SHOULD FIRMS BE USED AS SAMPLING UNITS FOR SELECTING ESTABLISHMENTS FOR THE 1997 NATIONAL EMPLOYER HEALTH INSURANCE SURVEY?

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KEY WORDS: State estimation, Respondent burden, Two-stage sampling

1. Introduction

The National Employer Health Insurance Survey (NEHIS) is a national survey of business establishments (locations) and governments, which was first conducted in 1994 by Westat, Inc., under contract to the National Center for Health Statistics (NCHS). The survey was jointly sponsored by NCHS, the Agency for Health Care and Policy Research (AHCPR), and the Health Care Financing Administration (HCFA). The survey collected establishment and employee data on health insurance coverage of employees and on health plan characteristics, for nearly 40,000 establishments in both the private and public sectors. A major objective of the 1994 NEHIS was to provide state-level estimates. The types of survey items collected in the 1994 survey included:

(1) Whether or not an establishment offers health insurance to their employees.
(2) If so, the number and types of plans offered.
(3) The number of employees eligible for health insurance and the number enrolled in different plans.
(4) The characteristics of the establishment's health plans, including premiums.
(5) The costs to the employer of health insurance.
(6) Total benefits paid (claims).

The second administration of NEHIS will be in 1997. This paper addresses a basic sample design issue associated with the selection of the 1997 sample: whether or not firms (groups of one or more establishments under common ownership) should be included as first-stage sampling units for selecting the private sector sample. (Sample selection for the public sector is not addressed in this paper because the sample units are individual governments and selection of higher level organizational units is not an issue.)

Firms were not used as sampling units in the selection of the 1994 NEHIS sample, primarily because of the goal of producing state estimates. This goal dictated that establishments, rather than firms, would have to be the unit of analysis since these can be uniquely identified with a specific state, whereas many firms are located in two or more states. Since an adequate establishment level sampling frame was available for selecting the 1994 sample, there did not appear to be any advantage to selecting firms as first stage sampling units. Therefore, the 1994 NEHIS was selected as a single stage stratified random sample of establishments.

This method of selection did not control the number of establishments that were selected from any single firm for the 1994 sample. As a result, one firm had about 140 establishments selected for the sample, and several others had about 100 establishments selected. This created a large respondent burden for these firms because the health insurance data collected in NEHIS often had to be collected from a human resources department at the firm level.

For the 1997 sample, state level estimates will still be a priority. Therefore, the establishment will again be the basic unit of analysis. However, it is intended that some method be used to control the number of establishments selected from any one firm to reduce the respondent burden for these firms.

This paper describes two methods that have been considered for controlling the number of establishments selected from a single firm:

(1) A two-stage sampling approach: firms and establishment within firms (referred to as the two-stage approach).
(2) A single-stage sample that reduces the selection probabilities of establishments in large firms (referred to as the probability adjustment method).

A discussion of sample selection issues for small and large firms is provided in Section 2. The two methods being considered are defined in Section 3. Section 4 discusses the advantages and disadvantages of the two methods. Our conclusions are given in Section 5.

2. Sample Selection for Small Firms Versus Large Firms

Establishments in the private sector can be classified as belonging to either single-establishment firms (SEFs) or to multi-establishment firms (MEFs). A SEF is an establishment that is self-owned. A MEF is a collection of two or more establishments that have common ownership. The highest level of ownership is referred to as the enterprise or the ultimate parent.

Of the approximately 6.3 million establishments in the nation, only about 1.3 million belong to MEFs. The distribution of the size of MEFs in terms of number of establishments in the MEF is given in Table 1. This table is based on the linkage information in our sampling frame, Dun and Bradstreet's Dun's Market Identifiers file. The table includes for each firm size category the number of establishments and employees covered, rounded to the nearest thousand. This table shows that in 1994 there were only 1150 firms with 100 or more establishments nationwide.

In the 1994 NEHIS, a MEF was defined as a first or second level subsidiary within an enterprise, as a first approximation to the level within an enterprise that administers health insurance benefits. However, for purposes of this investigation, we have defined the firm as the enterprise. This definition maximizes the potential problem in terms of considering the number of hits in a single firm.

There is no issue of controlling the number of selections of establishments within firms for sampling SEFs since, by definition, establishments and firms are identical for SEFs. (The SEFs consist of about 5.0 million of the approximately 6.3 million establishments in the nation.) The control of the number of establishments selected is not necessary for small or medium-sized firms either, since the number of selections in any one firm is not likely to be large for these firms. The need for control is in the selection of establishments from large firms.

