SAMPLING AND NON-RESPONSE: A METHOD FOR DECIDING UPON A FOLLOW-UP SAMPLING STRATEGY

Edward J. Lusk and Ruth A. Pagell, University of Pennsylvania

Survey research depends fundamentally upon the use of statistics to make inferences from a sample. Researchers routinely plan surveys to consider the sample size necessary to make inferences with a specified level of precision.

The sample size calculation very often is done recognizing that the survey will not receive a 100% response. After the survey has been sent and the returns received, the researcher analyzes the responses and reports the results. Sometimes the number of the non-respondents is reported or the percentage of the responses is reported.

In many situations, the percentage of respondents is less than 50% of the total sample. Armstrong and Lusk (1984) in a review of studies found the average return rate to be 46%. Even when the response rate is low, researchers often use the survey results to make an inference. They rationalize these inferences by showing that the respondents and non-respondents do not differ demographically. While demographically similar respondents and non-respondents sometimes share the same opinions (Westerhover, (1980)) such is not always the case. (Rosenthal and Rosnow (1975), Ogren (1975) and Schwirian and Blaine (1966)). However, as is apparent from the literature, researchers seem to feel that if enough responses are received to justify utilizing the usual statistical methods, then the researcher is justified in making an inference. This scenario is adequate from an experimental design perspective only if the non-respondents are distributed in a way so as to leave the inference unchanged.

Given the presumed importance of survey data reported in the medical literature, we believe that for surveys reported in this literature the authors must provide an indication of the possible effect of the non-response bias regarding the inferences drawn from the respondents. The purpose of this paper is to suggest a method of dealing with the non-response bias which will give more definitive meaning to survey research inferences.

THE METHODOLOGY

It is assumed that the researcher has a hypothesis which can be tested using the questionnaire returns. The validity of the inference respecting the alpha error made from the respondents is dependent upon the number of non-respondents and the distribution of these non-respondents in relation to the respondents.

There are two situations which routinely are encountered in practice. The first is that the researcher is testing to ascertain the relationship between the population proportion and a hypothesized proportion. The second finds the researcher testing the relationship between two population proportions. In either case, the non-response bias may effect the validity of the inference made from the samples collected. The methodology for dealing with non-response bias is focused on these two cases.

If the researcher collects a sample which is large in relation to the number of non-respondents, the non-respondent effect on the inferences drawn from the sample will be of no consequence. In this case, the non-respondents could not have effected the inferences made regardless of their responses on the survey instrument. This fact should be reported in a statement in the text of the report or manuscript.

A more likely situation however is that the number of non-respondents is sufficiently large that the inference made from the sample depends upon the distribution of responses from the non-respondents. In this case, the following procedure is suggested:

1. Assuming the worst case regarding the distribution of the non-respondents, determine the number of non-respondents which would make the researcher indifferent regarding the inference made from the surveys received to date. Refer to this as the critical number.

This computation is slightly different for tests of a single proportion and tests of the difference between two proportions. Both cases will be illustrated in the next section.

2. Given the critical number of non-respondents, determine the number of non-respondents who should be contacted as the second sampling wave.

The minimum number of non-respondents should be surveyed. The minimum depends upon the inference made from the results of the first survey. In some cases it will require fewer responses to reject the null of the inference made from the data than to collect the responses to fail to reject the null.

3. The information received from the second sampling is analyzed similarly to determine if another sampling is required.

4. When the inferences are uneffected by the non-respondents the process stops.

Consider now a discussion of both a case and a hypothetical example which examine several technical aspects of this suggested process.

SURVEY OF UNORTHODOX PRACTITIONERS

Practitioners of unorthodox cancer treatments were being surveyed to collect a variety of information. One of the principle questions of the survey was how many of these individuals were practicing MDs. The list of unorthodox practitioners was compiled from a number of sources. At the time of the survey, 255 names had been collected. The sample was a convenience sample and reflected a geographic concentration of individuals practicing in the Northeastern part of the U.S..

The hypothesis of interest regarding the professional credentials of the individuals was that one-third of the individuals in the population of individuals who were unorthodox practitioners would be MDs. The results of the survey were that of the 130 individuals who responded, 60 percent were MDs. There was a statistically significant difference between the 60% and the 33 1/3% hypothesized. However, since there were a relatively large number of non-respondents, 125 in this case, the question of the possible effect of the non-response bias became an issue. It seemed logical to argue that the MDs would be more likely to respond. If none of the 125 non-respondents were MDs (the worst case given the survey results), the inferences would change since 78/255 is 31 percent and 31 percent would not allow the null of the hypothesis to be rejected at the level of confidence selected by the principal investigator (p .05).

Since the inference is effected by the possible distribution of the non-respondents, a second survey was planned to more definitely answer the research question implied by the hypothesis. The number of non-respondent MDs required to support the inference made from the results of the original survey was computed as follows.

The test used to make the inference was the test for a single proportion. Therefore, by estimating the standard error of the mean for the test of proportion it was possible to compute the number of non-respondents required to be MDs so that the researcher was indifferent to rejecting the null hypothesis, i.e., the critical number. Since the hypothesis was that one-third of the alternative therapy practitioners would be MDs and 130 responses had been received, the standard error was initially estimated as:

$$S = \left[\frac{(.67)(.33)}{130}\right]^{1/2} = .041$$

The sample size required to test for a significant difference from p=1/3 given an alpha of .05 is found by solving the following equation for x (the critical value):

$$\frac{\frac{78 + x}{255} - .33}{S} = 1.63$$

In this case, the critical value of x is 24. This means that if more than 24 non-respondents are MDs the inference made from the survey results is supported, regardless of the proportion of MDs in the remaining non-respondents. Alternatively to support the original hypothesis, 101 or more individuals would have to be non-MDs. In this case the sampling plan was organized to focus on the non-respondents who are MDs.

