TWO DIRECT APPROACHES TO SURVEY NONRESPONSE: ESTIMATING A PROPORTION WITH CALLBACKS AND ALLOCATING EFFORT TO RAISE RESPONSE RATE

Charles H. Proctor, North Carolina State University

1. Introduction

The impetus for the work reported here was a problem of nonresponse in a survey of North Carolina dairy farms. That problem will be described and treated briefly in the last section. First, an outline and review is presented of approaches to nonresponse that are so excellently surveyed in the sampling textbooks, particularly Cochran [4] and Kish [12], as well as Hansen, Hurwitz, Madow [8], Sukhatme and Sukhatme [18] and Deming [6]. Also the somewhat specialized sample survey treatments of nonresponse are related to more conventional methods in statistics. In particular, maximum likelihood scoring is applied to data from repeated callbacks in order to estimate an underlying population proportion.

2. Some Passive or Post Hoc Approaches to Nonresponse

Data that are lost or misplaced in the office, that were not collected because of equipment failures or that are missing for any reasons that are clearly part of a causal nexus almost completely disjoint from that which sets the levels of the variables of interest in the survey, can usually be handled as a case of simple random subsampling from the initial sample (see Rubin [17] for conditions that allow this). When the initial design specifies simple random sampling this approach is easily implemented by reducing sample size to the number of respondents. When, however, unequal probabilities or other complex design features were used it is likely to be tedious to make adjustments. Some form of "hot deck" imputation as described by Chapman [3], may be useful in this case. "Hot deck" imputation requires location of a respondent with inclusion probability and other auxiliary characteristics similar to those of the nonrespondent and attribution of that respondent's data to the missing case. "Cold deck" imputation also refers to use of a similar case's data, but from an earlier survey.

In contrast to the disjoint causal nexus case are instances where data are missing whenever the variable of interest falls outside a critical range. Light bulbs, for example, are burned until they fail or until 100 days go by, at which time the test may be discontinued. Such data are taken to be drawn from a truncated distribution. A similar, but as Kendall and Stuart point out [11, p. 522 ff], a theoretically distinct case is that of censored data. The criterion for excluding data here is the relative standing of the observations among others in the sample. The practice of discarding the largest or the smallest observations has been found to be positively beneficial in some cases. It is perhaps better in gaining approval of the method to call it "trimming" rather than "throwing data away." These topics of truncated distributions, censoring, discarding outliers, trimming or making use of what are called "robust" estimators are, of course, too extensive to review, but it may be helpful to recognize their kinship to methods more in the traditions of sample survey work, to be discussed presently.

There is an approach related to truncation that can sometimes resolve cases of nonresponse as well as problems of outliers. It may happen, upon scanning what can be learned of a case of either nonresponse or "outlying," that the unit should not have been included in the population of interest in the first place. Such an observation can then be declared a blank.[1] There may arise the problem of knowing the size of the surveyed population since the original frame size was apparently too large. However, if one is interested in estimating a mean or other ratio, there may be no critical need of exact knowledge of the population size. The solution then is simply to declare the missing data case as outside the scope of interest.

As an example where this method may be employed one thinks of a legislator polling his constituients. Those who do not reply can be declared to be insufficiently politically active to have ideas that are of interest. In surveys of product preferences in market research the investigator may simply not care what household members may think who are not sufficiently motivated by the "free offer" to return the survey forms. The method may appear to be a somehow shoddy practice, perhaps because it is so inexpensive, but I feel that it could be used more widely. At any rate it is often done surreptitiously when, if it enjoyed a bit higher degree of respectability, it may be more often acknowledged and this would help to make survey reporting more complete and honest.

3. Some Indirect Adjustment Methods

Now we arrive at the more common cases of nonresponse, in which a tie can be identified between the process producing the missing data and that behind the variable of interest. There are a group of methods used in household surveys that call for the collection of additional data directly relevant to the causes of nonresponse, mainly being "not at home," and then make corrections based on this auxiliary information. We will not attempt an extensive review of these, as already appears in Cochran [3, pp. 371-374], but only describe three of them briefly to see how they compare operationally to other approaches that might be used.

