decreases if stratification is applied. By contrast, a clustered sample is generally characterized by a larger variance which in turn raises the sampling error for a particular estimate. However, for a fixed budget clustering usually increases precision since the effective sample size can be increased even though the variance suffers from the design effect caused by clustering.

(3) The unit non-response error is probably the facet that is best studied among all bias components in the total survey error framework (Groves and Couper 1998; Groves et al. 2002). Since the early days of survey methodology researchers have been aware of the fact that some portions of the gross sample cannot be reached in the field phase of a survey or are not willing to comply with the survey request for cooperation. Since the responses of those groups may differ considerably from the responses of those members of the gross sample who can be reached and who are willing to cooperate, the unit non-response is considered a serious source of systematic error that yields a non-response bias. The literature provides comprehensive theoretical approaches to explain the various stages of respondent cooperation and also findings that can be generalized beyond particular surveys. In part, this is due to the fact that a potential non-response bias can the assessed for variables where parameters are available from official statistics. Compared to other sources of error, this leaves survey researcher in a comfortable situation, since a possible bias can be observed more easily.

(4) Finally, the net sample needs to be adjusted for design effects introduced by the sample design. If the sample design, for example, would ask for a disproportional stratified sample an appropriate weighting procedure would have to compensate for the unequal selection probabilities when estimating the population parameter. In addition, the net sample may be adjusted for a possible non-response bias (=re-dressment) – even though this is a questionable procedure (Schnell 1997). Both procedures require complex computations considering information from the gross sample or from official statistics. While the first approach may potentially increase the random error of the estimate, re-dressment may introduce systematic errors into the sample and thus a bias of the estimate.

1.2 Total survey error components affecting measurement

The four sources of error discussed so far are related to the representation of the target population by the weighted net sample. Coverage error, sampling error, non-response error and adjustment error all potentially contributed to the random error or systematic error of the survey estimate. The next three sources of error are concerned with the measurement process. First we will discuss the specification error, then we will cover the measurement error and finally we will address the processing error:

(5) Most concepts of interest in survey study cannot be observed directly. Instead, the measurement requires researchers to operationalize and translate the concept into questionnaire items that can be asked by interviewers and answered by respondents. For example, the general public's attitudes on illegal immigration need to be decomposed into several items describing various aspect and dimensions of illegal immigration. Respondents are then supposed to report their degree of agreement with these items. The combined score of all items on this subject would then be treated as a measurement of the attitudes on illegal immigration. If an important aspect of this concept would be missing on the scale the validity of the operationalization would be harmed because the scale would not measure the defined concept completely and a specification error would occur. Usually, this results in a serious bias because the estimates based on an incomplete scale would not mirror the complete true attitudes of the members of the target population on illegal immigration. Unfortunately, the specification error is hard to determine, it requires a qualitative assessment and it is not based on standard procedures, so far.

(6) The measurement error is a rather complex component of the total survey error (Lyberg et al. 1997). It consists of various elements that may cause individually and jointly systematic survey error as well as random survey error. Accordingly, measurement error potentially contributes to an increase of the estimate's variance as well as to its bias. Measurement error arises from the mode of survey administration, from the questionnaire or survey instrument and from the setting in which the instrument is administered, from the interviewers (if present), and also from the respondents (Lyberg et al. 1997).

Survey mode: The traditional trichotomy differentiates face-to-face surveys, telephone surveys, and self-administered surveys. They differ with respect to the presence or absence of an interviewer - which allows for various degrees of standardization of the measurement process and also for different types of motivational support as well as explanation and help for the respondent - and the dominant communicative channel (audio-visual, audio-only, visual-only). In recent years, many new survey modes have evolved with the introduction of modern information and communication technologies. Some of these modes transfer an established methodology into a computer-assisted mode (Couper et al. 1998), other new modes evolve as a consequence of merging survey modes (Conrad and Schober 2008). Each of these survey modes has its particular strengths and weaknesses for specific survey topics and survey designs. While a Web survey might increase the variance of an estimate because respondents tend to answer a frequency question superficially compared to a face-to-face interview, the response to a face-to-face version of the very same questions might be prone to a higher degree of social desirability distortion which in turn contributes to measurement bias.

