The effect of accounting for all weight adjustments in the construction of student replicate weights in a national, cross-sectional study

Ruby E. Johnson, Peter H. Siegel

RTI International, 3040 Cornwallis Road, Research Triangle Park, NC, 27709-2194

Abstract

Replicate weights can be constructed using different procedures, including replicating some or all stages of sampling and replicating some or all weight adjustments. For the 2011-2012 National Postsecondary Student Aid Study (NPSAS:12), weights were replicated for only the poststratification weight adjustment for the second stage of sampling (student).

We used data from NPSAS:12 to compare design effect estimates computed using two different approaches to replication. The two different replication approaches were 1) replicating only the student-level poststratification weight adjustment (as was done for NPSAS:12) and 2) replicating all stages of the student-level weight adjustments, which encompasses replicating weight adjustments for student-level multiplicity, unknown eligibility, nonresponse and poststratification.

We compared design effect estimates to explore the differences between the variance estimates using the two approaches.

Key Words: replicate weights, NPSAS, nonresponse weight adjustments, calibration, weighting

1. Introduction

1.1 Background and Purpose of the Research

Accurately estimating variance is an important concern when analyzing survey data. Two commonly used approaches to estimating variance are Taylor series linearization and replication. In Taylor series linearization, an approximation to some nonlinear function is obtained, and then the variance of the function is based on the Taylor series approximation to the function. The replication approach estimates the standard error by calculating the variation of a statistic across multiple samples of a given population.

There are several ways to perform weight replication, including replicating some or all stages of sampling and replicating some or all weight adjustments. In the past, NPSAS staff have replicated only the student-level poststratification weight adjustment due to time constraints. In this analysis, we compare design effect estimates computed using replicate weights obtained through the replication of only the student-level poststratification weight adjustment to replicate weights obtained through replication of all stages of the student-level weight adjustments.

1.2 Overview of NPSAS:2012

The 2011–12 National Postsecondary Student Aid Study (NPSAS:12), conducted for the U.S. Department of Education's National Center for Education Statistics (NCES), is a comprehensive, nationwide study to determine how students and their families pay for postsecondary education.

NCES and other federal agencies require that survey-based data be analyzed using methods that recognize the survey's sample design including unequal probabilities of selection, clustering, stratification, and any adjustments to sample weights resulting from nonresponse adjustment and poststratification.

2. Replication of All Stages of Student Weight Adjustments

For the NPSAS:12, NPSAS staff created a set of 200 replicate weights. For these 200 replicate weights included on the analysis file, staff repeated the student-level poststratification process so that the variance would account for the student-level poststratification weight adjustment.

For this experiment, we repeated all stages of the student-level weight adjustments so that the variance would account for all stages of the student-level weight adjustments.

The student-level weight adjustments that were replicated included:
- student multiplicity adjustment
- student unknown eligibility adjustment
- student not located adjustment
- student refusal adjustment
- student other nonresponse adjustment and
- student poststratification adjustment

As was done for the NPSAS:12 analysis weight adjustments, all the replicate nonresponse and poststratification adjustments listed above were computed using the WTADJUST procedure in SUDAAN (RTI 2012). Each stage of the student-level weight adjustments are described below.

2.1 Student Multiplicity Adjustment
Students who attended more than one eligible institution during the 2011–12 academic year had multiple chances of being selected; that is, they could have been selected from any of the institutions they attended. These students therefore had a higher probability of being selected than was represented in their sampling weight. This multiplicity was adjusted by dividing their sampling weight by the number of institutions attended that were eligible for sample selection. Specifically, the student multiplicity weight adjustment factor was defined as $1/M$, where M is the multiplicity, or number of eligible institutions attended. The multiplicity was determined from the student interview, and the National Student Loan Data System (NSLDS).

2.2 Student Unknown Eligibility Adjustment
Final eligibility status could not be determined for nonresponding students. These students were treated as eligible, and their weights were adjusted to compensate for the small portion of students who were actually ineligible (as described below). Weighting classes were defined by the intersection of institution type with the students' matching status to financial aid files (Central Processing System [CPS] and NSLDS). These weight adjustment factors were based on the estimated rate of eligibility among students with known eligibility status. For the known-eligible students, the weight adjustment factor was set equal to 1.

