Overcoming the challenges of computing a single analysis weight when a state-level component is incorporated into a traditional national-level study

Ruby E. Johnson, Peter H. Siegel, Kimberly Janda
RTI International, 3040 Cornwallis Road, Research Triangle Park, NC, 27709

Abstract

When a national-level study updates its design to include a state-level component, the historical methodology of the study must be revised to accommodate the new design including revisions to the weighting process. The 2017–2018 National Postsecondary Student Aid Study, Administrative Collection (NPSAS:18-AC) was the first NPSAS study to include a state-level component for undergraduates in all 50 states, Washington, D.C., and Puerto Rico.

We use our experience with NPSAS:18-AC to illustrate the challenge of adapting established weighting methods to a new study design. We describe our process for computing a single undergraduate weight that can be used for analyses at both the national and state levels. We discuss the evolution of the NPSAS:18-AC weighting approach which included both model-based adjustments using the SUDAAN WTADJUST procedure and weighting-class adjustments. We evaluate the final undergraduate analysis weights by comparing NPSAS:18-AC estimates with prior NPSAS estimates to show how the new single weight produces national-level estimates that are comparable to prior estimates and yet has the ability to produce state-level estimates.

Key Words: weighting, weight adjustments, poststratification, state-level data, NPSAS

1. Introduction

1.1 Background and Purpose of the Research

The National Postsecondary Student Aid Study (NPSAS), conducted by the National Center for Education Statistics (NCES) at the U.S. Department of Education's Institute of Education Sciences, is a traditional national-level survey. NPSAS, which has been conducted every three to four years since 1987, is a nationally- representative study of postsecondary students which examines how students and their families finance postsecondary education. It serves as a foundation of two longitudinal studies – the Beginning Postsecondary Students Longitudinal Study (BPS) and the Baccalaureate and Beyond Longitudinal Study (B&B).

NPSAS:18-Adminstrative Collection (NPSAS:18-AC) was conducted two years after the previous round of NPSAS and was the first administrative collection of its kind, consisting exclusively of administrative data from institutions in all 50 states, the District of Columbia, and Puerto Rico.[1] NPSAS:18-AC was designed to be representative of undergraduate students at the state level in addition to being nationally representative. The addition of the state-representative component necessitated modifications to the weighting process in order to compute a single undergraduate weight that could be used for analyses at both the national and state levels. This paper will discuss the weighting process for the computing this single undergraduate analysis weight.

[1] From this point forward, the words "state," "state level," and "state representative" refer to the 50 states, the District of Columbia, and Puerto Rico.

1.2 Comparing NPSAS:18-AC to NPSAS:16

NPSAS:18-AC had many characteristics of a typical NPSAS. It was a nationally representative study of both undergraduate and graduate students. Data were collected from administrative data sources such as academic and financial data from the postsecondary institutions, federal aid application and student loan data from federal agencies, and additional administrative data from the College Board, ACT and Veterans Benefits Association.

However, NPSAS:18-AC differed from a traditional NPSAS in that it was state-representative for undergraduate students and therefore had an undergraduate sample size of more than three times the sample size of a traditional NPSAS (n=325,220 for NPSAS:18-AC vs n=99,080 for NPSAS:16). Also, NPSAS:18-AC did not have a survey component; data were only collected from administrative data sources as described above.

Another difference was in the sampling stratification. Typically, NPSAS stratifies institutions by their control and level resulting in eleven institution-level strata which includes public, private nonprofit and private for-profit institutions by their highest level offered (i.e., less-than-2 year, 2-year, 4-year) and stratifies undergraduates by student type (i.e., specific majors, first time Baccalaureates, veterans, Baccalaureate recipients). For NPSAS:18-AC, institutions were stratified by 3 sectors (public 2-year, public 4-year, and all other institutions) within state for a total of 153 institution strata[2]; the strata variable was labeled SECTOR156 prior to data collection to account for the three institution types within each state (52 states * 3 = 156). For NPSAS:18-AC, there was no sampling stratification for undergraduate students.

In general, we were able to adjust the weights using the same methods used in past rounds of NPSAS. But due to the differences mentioned above, we had to modify the traditional NPSAS weighting process for undergraduates to account for the state-representative component of NPSAS:18-AC. Those modifications to the NPSAS weighting design are described in the following section.