A fundamental step in the process is to define "large firm" since both procedures will focus on controlling the establishment sample size for these. Methods of defining "large firm" could be based on the number of establishments or employees in the firm. However, since our concern is with the number of establishment selections in a firm, we have defined "large firm" in terms of the expected number of establishments selected for the sample from the firm, based on a single-stage selection method like that used for the 1994 NEHIS. For a given firm, the expected number of "hits" (i.e., establishments selected from the firm) is the sum of the probabilities of selection of each of the establishments in the firm.

The choice of the number of hits used as the criterion to define "large firm" will depend on the perceived burden on firm respondents associated with various numbers of sampled establishments. We expect that a number like 15 or 20 might be used, but that will be determined at a later time. For our initial investigation, described in this paper, we have used 20 as the criterion. The basic methods discussed would be the same if a different criterion is later selected.

3. The Two Methods of Controlling the Number of Hits per Firm

The two methods being considered for controlling the number of hits for a single establishment were discussed briefly in the introduction. These methods are described in detail in Subsections 3.1 and 3.2.

3.1 The Two-Stage Approach

Perhaps the most natural way to control the number of establishments selected per firm is to select firms as the first stage in a two-stage sampling procedure. For the second stage, a sample of establishments would be selected from all those in the firm. This would certainly allow us to control the number of hits per selected firm. However, a number of design choices would be required in developing an efficient two-stage selection approach.

As was pointed out in the previous section, two-stage sampling would only be applied to the large firms: those with expected numbers of sample establishment hits greater than some threshold (e.g., 20). To identify these firms, the establishment universe would be stratified as though there would only be a one-stage sample, similar to the 1994 design. Once this is done, the expected number of hits per firm would be computed by adding up the selection probabilities (i.e., stratum sampling fractions) for all establishments in each firm. This would allow us to define the set of large firms. For the SEFs and the establishments belonging to the small and medium-sized firms, the sample would be selected as a single-stage sample.

Once the large firms are defined, the sample design for them would have to be developed. The first step in this process would be to allocate the sample between (1) the SEFs and the small and medium-sized MEFs and

(2) the large MEFs. This allocation would presumably be based on both the number of establishments and the number of employees in these two primary strata since both of these types of estimates are of interest in NEHIS.

The next step would be to determine how many MEFs would be selected from the MEF stratum and how many establishments would be selected from each MEF. We would approximate the optimum solution to this allocation, using the simplified formula from Hansen, Hurwitz and Madow (1953, p. 286) for the optimum cluster sample size (n-bar) for simple two-stage cluster sampling:

$$opt.\ \bar{n} = \sqrt{\frac{C_1}{C_2} * \frac{1-\delta}{\delta}}, \qquad (1)$$

where

C_1 = the unit cost that varies per sample PSU,

C_2 = the unit cost that varies per sample establishment,

δ = the intraclass correlation for a characteristic between two establishments in the same firm.

The sampling plan within the large MEF stratum would not fit the simple cluster sampling model used to derive the optimum cluster size in Equation (1) because clusters (firms) would not likely be selected with equal probability. However, this calculation should give some indication of what the optimum cluster size should be.

Neither the cost or intraclass correlation parameters in the above equation are available at this time. If this method were used to select the 1997 sample, estimates of the parameters could be estimated from the 1994 NEHIS data. It is expected that there is a positive intraclass correlation for health insurance coverage variables for establishments in the same firm. That is, it seems reasonable that establishments in the same firm have similar health insurance characteristics. Note that we conducted a small-scale investigation of this hypothesis using 1994 NEHIS data; although the investigation was too small to draw conclusions from, we feel that our results tended to support the hypothesis.

It is likely that a probability proportional to size (PPS) type sample of firms would be selected at the first stage. It could be difficult to develop a two-stage procedure which would provide establishment-within-firm sample sizes that would be appropriate for meeting the state-level sample size targets while achieving the target cluster size. One approach would be to assign a composite measure of size to each firm based on the number of establishments in a firm in each of the single-stage sampling strata. This method of defining composite measures of size is described by Folsom, Potter, and Williams (1987).

With their approach, the measure of size, A_i, assigned to the i^{th} large MEF in the frame is computed by multiplying the number of establishments, N_{hi}, in the MEF in stratum h state by the target sampling rate, f_h, for the stratum, and summing these products across all strata:

$$A_i = \sum_{h=1}^{L} f_h * N_{hi}. \qquad (2)$$

This measure of size is a weighted sum of the firm's establishments in each stratum, where the weights are the target stratum sampling rates, based on the single-stage design.