In the Politz-Simmons [15] method persons are called upon once only, but if found at home are queried as to whether they were at home: "At this time yesterday?" and four more times are asked: "And the day before?" Data from those persons who report being away more often are expanded to that extent in the tabulations to account for calls that found no one at home. In Bartholomew's [1] method, where no one is found at home the interviewer goes to neighboring houses and apartments to determine a time to return which will maximize the probability of finding someone there. He then calls back only once more. Initially successful interviews are treated as from one stratum and successful callback interviews as from a second stratum. Different expansion factors are used for the two strata. Finally, in Kish and Hess' [13] method, addresses that in earlier surveys yielded not-at-homes are added to those in the current selected sample in such numbers that the resulting completed interviews need not be differently weighted.

All three of these methods depend on well-trained interviewers carrying out their instructions carefully. All three are most useful when conducted by a fairly large-scale survey organization. When used responsibly, any one of the three methods can be very effective in reducing bias caused by not-at-homes.

4. Some Direct Approaches

Moving now from the adjustment methods brings us to approaches that depend on the controlled use of a variety of techniques for collecting data from mobile or reluctant respondents. The simplest approach is perhaps to "throw money at the problem," a substantial payment to the respondent for a completed schedule is worthy of serious consideration. Alternatives in survey methods that might affect rates of nonresponse include:

1) Pre-contact publicity using letter of introduction, media publicity, various sponsorships, local clearances, professional certifications, etc.

2) Telephone versus mail versus personal visit.

3) Use of interviewers whose sex, ethnic membership, social standing, etc. are different from or the same as respondent's.

4) Interviewers being experienced or not or local or not.

5) The survey instrument is loosely focused with a check list, it is a schedule or detailed outline, or it is a tightly structured though naturally worded questionnaire.

6) There is a lengthy explanation of survey objectives, guarantees of anonymity and confidentiality or such are minimal.

7) Randomized response or unrelated question methods may be used for sensitive topics.

8) A legal obligation to respond may be invoked.

Four styles of using such varying efforts in a systematic way in combatting nonresponse may be distinguished:

1) Make repeated calls (i.e., callbacks), mailings or telephone dialings using the same approach each time. In extreme cases one can reduce nonresponse in this way, a little bit at a time, almost "forever." In other cases the no-further-return plateau arrives quickly.

2) Make an initial attempt using a relatively inexpensive approach to a fairly large sample and then subsample the nonrespondents for applying a fairly elaborate approach that can almost guarantee response from those in the subsample.

3) Consider a continuum of approaches along a proportion nonresponse by effort curve, locate the optimum level of effort to devote to nonresponse relative to other survey expenses, and carry out that one level of effort for each and every selection in the sample.

4) Use a graduated series of approaches until the respondent is induced to respond.

Style 2, the use of a follow-up subsample as developed by Hansen and Hurwitz [8], has been widely and successfully used. It has more recently been given a Bayesian formulation by Erikson [7]. Whenever there is any appreciable number of hard core nonrespondents, this tends to upset the method. A relatively minor additional point is the possible presence of differing measurement biases for the initial as compared to the follow-up interviews. This drawback of differing measurement biases probably becomes more aggravated under Style 4, the "escalation" approach. Here, however, there enter also considerations of fair treatment of respondents. It seems to me unjust either to reward recalcitrant respondents with high payments or on the other hand to apply legal compulsion or punishment only to the reluctant ones. Because of these problems with Style 4 and the already available material on Style 2, further consideration is given only to methods of Style 2 and Style 3, the repeated calls case and the optimal choice of uniform level of effort to reduce nonresponse.

5. Maximum Likelihood Estimation of a Proportion in a Survey With Callbacks

The relative performance of differing numbers of calls has been investigated by Deming [5] with a rather elaborate model. It appears possible to simplify this formulation, although the results may be applicable more to telephoning than to door-to-door interviewing which was Deming's original interest. Consider the problem of estimating a population proportion, call it P . There are PN ones (e.g., persons saying "Yes") and QN zeroes (e.g., persons saying "No" or "Don't know") in the population, where $Q = 1-P$. Suppose that upon being called, a zero has a chance of, say, α of not responding, while the chance of nonresponse for a one is β . Thus the chance of a zero holding out for r calls is α^r, while β^r is the chance that a one will persist as a nonrespondent for r calls.