Questionnaire: Over the past 25 years questionnaire design has been seriously developed from an “art of asking questions” to a “science of asking questions” (Schaeffer and Presser 2003). This line of research has demonstrated on innumerable occasions that slight modifications of the wording of a question or the response categories, of the order of the questions and response categories and also the visual design of the whole questionnaire as well as of single questions affect the answers obtained from the respondents. Since the early days of the CASM movement, a multiplicity of research papers and text books (Sudman et al. 1996; Tourangeau et al. 2000) contributed to a coherent theoretical approach that helps explain and predict random measurement error and systematic measurement error related to the questionnaire.

Respondent: Also in the framework of the CASM movement a detailed theoretical approach on how respondents consider and answer survey questions has been developed. As a result, the question-answer process has been described in great detail. Using this framework several systematic and random respondent errors when answering survey questions have been identified. For example, satisficing behavior - as opposed to optimizing response behavior (Krosnick and Alwin 1987) - as well as mood effects and a “need for cognition” have been demonstrated by methodological research.

Interviewer: Finally, it was demonstrated that personal and social characteristics of interviewers - if present in the interview situation - as well as their task related and non-task related behaviors may have a considerable influence on the answers obtained from the respondents. Accordingly, in addition to a study specific instructions a professional interviewer training that focuses on general aspects of the interviewers' duties and responsibilities has been strengthened. However, one has to be aware that it is impossible to avoid individual respondent reactions to personal and/or social characteristics of an interviewer, since interviewer administered surveys require a personal encounter of respondents and interviewers.

(7) Processing and editing of the responses: In addition to the error components mentioned so far, the errors when editing the survey responses obtained from the respondents have been included into the total survey error framework. Poor handwriting with open questions, the treatment of inconsistent responses and of answers that were initially not codable as well as the classification of occupations are just a few examples of possible errors on the editing stage of a survey. Also, scanning paper forms using OCR technology or keying the answers from a paper questionnaire into a database are prone to errors. In addition, some crucial responses may be imputed in the presence of item non-response which is also susceptible to random or systematic error. Accordingly, these survey steps and the errors associated might either increase the variance of a variable - which in turn inflates the standard error and the margin of error - or compromises the accuracy of a response because a bias is introduced.

1.3 A simplified formula for the mean squared error

Technically speaking, the total survey error is the difference of a sample estimate and the respective parameter in the target population. This difference is measured by the mean squared error (MSE) which in turn consists of two components: the squared sum of the bias components plus the sum of the variance components (Biemer and Lyberg 2003, for an intuitive discussion of this concept). For the mean squared error we need to combine both bias and variance from all sources to obtain an estimate of the total survey error. Even though, most sources of error contribute possibly to a bias and to the variance simultaneously, some error sources are predominantly responsible for an increase of either variance or bias. Thus, a simplified formula for the mean squared error is as follows:

$$MES = (B_{spec} + B_{meas} + B_{proc} + B_{cov} + B_{nr})^2 + VAR_{meas} + VAR_{samp} + VAR_{adj}$$

where the abbreviations have the following meaning:

B_{spec} Specification bias/reduced validity

B_{meas} Measurement bias

B_{proc} Processing bias

B_{cov}	Coverage bias
B_{nr}	Non-response bias
VAR_{meas}	Measurement variance
VAR_{samp}	Sampling variance
VAR_{adj}	Adjustment variance

Even though it is easy to estimate sampling variance - every introductory statistic text book covers basic approaches in order to compute the sampling variance - it is less than trivial to estimate the other types of variance and especially the biases. Thus, the mean square error as a measure for the total survey error is often only of heuristic value, because the exact value of a particular variance or bias component cannot be computed.

