Survey Error: It's Implication on Research and Possible Remedies.

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ABSTRACT

This paper identifies and describes the primary sources of survey error in mail surveys and some methods typically used to assess and quantify some of these sources of error. Four sources of survey error-sampling error, non-coverage error, non-response error, and measurement error were discussed. Descriptions of how each of these sources of error occurs in mail surveys are provided. The paper summarizes ways of reducing these errors, if they cannot be totally avoided.

(Keywords: survey error, sampling error, non-coverage error, non-response error, measurement error, true score model)

INTRODUCTION

Surveys, perhaps the best method to describe and observe large population directly, make it possible for collection purpose of making inferences on the entire population at large. They may be used to explore, explain, describe or determine the characteristics of the whole member of the n of data/ information for target population. Surveying every member that makes up a population of interest would be costly, time consuming, and at times inconvenient. Therefore, selecting a sample that represents the whole population under study is more realistic.

For the simple fact that they cost less and easy to implement, less time consuming and more advantageous to people with hearing problem, mail surveys are used more frequently in researches more than other types of surveys such as telephone or face-to-face interviews (Dillman, 1991 and Wei Wei Cui, 2003). Since each survey method has the potential for error or inaccuracy, researchers conducting surveys should take cognizance of and recognize four potential sources of error-sampling error, non-coverage error, non-response error, measurement error. Any one or group of these sources of error may render and make survey results unacceptable: Grove (1989), Salant and Dillman (1994), and Dillman (1991, 1999).

This paper identifies and describes the four sources of survey error in mail surveys. Some methods of assessing and quantifying these errors are highlighted. Above all the paper summarizes ways to reduce these errors.

SOURCES OF SURVEY ERROR IN MAIL SURVEYS

Sampling Error

Sampling error is the result of surveying a sample of the population rather than the entire population. In other words, it occurs when only a subset of the target population is surveyed yet inference is made about the whole population.

Assuming that no difference exists between the population of interest (inference) and the target population, the sampling error is imply a quantification of the uncertainty in the sample statistics. This uncertainty can be divided into a variance component and a bias component. Groves (1989) stated that variance characterizes the variability in the sample statistics that arises from the heterogeneity on the survey measure (or estimate) among the population. In other words, variance characterizes the variability of an estimate that stems from the fact that different drawing a different sample will result in a different estimate. Bias on the other hand is the systematic and the actual population parameter of interest.

Mail surveys, like all other surveys, collect information only from the people who are included in the sample. Because certain members of the population are deliberately excluded through selection of the sample, their responses are not obtained. Conclusions about the population at large are thus drawn from samples survey results. The heterogeneity of the survey measures among members of the population (in other words, the degree to which it does not represent the entire population) will cause the so-called sampling error.

Sampling error is examined through inferential statistics applied to the sample survey results. When thinking most simply about the precision of statistical estimates that are drawn through probabilistic sampling mechanisms, such estimates are improved by large sample sizes, which can be achieved by either selecting a larger sample of potential respondents to begin with or minimizing non-response through various mechanisms or combination of both approaches.

Increasing sample size will generally decrease sampling error when simple random sampling is used. For example, when the sample size is increased from 100 respondents to 1,000 respondents, for a simple random sample, the sampling error decreases from 5% to 3% (Cui, Wei Wei, 2003). Survey organizations tend to consider this an acceptable trade-off between precision of estimate and costs, that is, increase in sample size will definitely bring about increase in costs of the survey. Most national polls in developed countries, for example, reported a 3% margin of error (Cui, Wei Wei, 2003).

For simple random sampling, the margin of error for proportion:

$$\dot{P} = \pm Z \quad (1)$$

Where **p** denotes the sample proportion, n is the sample size and z represent the critical value from standard normal distribution for the desired confidence level. For the **95%** confidence level and a reasonable sample size, **Z = 1.96**. The margin of error is widest when **P=0.5**

In the absence of significant non-response, the probabilistic sampling mechanism, such as simple random sampling scheme is assumed to minimize the possibility bias. Convenience sampling on the other hand is generally assumed to result in biased samples (which always increase sampling error) because the mechanism that generated the sample is not understood (that is, the probability with which an individual is selected into the sample is not known). Convenient sampling frequently is undertaken because it is either too difficult or too costly to create a sampling frame.

Non-Coverage Error

Any discrepancy between the sampling frame and the target population is referred to as coverage error. In other words, if some members of the population are not yet covered by the sampling frame, they have no chance of being selected (or included) into the sample, non-coverage error results. Furthermore, coverage error is the result of all units of a population not having a known non-zero probability of inclusion in the sample which is drawn to represent the population.