The sample proportion ones after r calls to a sample of size n, written p_r , is the ratio of two random variables and its expectation, $E(p_r)$, is determined approximately as:

$$(1-Q\alpha^r-P\beta^r)E(p_t)\doteq Q(1-\alpha^r)\times 0+P(1-\beta^r)\times 1=P-P\beta^r \quad (5.1)$$

As r goes large this tends to P, but short of $r = \infty$ there is a bias in p_r of:

$$PQ(\alpha^r- \beta^r)(1 - Q\alpha^r- P\beta^r)^{-1} \quad . \quad (5.2)$$

Notice, as Deming [5] pointed out, that after r calls the data can be recorded as frequencies and taken as having a multinomial distribution.[2] The model equation for these frequencies may be written as:

$$E(n_{ij}/n) = Q^{1-i}(\alpha^{j-1}- \alpha^j)^{1-i}P^i(\beta^{j-1}-\beta^j)^i \quad (5.3)$$

where n_{ij} is the number of cases that answer $i=0$ or $i=1$ at $j^{\underline{th}}$ call ($j=1, 2, \ldots, r$). The data can be exhibited as in Table 1, which also shows the residual frequency of nonresponders as n_{r+} along with its model proportion. Ignore γ in Table 1 for now, it will be treated shortly.

Under the supposition that the actually observed frequencies follow a multinomial distribution it becomes simple enough by the method of scoring (see C. R. Rao [16, p. 165]) to find maximum likelihood estimates of α, β and P. An approximate expression of the variance of the estimate of P when based on r calls can be found by evaluating $\{-E(\partial^2 \ell og\, L/(\partial P)^2)\}^{-1}$ where L is the likelihood of the multinomial distribution. This turns out to give:

$$V(\hat{P}) \doteq \left\{ n \left(\frac{1-\alpha^r}{Q} + \frac{1-\beta^r}{P} + \frac{(\beta^r-\alpha^r)^2}{Q\alpha^r+P\beta^r} \right) \right\}^{-1} , \qquad (5.4)$$

which looks plausible since as r goes large the expression tends to

$$\left\{ n \left(\frac{1}{Q} + \frac{1}{P} \right) \right\}^{-1} = PQ/n \quad . \qquad (5.5)$$

A cost function that has been used for such surveys charges an amount c_0 for each call and each callback. Then when data are obtained on a case the added cost is c_1 for processing. The expected total survey cost for r calls then becomes:

$$TC = n\{c_0(Q\frac{1-\alpha^r}{1-\alpha} + P\frac{1-\beta^r}{1-\beta}) + c_1[Q(1-\alpha^r)+P(1-\beta^r)]\} . \qquad (5.6)$$

When, for example, $P = .5$, $\alpha = .9$, $\beta = .7$, $c_0 = \$.50$, $c_1 = \$1.00$ and $TC = \$1000$ the survey using $r = 3$ calls and an initial sample of size $n = 653$ has an estimate with smaller variance than for any other number of calls. If the nonresponse rates are thought to be $\alpha = .1$ and $\beta = .3$ with the other conditions staying the same, then to make one call is optimum according to (5.4). However, in this case no estimate is possible, since there is no way to estimate α separately from β, and so two calls must be made. This would be done by using an initial sample of size $n = 645$.

A computer program was written to calculate the estimates and their standard errors.[3] One needs only to differentiate the theoretical proportions in Fig. 1 and follow the procedure as shown in Rao [16]. With this approach one makes a test of fit of the model using a chi-square distributed test statistic, X^2 say, on (2r-3) degrees of freedom, where:

$$X^2 = \Sigma(O - E)^2/E \quad , \qquad (5.7)$$

where O are observed frequencies in the 2r+1 cells and E are the corresponding theoretical frequencies.

One should not be discouraged by a lack of fit at this stage, since we would expect rather often to find n_{r+} larger than its theoretical frequency due to the presence of never-answer cases. For example, in telephone surveys the additional parameter γ, shown in brackets as optional in Table 1, could represent the proportion of non-working telephone numbers as well as hard-core nonrespondents. In practice one would reset the observed value of n_{r+}, by reducing it, equal to its corresponding theoretical frequency and rerun the fitting routine. This resetting of n_{r+} can be iterated until equality of observed and theoretical frequencies is attained. The difference between the original and the finally fitted proportion in the residual cell is then taken as an estimate of the combined proportion of non-working numbers and hard-core nonrespondents. Notice that $\hat{P}$ is now an estimate of a conditional proportion, namely the proportion of ones after excluding, for example, the hard-core nonrespondents and non-working numbers.

As an example of the estimation and fitting procedure some data from Kish's textbook [12, p. 544] were examined. These observations resulted from an enumerative survey of gardens in an initial sample of $n = 1415$ households where $r = 3$ callbacks were used. The resulting theoretical frequencies are shown, as well as what can be taken as the original counts, in Table 2. The fit statistic, X^2 of (5.7), was .05 on 2 degrees of freedom which indicates that the model can not be faulted.

