Comparison of Traditional Weight Adjustments to Calibrated Weights in the Medical Expenditure Panel Survey for both Non-response and Post-stratification[1]

Robert M. Baskin[†], Lap-Ming Wun[†]
[†]AHRQ, 540 Gaither Road, Rockville, MD 20850

Abstract
The Medical Expenditure Panel Survey Household Component (The MEPS) is an annual two year panel survey of Households sponsored by the Agency for Healthcare Research and Quality and conducted by Westat. The survey collects data on household characteristics, insurance coverage, healthcare use and expenditures. The MEPS survey is a subsample of responding households to the National Health Interview Survey (NHIS). Current non-response and post-stratification steps for the MEPS are carried out in traditional sequential steps. This project investigates the possibility of using calibration through SUDAAN'S Proc WTADJX to perform non-response adjustment and post-stratification on the MEPS weights at the household level. The results from this calibration approach will be compared to the current approach empirically. This simulation will measure bias in the methods by using values for the non-respondents to the MEPS created from a combination of NHIS information and modeling. Since the bias can be measured in this way, then the total Mean Squared Error for estimates under the two approaches can be compared.

Key Words: Household Survey, Nonresponse, Post-Stratification, Calibration

1. Introduction

The Medical Expenditure Panel Survey – Household Component (The MEPS-HC) is an ongoing panel survey of households of the non-institutionalized population of the United States sponsored by the Agency for Healthcare Research and Quality (AHRQ) in coordination with the National Center for Health Statistics (NCHS). The MEPS-HC employs a complex survey design which is a stratified multi-stage design with unequal probability selection within strata. Households are subsampled from the eligible responding households in the National Health Interview Survey (NHIS) conducted by the NCHS. The sample from each year of the NHIS becomes a panel of the MEPS-HC. The households subsampled from the NHIS are followed for five consecutive rounds covering a two year period so that the MEPS-HC is an overlapping panel design which always has two panels in collection simultaneously. The data are collected through personal household visits using computer assisted personal interviewing (CAPI). Among the main purposes of the MEPS-HC are to collect data on insurance coverage, healthcare utilization and medical expenses for persons in the U.S. civilian non-institutionalized population.

[1] The views expressed in this paper are solely those of the authors' and do not reflect policy of the Agency for Healthcare Research and Quality nor the Department of Health and Human Services

In spite of best efforts, nonresponse, including at the household level, still occurs in the MEPS-HC. Current best statistical practice dictates imputing missing items but adjusting weights if an entire unit does not respond. The current procedure in the MEPS-HC is to form nonresponse adjustment classes at the household level based on information available for both responding and nonresponding households. Within each of the adjustment classes the weights of the responding households are multiplied by a constant factor that is the ratio of the sum of the base weights of all households in the adjustment class divided by the sum of the base weights of the responding households in the adjustment class. Therefore estimates from the responding units based on the adjusted weights represent the same population as the base weights for both the responding and nonresponding units. Furthermore, the adjusted weights are poststratified[2] to values from the Current Population Survey based on demographic groups.

The two MEPS-HC processes of nonresponse adjustment and poststratification fall under a general method of weight adjustment known as calibration. The current paper investigates the possibility of using standard calibration software to perform the current two functions of nonresponse adjustment followed by poststratification. There is a possibility that using standard calibration software might allow more variables to be used for adjustment than using the current approach. It has also been noted that using standard calibration software could possibly combine the two steps of nonresponse adjustment and poststratification into one program.

The approach in this study is to use 2012 MEPS-HC panel 17 round 1 data together with the corresponding year of HIS data and simulated data for both responders and nonresponders as the study variable. The weights for the responders under the current method are available. The calibrated weights for the responders were constructed using Proc WTADJX in SUDAAN. Because the simulated study variables have been created for the responders as well as the nonresponders then it is possible to create a gold standard to test the estimates using different weights for the responders. This approach allows the estimates based on different weights to be measured, both in terms of bias and variance.

2. Sample Design

As mentioned in the introduction, the MEPS-HC is an ongoing panel survey of households which are subsampled from the NHIS. Information on the NHIS design can be found in Botman (2000) and information on the MEPS sample design can be found in Ezzati-Rice (2008). The current NHIS design is a multi-stage geographic cluster sample based on information from the 2000 Census and supplemented by a new construction sample. The first level of sampling, referred to as PSUs, is comprised of geographic clusters based on county level information from the Census. The PSUs are stratified within state by population and selected probability proportional to size. Within each PSU the housing units are subdivided into geographic areas called *segments* in a way that each segment has a minimal number of housing units. The segments are grouped into strata based on Census information plus one stratum for new construction. Within each stratum, segments are selected probability proportional to size with the size measure based on the number of housing units in the segment. For each segment the housing units are listed and selected within segment with equal probability. If a housing unit is deemed eligible then all eligible persons within the household are included in the sample.