The mean squared error offers the opportunity to evaluate survey designs and the estimates computed based on these survey designs. Thus, when reporting the results of a survey "users" of particular survey can assess the quality of the estimate not only based on sampling error and the margin of error but also based on other error components. This is especially important, since the bias component of the mean squared error is assumed to exceed the sampling error. Thus, the sample estimate of the population parameter departs usually more pronounced from the true value than assumed based on the sampling error alone.

1.4 Some pros and cons of the total survey error framework

Even though the total survey error offers a convincing framework for the accuracy of a survey estimate, it also suffers from a serious drawback:

The effort necessary to compute a reasonable estimate of the magnitude for a particular error component usually exceed the available resources. The estimation of the mean square error requires multiple repetitions of the survey design, which is usually too costly and also not feasible since the target population does not remain unchanged in between the repetitions. Also, for many survey designs some error components are not accessible because of the field procedures applied or legal constraints (e.g., privacy laws prohibit extensive non-response follow-up studies in many countries). Also, it should be noted that for the exact computation of the mean square error the parameter needs to be accessible. Because this is usually not the case the means square error is seldom explicitly determined in practice. More often only a few key components are estimated or a survey design is rated along the various components of bias and variance on a scale from "low" to "high". The decision for a particular survey design is then taken based on a detailed computation of some error components and a rough assessment of the magnitude of the other error components. This leaves the researcher as well as the user of a survey statistic in a situation where a qualitative assessment of the magnitude of the total survey error is the best available assessment.

Regardless of this serious limitation of the total survey error framework, survey research and survey methodology have greatly benefited from the emerging total survey error approach.

(1) The total survey error framework makes researcher aware of possible errors in their survey statistics. If the response rate and the size of the net sample are the only noticeable indicators for a given survey, many likely biases remain undetermined. Thus, the total survey error framework motivates a systematic reflection on possible impairments of survey quality. Thus, it stimulates a professional evaluation of ongoing surveys in terms of data quality and provides a common language and terminology for a critical discussion.

(2) In addition, the total survey error framework provides a theoretical explanation for the various types of possible errors (variance and bias) and also for the underlying mechanisms (random error vs. systematic error). Also, it names a wide range of possible sources for the nuisance of data quality. Hence the total survey error framework suggests a theoretical approach for further developments of the survey methods beyond a traditional "keep at it!" In addition, it provides measurable indicators in order to evaluate the improvements introduced by these new survey methods.

(3) Also, the total survey error framework has provided a basis for an interdisciplinary discourse across the boundaries of traditional disciplines. Surveys have been used for a long time among others in sociology, psychology, economy, and educational research. Even though, it is too early to state an integration of the field-specific methodologies, one can say that the survey branches of the subject-specific methodologies have merged or at least are in the process of integration based on the total survey error framework and the survey methodology.

(4) Also in an international perspective, the integrated concept of a total survey error has contributed to the dissemination of similar quality criteria and a set of methods in order to meet those criteria. International survey endeavors like the Programme for International

Student Assessment (PISA), the International Social Survey Program (ISSP) or the European Social Survey (ESS) would not be feasible, if researchers of diverse cultural and disciplinary backgrounds could not interact and cooperate in a common framework. Even though there are still many national specifics in the design and the administrations of a survey, a minimum degree of concordance in the assessment of the data quality is stimulated by the total survey error framework.

2. Survey error and survey cost

The survey designer's goal is to reduce the total survey error by proper design decisions in the preparatory stage of a survey and throughout field work. Most of the time, however, design decisions - like a certain mode of administration, a particular question format or a special interviewer training procedure - do not only affect one specific source of error, but rather multiple sources. Thus, each improvement in terms of a particular error source may be accompanied by an increase of some other error. Thus, survey designers need to compromise and balance several sources of error.

The total survey error framework offers the opportunity to determine the relative importance and weight of various error components in a given survey. Even though not every component can be determined for each survey, an evidence-based assessment of multiple error sources is possible. Once the existing body of literature on the various error components is rounded off and extended, researchers can choose cost efficient strategies that help reduce the total survey error (Groves 1989). However, in practice survey designs are not only evaluated in the presence of fixed constraints in term of time and money; often survey design A in preferred even though it produces data of lower quality in terms of the means squared error compared to survey design B. However, because the estimated cost for survey design B is considerably higher the person responsible for the survey would nevertheless decide to apply survey design A.