Assuming that 60 percent of the respondents are MDs and a 51 percent response rate, i.e. 130/255, the sample size of the second survey was estimated to be 79 i.e., 24/.6/.51. Now since the number of surveys has been estimated, the standard error should be recomputed using 209 as the denominator rather than 130. In this case, the reestimated standard error yields an x of 20 or a sample of 66 respondents. Recalculation of the standard error using 196 rather than 209 increases the value of x to 21 which suggests a sample size of 69. Further recomputation of the standard error does not alter the value of x. This information was used to select a random sample of 69 non-respondents.

To deal with the possibility that the non-respondents may have a lower response rate than that found initially, a special letter was prepared and non-respondents were phoned to inform them that they would be receiving a questionnaire. Prior notification has been used extensively to stimulate responses (Pressley (1980)). The response from this mailing was 53 returns, 24 of whom were M.D.s. This concluded the survey since the hypothesis that the proportion of M.D.s practicing alternative therapies was no more than one-third was not supported by the data and the number of non-respondents would not effect that inference. This may be demonstrated by noting that:

$$1.63 < \frac{(78 + 24)/255 - 1/3}{.03333}$$

In this case, the total of non-respondents sampled was about one-half of the non-respondents remaining after the first mailing. Given that the non-respondents were to be phoned and notified by letter, reducing the second survey by 50 percent resulted in considerable saving in both time and expense.

TESTING FOR THE DIFFERENCE BETWEEN TWO PROPORTIONS

Assume that the researcher is interested in sampling a population to ascertain if there is a difference in prevalence (characteristic A) between two groups of individuals (Groups 1 and 2). The difference in prevalence is to be tested by a statistical test of proportion. The researcher is interested in an alpha level of .95 and the test is two-tailed. A sample of 250 is decided upon and the survey instrument is distributed. The result of this sampling is 145 surveys are returned. Of these, 75 belong to Group 1 and 70 belong to Group 2. Of the 75 in Group 1, 45 have characteristic A while 14 in Group 2 have characteristic A. The test of proportion suggests that the null hypothesis, i.e., no difference, could be rejected. However, the validity of this inference depends upon the distribution of the non-response. The question is: could the non-respondents affect the inference? In this case, there are 105 individuals who have not responded. This number of individuals could affect the inference. To ascertain how many non-respondents must be surveyed, the following question is posed:

Given the alpha risk, what is the largest number of non-respondents which could not effect the inference? This is the critical number.

To answer this question, a number of assumptions must be made. For purposes of estimating the sample size needed to answer this question, it can be assumed that the proportions found in the sample are the same as those which exist in the population of non-respondents. If this were true, the number of observations needed to assure that the non-respondents could not effect the inference made from the first sample can be estimated by ascertaining the minimal difference in proportion which would make the test for the difference in proportion equal to the z value for the desired alpha at the point of indifference. Then the number of non-respondents can be allocated in the proportion of the sample until the number of non-respondents leaves the proportional difference equal to the minimal difference. The researcher must then determine the best way to reach the required number of non-respondents.

For example, in the situation constructed above, an additional 79 subjects are needed to respond. If these respondents are distributed as the respondents in the first sample respecting membership in group 1 and 2, the 26(i.e. 105-79) non-respondents will not effect the inference made from the first sample. Therefore, the researcher must determine a method of collecting the opinions of the non-respondents so that 79 are collected. We suggest letters and phone calls to inform the non-respondents that the survey will be delivered to them. The researcher should monitor the returns so that if there is an important change in the distribution of opinion, adjustments can be made in the critical number. This implies that the critical number changes as more information is collected.

DISCUSSION

This method of determining the sample size illustrated in these two cases is straight forward. The difficulity arises in appreciating the reasoning underlying the need to do it in the first place. It is too easy to assume that the non-respondent opinion is not significantly different from that of the sample. The chance of making an erroneous inference is too great if the number of non-respondents is large in relation to the respondents. Some researchers will feel that this method is inefficient, i.e., that the sample sizes required to use it are excessive. Our method of analysis always assumes the worst case for the distribution of the non-respondents. This perspective seems warranted in medicine. Requiring a statement that the number of non-respondents regardless of their distribution does not effect the inference is a powerful way to assist individuals in interpreting the results of surveys.

REFERENCES

Armstrong, J.S., and Lusk, E.J.,"An Application of Meta-Analysis to Survey Research: The Effects of Return Postage" Working Paper Department of Marketing, Wharton School, 1984.

Ogren, Evelyn H. "Sample Bias in Patient Evaluation of Hospital Social Services", Social Work in Health Care, Vol. 1(1), Fall 1975

Pressley, Milton M. "Improving Mail Survey Responses from Industrial Organizations", Industrial Marketing Management 9, p.231-235 (1980)

Rosenthal, R. & Rosnow, R.L. (1975). The Volunteer Subject. New York: John Wiley and Sons.

Schwirian, K. P. and H. R. Blaine, "Questionnaire Return Bias in the Study of Blue Collar Workers," Public Opinion Quarterly, 30, Winter, (1966)

Van Westerhoven, E.M.C, "Covering Non-Response: Does it Pay? A Study of Refusers and Absentees Journal of the Market Research Society, Vol. 20 No. 4, 1980, pp. 245-247.