Folsom, et al., show that with this method of assigning measures of size, the within-firm sample sizes will be constant, except for firms selected with certainty. This result assumes that the conditional stratum sampling rates used are those based on achieving, except for roundoff errors, the target stratum sampling rates.

Once the composite measures are assigned, firms would be selected using a systematic PPS selection approach. With this method the selection interval is computed as the sum of the measures of size of all firms divided by the number of firms to be selected. Prior to selection, any firm whose measure of size exceeds the selection interval (or some high percent of the selection interval) would be selected with certainty. For certainty selections, the number of sample hits in the firm could not be controlled unless the target stratum sampling rates were reduced. This is a major drawback of the procedure.

Other than the problem with certainty selections, the two-stage approach is a viable approach to sampling large MEFs for the 1997 NEHIS. However, there would be some complex issues and problems that would

have to be resolved in applying it. These are discussed in the next section.

3.2 The Probability Adjustment Method

A second approach considered attempts to control the number of hits for a firm by reducing the probabilities of selection of the establishments in large firms. The amount of reduction is derived to be such that the expected number of establishment sample hits for the large firms will be reduced to the threshold number (e.g., 20).

This would be done by first developing the single-stage sample design without regard to the number of hits per firm, as was done for the 1994 NEHIS. Once these strata are defined, the expected number of establishment sample hits would be calculated for each firm. For those that are greater than 20, adjustments to the selection probabilities would be made. This is done by recognizing that, if establishments are selected with equal probability within a stratum, each establishment can be viewed as having a measure of size of 1 for a systematic PPS sample. The measure of size will be reduced (to below 1) for establishments in large firms.

To achieve the appropriate size reductions, the measure of size of each establishment in a large firm would be set equal to r=20/A, where A is equal to the initial expected number of establishment hits. For example, if the initial expected number of hits for a firm was 50, then the measures of size for establishments in the firm would be set equal to 0.4, instead of 1. The appropriate reductions would be made to the establishments in each large firm. Then, for each stratum, the total of the modified measures of size is computed. To achieve the desired reduction in the selection probabilities of establishments in large firms, the non-reduced measures of size have to be increased by an amount that will restore the sum of the measures of size in a stratum to the original sum, which was simply the number of establishments in the stratum, N_h.

This is achieved by replacing each of the non-reduced measures by a factor greater than 1 that will yield a revised sum of the measures of size of N_h. For example, suppose that the initial total of the measures of size for a stratum were 100 (N_h). Suppose that 20 of these 100 establishments had their measures of size reduced because they belonged to large firms, and that the new reduced stratum total of the measures of size was 88. To restore the original stratum total, the 80 unaffected establishments in the stratum would be assigned a measure of size of 1.15 (i.e., 92/80).

Care has to be taken in applying this process to not increase the expected number of sample hits for a firm to some number above the threshold as a consequence of the compensating adjustments. Therefore, it might be wise to only increase the weights in the stratum of the non-reduced establishments that belong to firms that have expected numbers of hits less than some specified cutoff, like 10 or 15. Alternatively, an iterative process could take place where any firm that exceeds the threshold after the compensating adjustment in the previous iteration would have its measures of size reduced. An upward adjustment would then be applied to other firms with expected sample size under the threshold. Presumably, such an iterative process would converge within a few iterations.

Once all of the measures of size have been adjusted appropriately, a sample of the original size would be selected from each stratum as a systematic PPS sample. In a given stratum, the selection interval would simply be N_h/n_h.

This procedure seems like a feasible approach to controlling the number of sample hits per firm. Comparisons of this procedure to the two-stage approach are made in the next section.

4. Advantages and Disadvantages of the Two Procedures

The main advantage of the two-stage approach is that the number of establishments selected in each of the large firms can be controlled exactly. With the probability adjustment method, only the expected number of hits for a firm is controlled. However, this does not seem like it would be a major problem.

Another advantage of the two-stage approach is that there would be a constant sample size in each large firm, except for the certainties. This could be an advantage in terms of administering the survey, or controlling the respondent burden.

A final advantage of the two-stage procedure is that it would be straightforward to compute firm-level estimates for large firms, since they are first stage sampling units. With the probability adjustment method, making firm-level estimates is difficult because of the need to compute firm selection probabilities from an establishment sample. Also, the firm selection probabilities could not easily be controlled in the probability adjustment method.

There are several disadvantages of the two-stage approach. First, it is rather complex with the need to allocate the sample between the large-firm stratum and the balance of the population, and the need to determine the optimum number of large firms to select at the first stage. The use of the composite measure of size would also add some complexity.