[2] The distinction between raking and poststratification will usually be ignored in this paper.

The MEPS-HC takes a subsample of the eligible responding units in the previous year of NHIS in the MEPS sampling strata based on priority populations. For a list of specific priority populations in given years see Table 1 in Ezzati-Rice (2008). If an NHIS responding unit is selected for the MEPS-HC then AHRQ will attempt to interview the same responding unit, even if the people who have moved from the address at which they were interviewed for the NHIS. This subsampling approach provides NHIS variables for nearly all the MEPS-HC respondents and has the advantage over not subsampling of providing more than the usual Census variables for non-response adjustment. The current MEPS-HC is designed to roster and collect information on all eligible persons within the unit. In the current design the MEPS-HC goes back to the responding units for five rounds of collection. The MEPS-HC collects data on medical expenses, health insurance, and healthcare utilization as well as socio-demographic information about the sampled persons.

3. Weighting Methods

3.1 Current Weight Adjustment for Round One Household Unit Nonresponse

As previously mentioned, in spite of best efforts, nonresponse, including at the household level, still occurs in the MEPS-HC. In order to deal with household nonresponse, a weight adjustment is made so that the weight of the responding units will represent the weight of the nonresponding units in addition to their own weight. The MEPS methodology creates classes of units for nonresponse adjustment using a tree based method called extended CHAID (Chi-Squared Automatic Interaction Detection). Once the adjustment classes are created then the weights of the responding units in the class are multiplied by a factor so that the sum of adjusted weights of the responding units in the class equals to the sum of unadjusted weights for both responding and nonresponding units. More details may be found in Wun (2007). The list of twenty covariates that were used as a starting point in the CHAID process for the 2012 MEPS first round data can be found in Table 1. These household level weights were further poststratified to control totals based on income, employment, race/ethnicity, health insurance coverage, and MSA. These nonresponse adjusted and poststratified weights are available on a secure LAN at AHRQ for research purposes which this study was able to take advantage of.

3.2. Calibration for Round One Household Unit Nonresponse

Calibration is a general method of weight adjustment described in Kott (2010) and was originally introduced in Deville (1992). While calibration software is also available in R (2014), in this analysis we used Proc WTADJX in SUDAAN (2012). Using the notation in Kott (2010), the design weights, i.e., sample weights, are denoted $\{d_k\}$, for *k* an index of the population units, and the calibrated weights are denoted $\{w_k\}$. Then nonlinear calibration finds a *g*-vector satisfying either

$$\sum_R \boldsymbol{w_k z_k} = \sum_R \boldsymbol{d_k \alpha(g^T z_k) z_k} = \sum_{k \epsilon U} \boldsymbol{z_k} \quad \textbf{(1a)}$$

$$\sum_R \boldsymbol{w_k z_k} = \sum_R \boldsymbol{d_k \alpha(g^T z_k) z_k} = \sum_S \boldsymbol{d_k z_k} \quad \textbf{(1b)}$$

where R denotes the responding sample, S denotes the original sample; $\{\mathbf{z}_k\}$ denotes a set of vectors known for the population in the first equation or for the original sample in the second equation, and the function α is given by

$$\alpha(g^T z_k) = \frac{l(u-c)+u(c-l)e^{Ag^T z_k}}{(u-c)+(c-l)e^{Ag^T z_k}} \qquad (2)$$

and $A = (u-\ell)/[(u-c)(c-\ell)]$ with u>c>l≥0.

The u, c, and l in the calibration are bounding values that can control the closeness of the calibration weights to the original design weights. In this particular simulation the default values were accepted so that l=0, c=1, and $u = e^{20}$. Kott (2013) describes combinations of conditions on $\{\mathbf{z}_k\}$, u>c>l and equations 1(a), 1(b), and (2) that produce raking, poststratification, or nonresponse adjustment.

For the purposes of this simulation this type of weight calibration was performed using the same variables currently used in the CHAID method. The simulation is described in the next section.

4. Simulation

In this simulation there are four distinct study variables, listed below, and there are two sets of weights used which gives a total of eight estimates. We begin by making estimates using the calibration method to adjust the household level weights of the 2012 MEPS panel 17 round 1 data. We then compare these estimates of the four selected outcome variables using the weights obtained from this calibration method with the estimate using the weights obtained from the method of CHAID currently used in the MEPS.