Thus, the total survey error framework also relates to cost and requires survey designers to consider the accuracy in relation to cost and timeliness of reporting. This raises the danger that researchers sacrifice the quality of their survey to cost. However, since the total survey error approach requires researchers to document and to publish key information on each survey, the scientific community can easily assess to what extent researchers have compromised the quality of their survey to cost constraints. It is hoped that this will prevent researchers from taking design decision solely or predominantly in the light of the cost involved. The acceptance of the total survey error framework would greatly benefit, if funding agencies would require applicants to make use of this approach in their proposals.

3. Organizational issues

Even though, the total survey error approach offers a set of standardized terms, concepts and measures, it needs to be adapted to the respective surveys, topics and also to the country specific conditions. In addition, the total survey error framework implies an evidence-based discussion of methodological issues and in turn advice and rules that is based on empirical tests and evaluations. Thus, a country-specific thorough assessment of the various components of the total survey error is needed, either in the form of an evaluation of ongoing surveys in the field, or in the form of independent experimental studies in the lab or in the field. While experimental studies on methodological issues provide basic knowledge and allow for the testing of methodological concepts, they lack applied results for the direct benefit of ongoing surveys. By contrast, in an evaluation study embedded in an ongoing production survey researchers are limited in the degree to which the experimental design of the methods study tests innovative approaches since highly risky designs might harm the quality of the production data. Based on this reasoning the advancements of the total survey error approach should be promoted by means of a strategy combining methodological evaluations in accompany of ongoing large scale surveys and stand-alone experimental studies or laboratory experiments.

Until recently, methodological research was backed by weak resources. Methods studies were either conducted as addendums to substantive surveys - which limits the scope and design of the methods study - of they were conducted with student populations or were otherwise restricted in their generalizability. Of course, the former ZUMA (now continued as a department of GESIS) has a long tradition of methodological research. Nevertheless, given a lack of resources the studies conducted elsewhere were usually either specialized with respect to specific surveys o - if conducted independently - limited in their size and thus in the broader impact of the results in the scientific community. In the past few years two extensions were to be noticed: On the one hand several large-scale surveys have started to use their own survey operation in order to evaluate new modes, innovative instruments, or means of reducing non-response. On the other hand, the projects funded by the German Research Foundation (DFG) since 2008 in the Priority Program 1292 “Survey Methodology” have the potential to function as a nucleus for a broader movement towards basic methodological research. Based on these experiences it seems advisable to promote a twofold strategy: (1) Methodological research should be implemented as part of every large scale survey funded by public resources. A respective research plan for methodological studies should already be incorporated in the design-stage of the respective survey and should be backed by a certain percentage of the overall funding (e.g. 5% of the total funds allocated to a particular survey). The research plan for the methods study should already be specified in the proposal for the surveys and evaluated by survey methodology experts according the same high standards as the proposal of the substantive study.

Unlike in the US and some other countries, German academic researchers do not have full range field organizations at their disposal. Even though several universities have built small to medium sized CATI facilities and some medium sized online access panels are available as well, the majority of the field work is conducted by private market research institutes. In order to promote the total survey error framework, a universal application of this concept in needed across all sectors including academia, official statistics and the private sector. At present, the GOR conferences (with respect to Web surveys), the meetings of the Section on Quantitative Research Methods in the German Sociological Association and a few other small scale events are the only occasions where researchers from academia, from the private sector and from official statistics come together and maintain joint methodological discussion. This is by far insufficient. In this respect the annual conference of the American Association for Public Opinion Research might serve as a role model for a similar conference scheme in Germany.