2.3 Nonresponse Adjustments

The adjustments for nonresponse were performed in several steps because the predictors of response propensity are potentially different for differing nonresponse outcomes. Nonresponse outcomes for which we adjusted for were unlocatable, refusal, and other nonresponse. Using several steps of nonresponse adjustment can achieve greater reduction in nonresponse bias than a single-step adjustment. Predictor variables were chosen that were thought to predict response status and were nonmissing for both study respondents and nonrespondents. The same predictor variables were used in all three nonresponse adjustments.

The three nonresponse adjustments were:
1. student not located adjustment - the first type of adjustment for student nonresponse was an adjustment for the inability to locate the student.
2. student refusal nonresponse adjustment - the second stage of the student nonresponse adjustment was an adjustment for refusal, given that the student was located.
3. student other nonresponse adjustment - the third, and final, stage of adjustment for student nonresponse was an adjustment for other nonresponse, given that the student was located and did not refuse.

2.4 Poststratification Adjustment
To ensure population coverage, the student weights were further adjusted, with the use of SUDAAN, to known population totals (control totals) for key variables. The random sample of students may have had a distribution that differed from the population distribution; poststratification is a method to reduce the standard errors by adjusting estimates to external data. Control totals were established by institution type for student enrollment counts as well as for financial aid totals including total amount of aid awarded and total number of financial aid recipients for Stafford Loans and total amount of aid awarded for Pell Grants and PLUS

The PLUS, Stafford Loan, and Pell Grant control totals were obtained from the U.S. Department of Education. The fall and full-year enrollment counts were obtained from the 2012 IPEDS Fall and Full-Year Enrollment Components for the 2011-12 academic year. In the same step, high-extreme weights were poststratified to the control totals, truncated, and smoothed by SUDAAN, while the other weights were poststratified to the control totals.

3. Comparison of Design Effects

In order to assess the effect of repeating all stages of the student-level adjustments, we computed standard errors and design effects using the newly calculated replicate weights and compared the results with the original set of design effects presented in Appendix N of the NPSAS:12 Data File Documentation (Wine, Bryan, and Siegel 2014). Design effects were calculated within domains for variables of interest and included aid receipt status for various types of aid, enrollment status, marital status, veteran status, disability indicator and employment-related variables.

Table 1 shows that for the majority (60.4%) of all estimates the standard errors and design effects were larger for the estimates when all student-level adjustments were replicated vs only replicating the poststratification adjustment. The percentage of estimates with an increase in design standard errors and design effects ranged from 29.2% for High-income undergraduate students to 86.4% for Undergraduate students at public 4-year doctorate-

granting institutions. Of the 22 estimates for all undergraduate students and all graduate students, 59 and 77 percent respectively of the standard errors increased when all student-level adjustments were replicated vs only replicating the poststratification adjustment.

Table 1. NPSAS:12 Replicate Weighting Results – Comparison of Standard Errors and Design Effects

Appendix Table Number	Student Domain	Total number of estimates compared	Estimates with increase in **design standard error and design effect** when replicating all student-level adjustments vs only replicating poststratification	
			n	%
1	All undergraduate students	22	13	59.1%
2	Undergraduate students at pubic less-than-2-year institutions	21	12	57.1%
3	Undergraduate students at public 2-year institutions	22	10	45.5%
4	Undergraduate students at public 4-year non-doctorate-granting institutions	22	13	59.1%
5	Undergraduate students at public 4-year doctorate-granting institutions	22	19	86.4%
6	Undergraduate students at private non-profit less-than-4-year institutions	22	12	54.5%
7	Undergraduate students at private non-profit 4-year non-doctorate-granting institutions	22	13	59.1%
8	Undergraduate students at private non-profit 4-year doctorate-granting institutions	22	17	77.3%
9	Undergraduate students at private for-profit less-than-2-year institutions	21	14	66.7%
10	Undergraduate students at private for-profit 2-year institutions	22	11	50.0%
11	Undergraduate students at private for-profit 4-year institutions	22	12	54.5%
12	Dependent undergraduate students	21	14	66.7%
13	Independent undergraduate students	24	10	41.7%
14	Low-income undergraduate students	24	16	66.7%
15	Middle-income undergraduate students	24	18	75.0%
16	High-income undergraduate students	24	7	29.2%
17	All graduate students	22	17	77.3%
18	Graduate students at public 4-year institutions	22	12	54.5%
19	Graduate students at private non-profit 4-year institutions	22	18	81.8%
20	Graduate students at private for-profit 4-year institutions	22	11	50.0%
	Total	445	269	60.4%

Figure 1 compares the distribution of the design effects using both sets of replicate weights and includes a pair of box and whisker plots for each Appendix table listed in Table 1 above. The plot on the left of each pair shows the distribution of the design effects using the weights from the original method. The plot on the right of each pair shows the distribution of the design effects using the experimental method.