The parameter estimates were $\hat{P} = .442$, $\hat{\alpha} = .260$, $\hat{\beta} = .183$ and $\hat{\gamma} = .158$, and an estimated standard error for $\hat{P}$ was found as .0144. Notice that the estimate of 44% with garden applies now to the sub-population defined by deleting from the frame those households which, no matter how many calls, would never furnish data. These results reinforce the common sense conclusion that the proportion of .447 = 526/1176 having gardens among respondents, fairly well summarizes the data.

6. Optimum Division of Effort Between Increasing Sample Size and Reducing Nonresponse

This brings us to Style 3 in which a pre-set level of effort to attain response is decided on beforehand and applied to all n cases in the sample. Its drawback is knowledge of a continuum or sequence of methods of steadily increasing efficacy and expense for reducing nonresponse.[4] In theory one can visualize the kind of cost function or plausible relationship between the targeted proportion of nonresponse, to be denoted W_2, and C the cost per case required to be spent in attaining this level of W_2. It is

$$C = \beta\, W_2^{-\alpha} \quad , \qquad (6.1)$$

and I would judge that $\beta = 1/4$ and $\alpha = 2$ might be reasonable. With these values of β and α a nonresponse proportion of 1/2 would result from spending \$1 per case, while 10% nonresponse would be achieved by spending \$25 and 5% with \$100. Such a function could only be expected to be realistic for a limited domain and this has perhaps been covered by the numerical values of the example.

An illustration of the use of Style 3 is provided by a sample survey of costs of milk production on dairy farms now going on in North Carolina. A feature of special interest there, and of widespread concern in connection with nonresponse, is the adversary nature of this survey. There are milk producing interests that wish to show how high is the cost of producing milk so as to justify a high price and there are milk consuming interests who wish to demonstrate low costs so that the Milk Commission will lower the price. In such a situation any nonresponse tends to be assigned extreme values, one set for one party and another for the other.

If the variable of interest takes the values of zero or one, or is otherwise limited, then the extremes are straight forward to provide (see

Deming [6, p. 68] and Cochran [4, p. 357]). However, if the variable is, as in this case, numerical and rather open-ended, the following scheme for obtaining the extreme estimates may be considered. In the presence of, say, 20% nonresponse one party would suggest that those 20% were the smallest and so could be balanced by deleting the largest 20% of the observed values and the average then taken. The other party would say that the lowest 20% observed should be deleted. These two estimates based on oppositely censored samples provided a range of uncertainty due to the nonresponse.

A reasonable mediation of these conflicting views might specify that this range be added to the width of a sampling 95 percent confidence interval to furnish a criterion distance to be minimized for fixed total cost by judicious choice of a division of effort between reducing nonresponse and other expenses of increasing sample size. There is an indeterminacy over how many sampling standard errors to combine with the range of nonresponse uncertainty. To be consistent with deleting extremes one should use at least "two sigma" limits and we also show the "three sigma" limits in Table 3. Such a formulation appears close enough to that offered in an article by Birnbaum and Sirken [2] to justify using their symbols: $U = S + b$ where U is total error, S is the familiar 1.96-times-the-sampling-standard-error and b is bias or half that distance between extreme estimates described above.

In connection with the dairy farm survey it is fairly realistic to assume a $200 data-processing cost per farm and to take $\beta = 1/4$ with $\alpha = 2$, along with a total survey cost of $15,000. The average reported cost of producing 100 lbs. of milk is around $10 with a farm-to-farm standard deviation of $2 . In order to foresee the size of b for varying amounts of percent nonresponse we reason as follows. With, for example, 100 normally distributed observations in hand the smallest is on the average, from sample to sample, 2.50759 standard deviations below the mean. This and other expected values of the normal order statistics (or "normal socres") are taken from tables in Harter [10]. Deleting this smallest value would move the mean upwards by 2.50759/99 = .02533 times the standard deviation. Deleting the two smallest would shift the mean upward by (2.50759 + 2.14814)/98 = .04751 σ's where 2.14814 is the average value of the second largest standard normal observation in 100 . The bias or uncertainty introduced would be ($2)(.02533) = $.051 for 1 percent nonresponse and ($2)(.04751) = $.095 for 2 percent nonresponse. The calculations in Table 3 use normal scores based on the actual sample sizes and also take account of the binomial variation in number of nonrespondents by finding the expected value of nonresponse uncertainty. Table 3 shows that under such conditions one should aim for W_2 of .05 or .06 and should spend about $70 to $100 per case in attaining response. The optimum is quite flat as might be expected.