The outcome variables selected for this study are:

- Limitation – whether the household had any member with limitation in daily activities.
- Doctor visits – whether the household had any member with doctor visits in the past two weeks.
- Barriers – whether the household had any member with a barrier to health care due to cost in the past 12 months.
- Dollar Denominated Index – simulated healthcare expenditures.

For the expenditure, we calculate the mean, and for the other three variables we calculate the percent of households that meet the given condition.

The healthcare expenditures variable is a major outcome variable in the MEPS, but it is not available in the National Health Interview Survey (NHIS), the sampling frame for the MEPS, nor is it available for MEPS sample units before the survey is completed. Therefore, we use a dollar-denominated index developed at AHRQ as a proxy for expenditures. Loosely speaking, this dollar-denominated index is estimated expected expenditure predicted based on qualitative health status, age, and sex. With the availability of variables for health status, age, and sex for each person in NHIS, a value for expenditures can be assigned to each person. Summing the

expenditures of each person in the DU gives the DU level healthcare expenditure which we used for this simulation.

Because the MEPS sample was drawn from the previous year's NHIS sample (i.e., 2012 MEPS panel 17 was drawn from the 2011 NHIS), the full NHIS sample is used as the population for our simulation. The values of the variables calculated from the NHIS are used as the 'gold standard'. The difference between the estimates from various sets of weights and this gold standard is used as bias in the calculation of mean square error (MSE).

5. Results

The results are given in tables 2 through 5. In these tables the first column is the results based on the PROC WTADJX in SUDAAN. The estimates from the current methodology are given in the last column of the tables.

For the dollar-denominated index the calibration method produced an MSE of $4856.01 and the MSE from CHAID method is $4853.51 (Table 5.). In the case of the percent variable, Percent of DU's with Member Not Getting Medical Care due to Cost, the MSE of the calibrated estimate is 0.27, and the MSE of the CHAID estimate is 1.96 (table 4). For the variable Percent of DU's with Member Having a Limitation the MSE of the calibrated weight is 1.8 versus the MSE of 1.87 for the CHAID weight (table 2). For the variable Percent of DU's with Member Having Office Visits the MSE of the calibrated weight is 0.87 versus the MSE of 1.89 for the CHAID weight (table 3).

6. Conclusion

The results of the simulations in many ways confirmed the expectations that calibration with the same nonresponse and poststratification covariates would be similar to results from CHAID.

Acknowledgements

The authors would like to thank Sadeq Chowdhury, Joel Cohen and Steve Machlin for support and helpful comments

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Table 1. Variables used for nonresponse adjustment by CHAID for panel17 round 1 are:

BORNUSA	Born in the U.S.
DU_AD4	Adult under 65, insurance coverage status in DU
DU_CH5	Child insurance coverage status in DU
DUSZ_CAT	Count of the number of persons in DU
ED_DU	Education level of the DU reference person
GEODIST3	CBSA size
HAS_FONE	Telephone number status in NHIS
HEALTHDU	Health status in the DU
HOMEOWN	Homeowner status
INC_REF	Family income of the DU reference person
INTVLANG	Interview language
MARRYREF	Marital status of the DU reference person
MEDEXPND	Category of family Medical Expenses Amount
MSA_STAT	CBSA/MSA status
REASONNW	Reason did not work last week
REGIONRF	Census region
SAMPDOMN	Sampling domain
SEX_REF	Gender
TIMENOPH	Time without a telephone
URS_STAT	Urban/Rural residence

Table 2. 2011 Percent of DU's with Member Having a Limitation (in %)

	WTADJX	CHAID
Estimate	28.7	28.75
Standard Error	0.71	0.67
MSE[2]	1.8	1.87
RMSE	1.34	1.37

[2]bias = MEPS estimate - NHIS value

Table 3: 2011 Percent of DU's with Member Having Office Visits (in %)

	WTADJX	CHAID
Estimate	36.82	37.45
Standard Error	0.76	0.72
MSE[3]	0.87	1.89
RMSE	0.93	1.37

[3] bias = MEPS estimate - NHIS value

Table 4: 2011 Percent of DU's with Member Not Getting Medical Care due to Cost (in %)

	WTADJX	CHAID
Estimate	12.62	14.02
Standard Error	0.51	0.49
MSE[4]	0.27	1.96
RMSE	0.52	1.40

[4] bias = MEPS estimate - NHIS value

Table 5: Mean of 2011 Dollar Denominated Index

	WTADJX	CHAID
Estimate	$7081	$7081
Standard Error	$62.41	$62.39
MSE[5]	$4856.01	$4853.51
RMSE	$69.69	$69.67

[5] bias = MEPS estimate - NHIS value