2. Institution and Student Weight Adjustments

2.1 Weighting Considerations

When developing our weighting design, we had to consider many options and the consequences of each option. We wanted our results to be comparable to a traditional NPSAS. We desired to be able to produce national-level estimates, as well as state-level estimates. We were missing traditional survey items such as income and private loans which limited the comparability to past rounds of NPSAS. We considered the option of having one weight vs two weights and decided to have a single analysis weight that would be used for both national and state-level estimates. A single analysis weight had been calculated previously for NPSAS:04 and NPSAS:08 when there were 12 and 6 states, respectively, that were state representative.

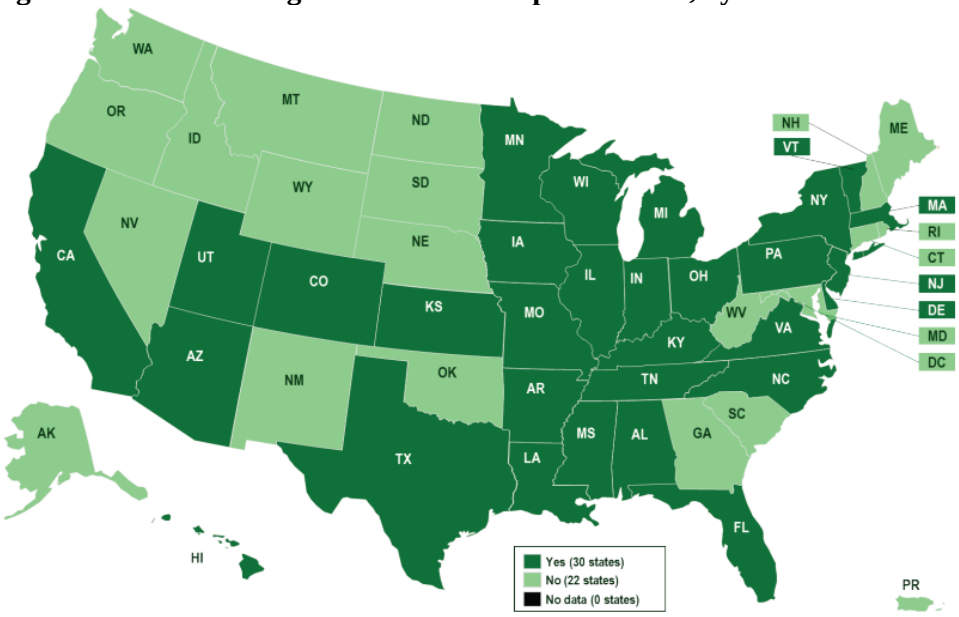
Other considerations included how to incorporate the state-level design into our weighting adjustments. We also had to develop a weighting plan that would allow for production of 200 replicate weights while minimizing the burden of time and resources. The state-level

[2] There were no public 2-year institutions in Alaska, Delaware, or the District of Columbia.

design necessitated that we include state-level control totals in poststratification adjustment which were additional control totals from a traditional NPSAS. These state-level totals included federal-sponsored financial aid and student enrollment by public 2-year, public 4-year, and other institutions within state (SECTOR156) and totals for state-sponsored financial aid by aid type for each state. We obtained the federal-sponsored financial aid and student enrollment control totals by splitting our traditional control totals by SECTOR156. We obtained the totals for state-sponsored financial aid by aid type for each state from the National Association of State Student Grant and Aid Programs (NASSGAP).

Another issue that we had to consider was which states and sectors within states had a sufficient number of respondents to be representative. Although the sample was designed to produce sufficient sample sizes for state representativeness in all states and sectors within states, due to institution and student nonresponse, some states and sectors within states were determined to be nonrepresentative. Figure 1 below shows the overall undergraduate student representativeness by state.

Figure 1. Overall undergraduate student representation, by state: 2017-2018



SOURCE: U.S. Department of Education, National Center for Education Statistics, 2017–18 National Postsecondary Student Aid Study, Administrative Collection (NPSAS:18-AC).

Due to nonresponse, 30 states were representative overall, and 36 and 45 states were representative for public 2-year and public 4-year institutions, respectively.