The survey of milk production costs has been in operation for three years and nonresponse appears to be around 34% this year, even though sample size has been reduced to 50 dairy farms. It remains to be seen whether such procedures as publicizing the study through milk producers associations and having recognized sympathetic authorities to explain how the case of the dairy farmers will be hurt by nonresponse will raise response rates. There is some suspicion that the refusals may be of the, so called, hard core nonresponse type which invalidates the cost function $\beta W_2^{-\alpha}$ and thus renders academic the optimum solution.

One other point of importance in using the results in Table 2 for planning a survey of milk production costs is the perhaps misleading size of Total Uncertainty. One might be distressed that after spending $15,000 the uncertainty U is still as high as 70¢ or 80¢, which is about 8% of the estimated cost. Part of this is due to the use of two and the even more liberal three sigma ranges which protect against relatively unusual selections, plus the extreme assignment of the nonresponses. A statement of survey precision more consonant with a sample coefficient of variation would be based on further dividing Total Uncertainty, when based on a two sigma range, in half.

7. Further Developments

The pair of direct approaches that were treated in some detail in Sections 5 and 6 can be viewed as special cases of a corresponding pair of more generalized strategies for dealing with survey nonresponse. There are any number of probabilistic models, in addition to the one offered in Section 5, that can be devised to reflect uncertainties about the appearance of cases of nonresponse. Such models need to be worked out and matched against the data. This is nothing more or less than "doing statistics." It is unfortunately true that one thereby looses his grasp of the finite population that is such a conforting concept when the only uncertainties arise from random number tables. However, measurement errors are often so prominent as to demand special attention anyway.

The other generalized strategy that includes the case of optimizing the level of effort to reduce nonresponse may be called the Institutionalization of Surveys Movement. The exercise of certain professions, the legal or the medical say, has become more or less institutionalized within society. Certainly this is true to some extent of census taking, of the conduct of the Agricultural Enumerative Surveys and of the Current Population Survey, as well as of the major public opinion polls. By institutionalization is meant the acceptance of the legitimacy of survey practices within the internalized norms of members of the society.

It is an acceptance that would be built up over a long period of the life of the society and is based on the very tangible advantages of surveys. In order for it to take place it would seem essential that almost all surveys have goals that are clearly seen to be of benefit to the whole society and that they be so carefully designed as to attain their objectives most efficiently. The difficulty in the way of a broad acceptance of surveys is the appearance from time to time of surveys with narrow or confused aims and designed so poorly as to tax a respondent's patience. If such surveys can be made more rare then it may happen that survey interviewing would become a completely legitimate and morally compelling practice with responding to a survey interview a deeply institutionalized societal norm. Of course, no such idyllic state is in sight but it is a worthwhile goal to pursue since some improvement or even a slowing down of the deterioration in nonresponse rates will be welcome.

FOOTNOTES

1/ For Deming [6] who uses the technique and the word "blank", such selections of non-members of the population are usually done for clerical convenience but the principle is the same.

2/ With such features as stratification and clustering the effective sample size may differ from the number initially selected and thus corrections will need to be made to the standard error calculations.

3/ Copies are available upon request to the author.

4/ That such a continuum may differ from one survey to the next or year to year is to be expected and perhaps one cannot be found. For some rather disappointing results in this direction see Koo et. al. [14].

REFERENCES

[1] Bartholomew, D.J., "A Method of Allowing for Not-at-Home Bias in Sample Surveys," Applied Statistics, 10 (March, 1961),52-59.

[2] Birnbaum, Z.W. and Sirken, M.G., "Bias Due to Non-availability in Sampling Surveys," Journal of the American Statistical Association, 45 (March, 1950), 98-111.

[3] Chapman, David W., "A Survey of Nonresponse Imputation Procedures," Proceedings of the Social Statistics Section, American Statistical Association (1976), Part II, 491-4.

[4] Cochran, William G., Sampling Techniques, Second Ed., New York, John Wiley & Sons, Inc., 1963.

[5] Deming, W. Edwards, "On a Probability Mechanism to Attain an Economic Balance Between the Resultant Error of Nonresponse and the Bias of Nonresponse," Journal of the American Statistical Association, 48 (December, 1953), 743-772.

[6] Deming, W. Edwards, Sample Design in Business Research, New York, John Wiley & Sons, Inc., 1960.