Groves (1989) specifies four different types of populations:

(i) The population of inference : this is the population about which the researcher ultimately intends to draw conclusion

(ii) The target population: is the population of inference minus various groups that the researcher has chosen to disregard

(iii) The frame population: is the portion of the target population that can be enumerated via a sampling frame.

(iv) The survey sample consists of those members of the sampling frame who were chosen to be surveyed.

Coverage error, in the light of the above is generally defined as the difference between the statistics calculated on the frame population and on the target population.

Non-coverage error is one of the major reasons that mail surveys have not been as useful as desired in surveying the general public as noted by Cui, Wei Wei (2003). If complete, up to date lists of populations were available, non-coverage error would not exist. As observed, however, by Cui, Wei Wei (2003); there are no up-to-date lists that provide complete coverage of all households in the United States. The situations on this issue in all the developing countries are even worse. Telephones directories are often out- of –date and also don't include the small number of households without a phone. Cui, Wei Wei (2003) observed further that a sizable number of households in developing countries do not have phones. Likewise, driver's license lists do not cover the population. The two most common approaches towards reducing non-coverage error generally are:

(1) Obtaining as complete a sampling frame as possible; and

(2) Post-stratifying to weight the survey sample to match the population of inference on some key characteristics.

(3) In some cases, it is also possible to employ a "frameless" sampling strategy that when properly designed may allow every member of the target population chance to be sampled.

Non-Response Error

This occurs when individual respondents do not participate in any part of the survey (unit non-response) or respondents do not answer individual survey questions (item non-response).

Grove (1989) stated that "non-response is an error of non- observation". The response rate, which is the ratio of the number of respondents to the number sampled, is often taken as a measure of goodness. Higher response rates limit the severity of the non-response bias.

When methodological statements are made about surveys, it is the response rate that is often mentioned first. Response rates are measured relative to the size of the sampling frame and therefore are only good as the sample frame itself. Any discrepancy between the sampling frame and the target population is referred to as non-coverage error.

No matter how carefully a sample is selected, some members of the sample simply do not respond to the survey questions. When those who respond to the mail survey differ on the survey measures from those who do not, non- response error will become a problem. A low response rate does not necessarily lead to non-response error. However, whether differences exist between the responding and non-responding segments of the sample is not known when the survey is conducted. Therefore, low response has long been considered the major problem of mail surveys and the vast majority of research on improving mail survey methods has focused on response rates (Cui, Wei Wei, 2003).

Research studies have successfully identified methods for improving response rates and individual factors associated with improved return rate (Cui, Wei Wei, 2003). Heberlin and Baumgartner (1978), for example, used the technique of meta-analysis to test the predictability of 71 characteristics on response rate. They determined that a ten- variable model predicted 66% of the variation in the final response rate. Seven of the ten variables were found to have positive effect on response rate:

(i) The number of contacts: more contacts will increase the response rate. Advance letters, post cards, follow-ups that include additional copies of questionnaires and even telephone calls are all examples of such contacts.

(ii) Topic Salience: Questionnaires are more likely to be returned if respondents consider them relevant. A very common reason given for non-response is that the survey doesn't mean anything to the person who received it.

(iii) Government Sponsorship: Government-sponsored survey research had higher response rates than that from private organization

(iv) Employee population: Samples from some special subgroups, such as employees from certain occupations are more likely to return survey research than the general population

(v) School or Army Population: Students and military questionnaires than the general population.

(vi) Special Third Contact: following up the advance letter and initial follow-up with the use of special mailing procedures such as certified mail or special delivery or with personal or special delivery or with personal or telephone contact increases the telephone response rate.

(vii) Incentive on the first contact : incentives included with the first mailing will increase on response rate:

Three factors were found to have negative effect on response rate:

(i) Marketing Research Sponsorship: market research surveys in which the information will benefit the firm have lower response rates.

(ii) General population: Samples drawn from the general population have lower response rates

(iii) Questionnaire Length: Questionnaires with more items or more pages have a lower return rate.

Goyder (1982) replicated this study with similar results, except that the negative effect of market research sponsorship disappeared. Church (1993) using meta-analysis, tested the effects of four types of incentives-monetary (cash and check) and non-monetary (entrance to lottery, donation to charity, coffee, books, pens, key rings, clips, golf balls, stamps, etc.). Incentives mailed with the survey and monetary and non-monetary incentives given upon the return questionnaire. His findings demonstrated meaningful increases in response rates only for the two initial mailing incentive conditions and not for those where the incentives were made contingent on return response. Further, no statistically significant difference was found between monetary and non-monetary incentives.

Eichner and Habermehl (1981), using studies from Austria and West Germany, suggested potential cross-cultural differences. In contrast to Americans, the European data suggested that government sponsorship has negative effect on final response rate, while general population and questionnaire length have positive effect.