2.2 NPSAS Weight Adjustments

NPSAS weight adjustments are traditionally done in two stages corresponding to the two stages of sampling. In stage one, the institution weights are adjusted for nonresponse and poststratification. In stage two, the institution weight is used as a component of the initial student weight, and this student weight is adjusted for multiplicity, unknown eligibility, nonresponse, and poststratification.

All nonresponse and poststratification adjustments were computed using the WTADJUST procedure in SUDAAN (RTI International 2012). The WTADJUST procedure used a constrained logistic model to predict response. The β-parameters of the logistic model, the lower and upper bounds set on the factors, and the centering constant were used to determine the nonresponse and poststratification adjustments for both institutions and students.

The purpose of this paper is to discuss the challenges we encountered when adapting established weighting methods to the new study design and how we addressed these challenges. Specific details of the weighting process can be found in the NPSAS:18-AC Data File Documentation (Siegel, P., Ramirez, N., and Johnson, R 2021).

2.2 Institution Nonresponse and Poststratification Weight Adjustments

As described above, during the first stage of weight adjustments, institution weights were adjusted for nonresponse and poststratification. We incorporated the state-level design into the institution weight adjustments by including the institution strata variable (public 2-year, public 4-year, and other institutions within state = SECTOR156) as a predictor variable in the nonresponse model. For the institution poststratification adjustment, control totals were included by public 2-year, public 4-year, and other institutions within state (SECTOR156) in addition to national-level control totals by control and level (SECTOR11) so that the institution weights incorporated the state-representativeness of NPSAS:18-AC in addition to the national representativeness in order to be comparable to traditional rounds of NPSAS.

2.3 Student Multiplicity and Unknown Eligibility Adjustments

The final institution weight was used as a component in the initial student weight which was first adjusted for multiplicity and unknown eligibility. These adjustments were done using traditional NPSAS methods and did not incorporate the state-level design.

Students who attended more than one eligible institution during the 2017-2018 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 based on data from the National Student Loan Data System (NSLDS) and the National Student Clearinghouse (NSC).

Final eligibility status could not be determined for students who had incomplete or conflicting student records data. These students were treated as eligible, and their weights were adjusted to compensate for the small portion of students who were actually ineligible. Weighting classes were defined by control and level of institution. These weight adjustment factors were simply the eligibility rate estimated among students with known eligibility status. For the known-eligible students, the weight adjustment factor was set equal to 1.

2.4 Student Nonresponse Weight Adjustment

An adjustment for nonresponse was performed to account for nonresponding students. A responding student was defined as any eligible student for whom there was evidence of at

least 1 month of enrollment and who had valid data from student records for a sufficient number of items.

Predictor variables were chosen that were thought to predict response status and were nonmissing for both study respondents and nonrespondents. The nonresponse models were run separately for each of the 52 states. When an individual state model failed to converge, we used a backward stepwise method, collapsing and removing variables sequentially until a converging model was achieved. Collapsing of variables was first done by collapsing public 2-year and public 4-year variables before collapsing into overall state-level variables. To inform the decisions on collapsing and removal of the variables, we worked with education analysts to prioritize the predictor variables and attempted to include higher priority variables in the models. During the model convergence process, we considered potential representativeness at the public 2-year, public 4-year, and state levels to inform our decision about collapsing variables.

2.5 Student Poststratification Weight Adjustment

The nonresponse adjusted weights from each of the 52 models were combined to create a dataset of nonresponse adjusted weights for all students. To ensure population coverage, these nonresponse-adjusted weights were further adjusted 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 SECTOR156 and by SECTOR11 for undergraduate student enrollment counts as well as for financial aid totals including total amount of aid disbursed and total number of financial aid recipients for Direct Loans and Pell Grants and total amount Parent Loan for Undergraduate Students (PLUS) disbursed.

The PLUS, Direct 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 2018 IPEDS Fall Enrollment and 2018-19 12-Month Enrollment Components for the 2017-2018 academic year. Totals for state-sponsored financial aid by aid type for each state from NASSGAP.

The initial student poststratification model, which had over 2,200 control totals and included state- and national-level control totals, did not converge. Our next attempt to achieve a converging model involved developing 52 state-level models, one model for each state, that included the state-level control totals. If these individual models did not converge, we collapsed and removed control totals as needed and used a backward stepwise process to develop 52 converging state-level models. To inform the decisions on collapsing and removal of the variables, again we worked with education analysts to prioritize the control totals and tried to include higher priority control totals in the models. The control totals from these 52 converging state-level models along with the national control totals were combined to form the control totals for the second version of the overall model. This second model failed to converge.