Figure 1. Distribution of Design Effects
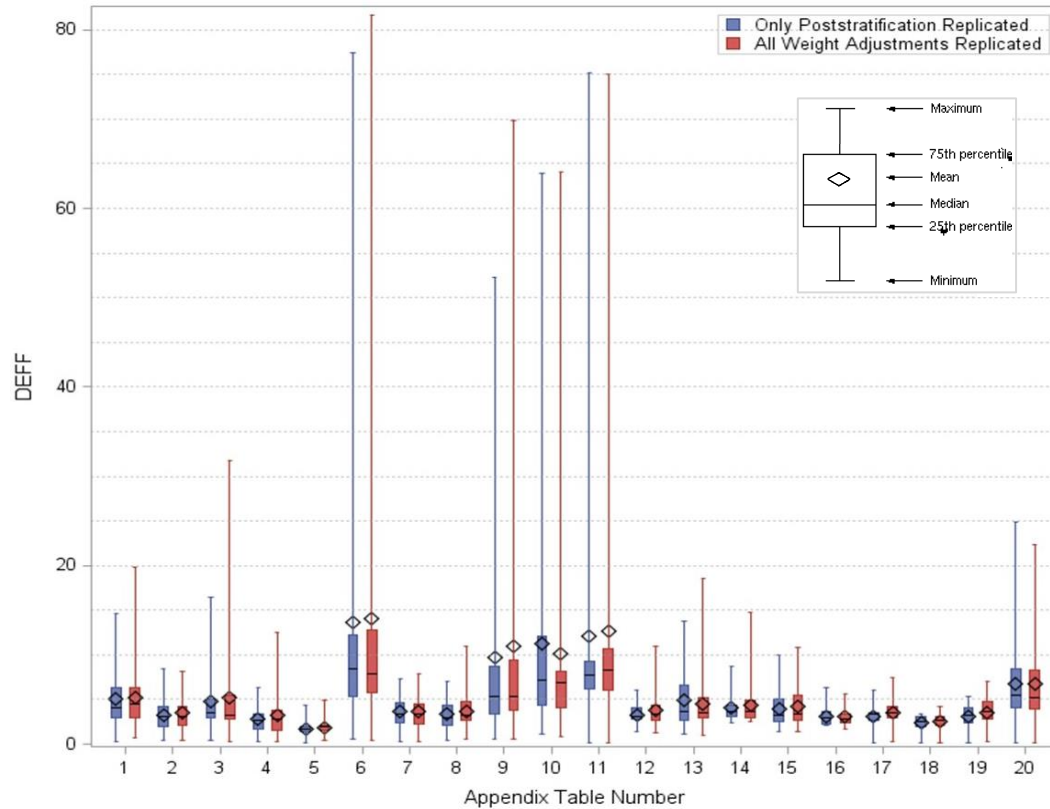
Overall, the mean, median and range of the design effects increased when using the experimental replicate weights. For all undergraduates and all graduates (Appendix tables 1 and 17 respectively), the design effect computed for the variables using the original replicate weights have a larger mean, median, and range than those computed with the experimental replicate weights.

4. Conclusions

The design effects were greater overall when using the replicate weights which took into account all levels of the student weight adjustments versus the replicate weights where only the student poststratification adjustment was replicated. The magnitude of these increases varied by the domain of students and by the variable being estimated.

As a result of these findings, we are working with NCES to explore replicating all student-level, and possibly all institution-level, weight adjustments, for NPSAS:16. Another approach to explore includes replicating all stages of weight adjustments including the institution-level adjustments and accessing the effect on variance estimation. We were unable to replicate the institution-level weights for this experiment due to how the

replicates were created. However in the future, we plan to construct the replicates so that institution-level weight adjustments can also be replicated.

Acknowledgements

References

Wine, J., Bryan, M., and Siegel, P. (2014). 2011–12 National Postsecondary Student Aid Study (NPSAS:12) Data File Documentation (NCES 2014-182). National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Washington, DC.

RTI International. (2012). SUDAAN 11 Language Manual, Volumes 1 and 2, Release 11. Research Triangle Park, NC: Research Triangle Institute.