So far, high rank permanent academic positions in the field of survey research are usually filled with experts in substantive research areas who are also qualified as survey experts and in particular as survey statisticians. Thus, for junior researchers it is hard to build a carer predominantly on survey methodology or even on a specialization in this field (e.g., sampling, measurement, or non-response). However, a professionalized survey methodology needs an infrastructure of experts who fully focus on the various components of the total survey error. Thus, in addition to survey experts in substantive fields and to survey statisticians, experts in data collection and survey methodology should be considered more often in the selection processes for permanent academic positions. In the past few years a few positions were deliberately offered to this group. Further actions should be taken in order to provide survey methodology with a sufficient human resource basis.

In order to disseminate survey methodology and the total survey error framework a few specialized master study programs are about to emerge in Germany. Given the long standing tradition of such programs in the US (e.g. Ann Arbor and the JPSM) and the UK (e.g. Essex) one could expect positive effects in Germany as well. Also, so far doctoral education in the field of methods research is offered on an individual basis only. Accordingly, a structured doctoral program that offers a set of integrated courses in survey methodology needs to be established.

A key challenge for the development of high quality survey research is the adoption of joint quality indicators and common standards for each of the qualitative measures. The rather diverse use of response rates and measures of non-response in the German discussion is a good example on how survey research could benefit from an integrated quality concept. Whether we should adopt the English terminology or whether we should develop a German terminology for the same concepts needs further discussion. In our view, the use of the English terms has the advantage that the words are clearly marked as technical terms. In addition, the use of a shared English language terminology facilitates the collaboration in international surveys such as the ESS of EU-SILC. Also, when using the international terminology it is easier to take part in the international discussion on conferences and in journals.

4. Summary of recommendations

In sum, this paper does not suggest a completely new approach in the methodological research on survey methods. It rather proposes an integration of the existing work into the total survey error framework and a rigorous application of this concept and other knowledge from the field of survey methodology in the planning and in the assessment of surveys. Also, it recommends the advancement of evidence-based rules and strategies for the improvement of surveys. This requires evaluation and validation studies embedded in ongoing surveys as well as independent experimental studies in the field or in the lab that are not bound within the limits of the existing ongoing surveys. The following recommendations summarize key elements of a strategy in support for this general suggestion:

- The total survey error framework should be adopted as standard to describe and assess the quality of surveys. Since this concept asks for the documentation of various variance and bias components associated to a particular survey, this will promote the methodological reflections and considerations in the planning phase of a survey, in its field phase as well as during the analysis.
- The error components of a particular survey should be assessed based on evidence gained in evaluation studies or through experimental work.
- Strategies und rules on how to improve the quality of surveys in general should be evidence-based. Experiments in the field and in the lab are key elements in support of evidence-based rules and strategies.
- Funding for methodological research in the total survey error framework should be provided in the context of ongoing large-scale surveys (5% or the overall budget for a particular survey) as well as by national funding agencies for independent experimental studies in the field and in the lab.
- Accordingly, the total survey error framework should be made mandatory by funding agencies. Applicants should be required to make use of this approach in their proposals.
- While recruiting for academic positions in the field of survey research at universities or similar research institutions (associate and full professors), successful candidates should not only be recruited from substantive areas or from the field of survey statistics. An addition, survey methodologists with a record of publications and projects in the various components of the total survey error should be considered. This will help establish expertise for survey methodology and contribute to the professionalization of survey methodology.
- In order to maintain a consistent flow of graduates and postgraduates in the field of survey methodology the emerging specialized master programs should be strengthened. Also, at least one structured doctoral program with an international teaching staff should be established in Germany.
- The further development of survey methodology in Germany should be fostered and flanked by the introduction of a featured international journal which offers a forum for survey methodologist for peer reviewed papers on data collection in English language.
- An annual joint conference of survey methodology experts from the academic sector, the private sector and from official statistics should be established in order to promote

and foster the use of the total survey error framework in survey research across the three sectors in Germany.

As these recommendations are set into practice, survey methodology will evolve as a professional “cross-disciplinary discipline”, that contributes to survey research in economic research, in sociology, political science, health research, educational research, consumer and market research and any other field in the academic sector, in the private sector and also in official statistics.

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