Second, as was mentioned in Section 3.2, the use of certainty selections would generate a set of the largest firms (certainties) for which the number of sample hits cannot be reduced unless the target sampling rates for their establishments were also reduced. As a result, either the sample sizes for the certainty cases will exceed the large-stratum threshold, or there will be sample size losses for the certainty cases that would have to be compensated for by increasing sample sizes for SEFs or other MEFs.

Perhaps the most significant disadvantage of the two-stage approach is that, by design, some large firms would be excluded from the sample. This would add considerably to the variance of the estimators and could cause severe problems in the estimates for some states if a somewhat dominant firm for a state were not selected into the sample. With the probability adjustment method, all the large firms are retained although the selection probabilities of their establishments are reduced. This probably is the biggest advantage of the probability adjustment method.

Another advantage of the probability adjustment method is that it is relatively straightforward to apply since it is a single-stage procedure. Calculating the reduction and corresponding inflation factors for the measures of size should not be too difficult.

A disadvantage of the probability adjustment method, which was already indicated, is that the number of sample hits for a firm cannot be precisely controlled. However, controlling the expected number of hits should be adequate, though some additional investigation of the possible variation in firm sample sizes, relative to their expected values, may be needed.

Two other potential disadvantages of the probability adjustment method could become apparent in strata where many establishments have their measures of size reduced. A first possibility is that there may be strata for which there would not be any establishments that did not have their measures of size reduced. If so, it would not be possible to restore the total of the measures of size to the initial number in the stratum. A second possibility also could occur where there may be some non-reduced establishments, but the number may be so few that the weight inflations needed for them would be excessive, creating substantial increases in survey variances.

Because of the concern with these potential disadvantages, we did some investigation of the availability of non-reduced establishments in strata for a portion of the 1994 NEHIS frame. The portion we used was those establishments in the approximately 250 strata for which the number of employees in an establishment was at least 50. This made the investigation manageable, while focussing on the strata where the potential problems would be most likely to occur. We reduced the sampling rates uniformly in all strata to account for the fact that the sample size is likely to be about 25,000 for the 1997 sample, rather than the nearly 40,000 respondents we had for the 1994 NEHIS. We computed the expected number of sample hits for MEFs across all strata.

We found that there were a total of 77 large firms (i.e., those with expected numbers of sample hits more than 20). Of these, the largest number was 187 with three others having an expected number of hits greater than 100. There were 14 firms with expected numbers of hits greater than 50. There were 148 strata containing at least one establishment that had its measure of size reduced. In these strata we only applied compensating weight increase factors to those establishments belonging to firms that had expected numbers of sample hits less than 10. (We did not explore an iterative process of multiple rounds of reduction followed by compensation.) For the procedure we investigated, the highest inflation factor assigned in a stratum was 1.78 and the next highest was 1.47.

With inflation factors in these ranges, we would not expect the variances of survey estimates to increase much. These results are very encouraging for the probability adjustment method.

5. Conclusions

In order to control respondent burden for large firms in the 1997 NEHIS, an attempt will be made to control the number of establishments selected into the sample from any one firm. We investigated two approaches to controlling the number of sample hits in a firm: the two-stage approach and the probability adjustment method.

The probability adjustment method appears to be

the better approach of the two, primarily because it retains representation of all of the large firms in the population. The exclusion, by design, of a random subsample of some of the large firms with the two-stage approach could produce large variance increases and special problems for some state estimates.

Also, the probability adjustment method has the advantage that it is much simpler to apply because it involves only one stage of sampling. Finally, the investigation we did based on a portion of the 1994 NEHIS sampling frame suggested that the probability adjustment method should work well for selecting the 1997 sample.

The only situation for which we would recommend the two-stage approach would be one for which firm-level data were needed.

Acknowledgement

The authors would like to thank Dale J. Sanders of the Klemm Analysis Group for his assistance in providing computer files that were used in the investigation discussed in Section 4.

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Table 1. Number of establishments per MEF for the 1994 NEHIS Sampling Frame

Number of Establishments per MEF	Number of MEFs	Number of Establishments in Category (rounded to nearest 1000)	Number of Employees in Category (rounded to nearest 1000)
2-4	221,931	518,000	10,718,000
5-9	23,152	144,000	5,544,000
10-19	7,276	95,000	4,684,000
20-49	3,382	101,000	5,981,000
50-99	1,112	77,000	5,068,000
100-199	630	87,000	6,586,000
200 or more	520	292,000	17,041,000
Total	258,003	1,314,000	55,622,000