Fox, Crask, and Kim (1988), using different meta-analysis method, identified the following six methods of improving response rate. There is little or no interaction effect among these factors:

- University Sponsorship (versus business sponsorship).
- Pre-notification by letter.
- Stamped return postage (versus business reply).
- Postcard follow-up, first class (versus second class and bulk) outgoing postage.
- Green questionnaire (versus white questionnaire).
- A small monetary incentive.

Armstrong and Luske's research (1987) also shows a positive effect for applying postage to a return letter (versus including business-reply envelopes).

The Total design Method for Improving Return Rates

An attempt has also been made to construct a comprehensive system of procedures or techniques to obtain high response rates. Total Design Method (TDM) developed by Don Dillman (1978, 1991) is comprehensive system used to accomplish higher response rates for mail surveys. Guided by social exchange theory, TDM emphasizes hoe the elements fit together more than the effectiveness of any individual techniques, though most of the important factors identified by the previous studies are included in TDM. Social exchange theory posits that questionnaire recipients are most likely to respond if they expect that the perceived benefits of responding will outweigh the perceived costs of responding. According to the theoretical frame of TDM, the questionnaire development and the survey implementation process is subject to three considerations:

(1) Reducing the perceived cost, such as making the questionnaire short and easy to complete,

(2) Increasing perceived rewards, such as making the questionnaire itself interesting to fill out and;

(3) Increasing trust, such as using official stationery and sponsorship.

Specific TDM recommendations include the following:

- Let the interesting questions come first.
- Use graphics and various question-writing techniques to ease the task of reading and answering the questions.

- Print the questionnaire in a booklet format with an interesting cover.
- Use capital or dark letters.
- Reduce the size of the booklet or use photo to make the survey seem smaller and easier to complete.
- Conduct four carefully spaced mailings: the questionnaire and a cover letter for the original mailing; a postcard follow-up one week after the original mailing; a replacement questionnaire and cover letter indicating that the questionnaire has not been received four weeks after the original mailing; and a second replacement questionnaire and cover letter to non- respondents by certified mail seven weeks after the original mailing.
- Include an individually printed, addressed and signed letter.
- Print the address on the envelops rather than use address labels.
- Use small stationery.
- Let the cover letter focus on the importance of the study and the respondent's reply.
- Explain that an ID number is used and the respondent's confidentiality is protected.
- Fold the materials in a way that differs from an advertisement.

Although some research studies (for example, Jasen, 1985) question the effect of some parts of the TDM procedure, such as photo reduction, there is evidence that when TDM is used, the response rate typically reaches 50 to 70 percent for surveys of the general public, and 60 to 80 percent for more homogeneous groups where low education is not a characteristics of the population (Dillman, 1978, 1983). It should be noted; however, that while TDM is a one-size-fit-all method, different survey situations may require quiet different procedures. For example, some surveys may require personal delivery, some may entail completion of diaries for certain days of certain weeks and other may require the surveying of the same individuals year after year.
Survey researchers have realized that mixed-mode surveys in which some respondents are surveyed by mail questionnaires, some by electronic mail, some by telephone and others by face-to-face interview can help increase the response rate over that of a typical mail survey.

To adapt the original TDM to different survey situations, including those involving the internet, Dillman developed a new method, called the Tailored Design Method (1999) in which base elements are shaped further for particular Populations, sponsorship and content.

Measurement Error

Unlike sampling error, non-coverage error and non-response error which arise from non-observations or non-participation, measurement error results from mistakes made by respondents. In am mail survey, data are collected by obtaining questionnaires filled in by the addresses (i.e the respondents). A packet containing a request latter, a printed questionnaire and a postage-paid envelop is mailed to the addressee. This questionnaire, for example, lists questions with their expected replies (options), grouped into suitable number of mutually and exhaustive boxes. A respondent has simply to reply a question by placing a check that purpose. This box is termed check-box which is a square for checking off a reply on a questionnaire.

Measurement error in a mail survey as described above arises when the check-boxes are not correctly checked off. This can happen when a respondent misunderstands a question. Respondent's negligence or oversight here may lead to a wrong placement of check in the box. On many occasions an addressees may pass on to other the questionnaire for filling in. this may also give rise to measurement errors.