[7] Ericson, W.A., "Optimal Sample Design with Nonresponse," Journal of the American Statistical Association, 62 (March, 1967), 63-78.

[8] Hansen, M.H. and Hurwitz, W.N., "The Problem of Nonresponse in Sample Surveys," Journal of the American Statistical Association, 41 (December, 1946), 517-529.

[9] Hansen, Morris H., Hurwitz, William N., and Madow, William G., Sample Survey Methods and Theory, Volume 1., New York, John Wiley & Sons, Inc., 1953.

[10] Harter, H. Leon, "Expected Values of Normal Order Statistics," ARL Technical Report 60-292, Aeronautical Research Laboratories, Wright-Patterson Air Force Base, Ohio, (July, 1960).

[11] Kendall, M.G., and Stuart, A., The Advanced Theory of Statistics, Volume 2., Third Ed., New York, Hafner Publishing Co., 1951.

[12] Kish, Leslie, Survey Sampling, New York, John Wiley & Sons, Inc., 1965.

[13] Kish, L. and Hess, I., "A 'Replacement' Procedure for Reducing the Bias of Nonresponse," American Statistician, 13, 4 (October, 1959), 17-19.

[14] Koo, H.P., et al., "An Experiment on Improving Response Rates and Reducing Callbacks in Household Surveys," Proceedings of the Social Statistics Section, American Statistical Association (1976), Part II, 491-4.

[15] Politz, A.N., and Simmons, W.R., "An Attempt to Get the 'Not-at-Homes' into the Sample Without Callbacks," Journal of the American Statistical Association, 44 (March, 1949), 9-31.

[16] Rao, C.R., Advanced Statistical Methods in Biometric Research, New York, John Wiley & Sons, Inc., 1952.

[17] Rubin, Donald B., "Inference and Missing Data," Biometrika, 63, (December, 1976), 581-592.

[18] Sukhatme, P.V., and Sukhatme, B.V., Sampling Theory of Surveys with Applications, Second, Rev. Ed., Ames, Iowa, Iowa State University Press, 1970.

TABLE 1

Model Notation for Observed Frequencies and Theoretical Proportions

Responds at Call No.	Observed Frequencies		Theoretical Proportions	
	Zero	One	Zero	One
1	n_{01}	n_{11}	$Q(1 - \alpha)$	$P(1 - \beta)$
2	n_{02}	n_{12}	$Q(\alpha - \alpha^2)$	$P(\beta - \beta^2)$
⋮	⋮	⋮	⋮	⋮
r	n_{0r}	n_{1r}	$Q(\alpha^{r-1} - \alpha^r)$	$P(\beta^{r-1} - \beta^r)$
Residual	n_{r+}		$Q\alpha^r + P\beta^r (+ \gamma)$	
Totals	n		1	

TABLE 2

Original Data and Fitted Frequencies for Responses to a Question on Having a Garden by Number of Visits to the Household Required to Obtain the Response

No. of Call (r =)	Observed Frequencies		Fitted Frequencies	
	No Garden	Had Garden	No Garden	Had Garden
1	489	432	488.42	431.39
2	129	80	128.42	79.40
3	32	14	33.76	14.61
Residual	239		15.3(223.7)	
Totals	1415		1415	

TABLE 3

Total Uncertainty as a Function of Targeted Proportion Nonresponse for Two Levels of Processing Cost and for Two Sigmas and Three Sigmas of Sampling Uncertainty.

Targeted Percent Nonresponse W_2	Expenditure Per Case on Attaining Response $(2\ W_2)^{-2}$	Sample Size, n[a]	Two Sigma Sampling Uncertainty S[a]	Expected Nonresponse Uncertainty b	Total Uncertainty, U = S + b — When Processing Cost Per Case is: $200		$100	
					2σ's	3σ's	2σ's	3σ'a
.01	$ 2500	6	1.633	.030	1.663	2.480	1.663	2.480
.02	625	18	.943	.075	1.018	1.490	.950	1.387
.03	278	31	.718	.120	.839	1.198	.756	1.072
.04	156	42	.617	.163	.780	1.089	.688	.949
.05	100	50	.566	.202	.768	1.051	.669	.900
.06	69	56	.535	.240	.744	1.041	.668	.880
.07	51	60	.516	.276	.792	1.050	.686	.887
.08	39	63	.504	.311	.815	1.067	.703	1.180

[a] Based on a processing cost of $200 per case.