The following models help a long way in assessing measurement error in a mail survey:
The model: for the hypothetically mail survey described above: Let X_i be the true value (or true score) for respondent I; and let X_i be the observed variable (i.e a reported sample value) for person I, both of X characteristics for the i^{th} population unit. A true Score Model can be written as :

$$x_i = x_i - x_i \quad (2)$$

In the True Score Model, the observed value is equal to the true score and a measurement error. The true score is a latent variable that cannot be measured perfectly (Peytchev and Emilia Peytcheva, 2006). The difference between X_i and x_i is called the measurement error for the i^{th} population unit, i.e.:

$e_t = X_t - x_i$ **(3)**

the process of filling in a questionnaire can be repeated which gives rise to hypothetical infinite population. The particular questionnaire replied by the respondent is an observation from this population. This questionnaire is marked "a" symbolizing respondent's attempt. Now, the model changes to:

$e_{i\alpha} = x_{i\alpha - x_i}$ **(4)**

consider a typical question with only two possible replies, either 1 or 0. Let λ be the proportion of X with 1. We assume that there is a probability ε *that the respondent checks off wrongly.*

Thus, if:

Xt = 1, then E($X_{i\alpha/i}$) = 1- ε **(5)**

On the same lines if $X_j = 0$,

Then E ($X_{j\alpha}$ /i) = ε **(6)**

We determine the unconditional probability P that X is one, we have:

$P = \{1 - E(\varepsilon / X_i = 1)\} \lambda + (1-\lambda)\{E(\varepsilon / X_j = 0)\}$
$= (1-\theta)\lambda + (1-\lambda)\theta$

Where,

$\Theta = E(\varepsilon / X_i = 1) = E(\varepsilon / X_j = 0) = -\lambda - \lambda\theta + \theta - \lambda\theta = \lambda + \theta - 2\lambda\theta = \lambda + \theta(1 - 2\lambda)$ **(7)**

Incidentally, θ may be termed the probability of checking off a box wrongly. The bias B is as follows. It is interesting to note that the bias vanishes when:

$\lambda = \frac{1}{2}$ **(8)**

In other to improve the measurement of the latent construct of interest, researchers often use multiple measures to identify it: Thus the true score can be replaced by multiple measures. We restate the true score model in equation 1 in terms of a multiple regression of observables.

$X_i = \alpha + \beta x_i + \beta z_i + \varepsilon_i$ **(9)**

Details of this model are given fully by Peytchev and Emilia Peytcheva (2006).

Measurement error results when respondents fill out surveys, but do not respond to specific questions or provide inadequate answers to open-ended questions or fail to follow instructions telling them to skip certain sections depending on their answers to previous questions. Measurement errors also arise from lack of control of the sequence in which the questions were asked, and various respondents' characteristics (Cui, Wei Wei, 2003). These problem areas tend to be balanced by two advantages of mail surveys: the absence of an interviewer lessens the likelihood both of respondents' feeling driven to provide socially desirable response and interviews' accidental or purposeful subversion of the purpose of the survey (Dillman, 1978).

Measurement errors are generally the results of inaccurate response stemming from poor question wording, poor interview, survey mode effects and / or the respondents behavior (Groves, 1989). Biemer and others 1991 identify four primary sources of measurement error:

- Questionnaire: the effect of the questionnaire design, its visual layout, the topic it covers and wordings of the question, length of questions, order of the questions, open and closed formats and the questionnaire itself.

- Data collection method: the effect of how the questionnaire is administered to the respondents- mail, face-to-face or diary. Respondents may answer questions differently in the presence of an interviewer, by themselves or by using diary.

- Interviewer: the effect that the interviewer has no response to a question. This effect excludes mail surveys since the respondents are to complete the questionnaire on their own.

- Respondent: the effect of the fact that respondents, because of their different experiences, knowledge and attitudes may interpret the meaning of questionnaire items differently.

These four sources are critical in the conduct of a sample survey. The questionnaire is the method of formally asking the respondent for information. The data-collection mode represents the manner in which the questionnaire is delivered or presented (self-administered or in person). The interviewer, in the case of the in- person mode is the deliverer of the questionnaire. The respondent is the recipient of the interest for information. Each can introduce error into measurement process. The source can, however, interact with each other. The ways in which measurement errors may arise and approaches to quantify them in the context of these four error sources are discussed comprehensively by Daniel Kasprzyk (2005) in his paper, "Measurement Error in Household Surveys: Sources and Measurement".

SUMMARY

Overall, we have so far identified and discussed four sources of survey error as they affect mail survey- sampling error (the result of surveying a sample of the population rather than the entire population); non-coverage error (the result of all units of a population not having a known, non-zero probability of inclusion in the sample which is drawn to represent the population) non-response error (the result of non-response from respondents in the sample who if they had responded, would have provided different answers than those who did respond to the survey); and measurement error (the result of inaccurate response stemming from poor question wording, poor interviewing, survey mode effects and /or the respondents behavior).

In this regard, we have followed Groves (1989), and his elaboration of the four fundamental sources of survey error with diver's approaches from many perspectives on improving quality survey data by assessing and reducing these sources of errors.

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