Our next attempt was to consider which state and sectors within states were representative and to develop a model that maintained the state- and sector-representation for only these states and sectors. The third overall model contained state- and sector-level control totals for only the representative states and sectors in addition to the national-level control totals. This third model converged, had over 1,600 control totals, and took around twelve hours

to run. This model produced a single undergraduate weight which fulfilled the goal of being able to produce both national- and state-level estimates.

3. Comparison of national estimates between NPSAS:18-AC and NPSAS:16

In order to evaluate the final undergraduate analysis weights, we compared NPSAS:18-AC estimates with prior NPSAS estimates to show how the NPSAS:18-AC single analysis weight produces national-level estimates that are comparable to prior estimates. Table 1 shows the comparison of the estimates for select variables between NPSAS:16 and NPSAS:18-AC.

Table 1. Comparison of the estimates between NPSAS:16 and NPSAS:18-AC

Variable	NPSAS:16		NPSAS:18-AC		Difference in Means (N:18 - N:16)	% Difference
	Mean	SE	Mean	SE		
Poststratification control total variables						
Direct Subsidized and Unsubsidized Loans	$6,609.30	$13.20	$6,616.40	$16.50	$7.20	0.1%
Direct Subsidized Loans	$3,721.60	$0.20	$3,761.90	$2.90	$40.30*	1.1%
Direct Unsubsidized Loans	$4,045.00	$0.40	$3,977.90	$3.40	$-67.10*	-1.7%
Federal Supplemental Educational Opportunity Grant (SEOG) total	$660.20	$10.80	$687.40	$14.20	$27.20	4.0%
Federal Pell grant total	$3,731.00	$0.00	$3,937.90	$2.20	$206.90*	5.3%
Parent Loan for Undergraduate Students (PLUS) loan total	$14,043.90	$218.00	$15,115.50	$224.50	$1,071.60*	7.1%
Received a Direct Loan	36.2%	0.1%	38.7%	0.2%	2.4%*	6.3%
Subsidized	31.5%	0%	33.4%	0.2%	2.0%*	6.0%
Unsubsidized	30.3%	0%	32.7%	0.2%	2.4%*	7.3%
Received a Pell Grant	39.1%	0%	43.8%	0.3%	4.7%*	10.7%
Other variables						
Major with a focus in STEM	23.7%	0.2%	23.2%	0.3%	-0.5%	-2.3%
Enrolled part-time or part-year	62.3%	0.3%	61.8%	0.3%	-0.6%	-0.9%
Enrolled exclusively fulltime	43.6%	0.4%	43%	0.4%	-0.7%*	-1.4%
U.S. citizen	92.7%	0.2%	92%	0.2%	-0.7%*	-0.8%
Female	56.5%	0.1%	57.1%	0.3%	-0.7%*	1.1%
Received any institution grant aid	24.4%	0.3%	25%	0.4%	-0.7%*	2.7%
U.S. Armed Forces veteran	4.9%	0.1%	4.1%	0.1%	-0.8%*	-19.3%
Received any work-study aid	5.2%	0.1%	6.7%	0.2%	1.5%*	22.5%
Received any state grant aid	21.9%	0.3%	24.5%	0.2%	2.6%*	10.8%
Attended more than one institution	9.7%	0.3%	12.5%	0.4%	2.7%*	21.9%
Has dependents other than a spouse	23.9%	0.3%	19.9%	0.3%	-3.9%*	-19.8%
Married	15.1%	0.2%	11.1%	0.2%	-4.1%*	-36.7%
Received any federal aid	54.5%	0.1%	59.1%	0.3%	4.6%*	7.8%
Received any employer aid	6%	0.1%	0.4%	0.0%	-5.7%*	-1564.9%
Total work-study	$2,410.60	$32.40	$2,498.20	$59.30	$87.60	3.5%
Total federal aid (excludes Veterans'/DOD)	$8,584.40	$19.10	$8,973.40	$28.90	$389.10*	4.3%
State grants total	$2,613.20	$35.70	$3,058.40	$21.40	$445.20*	14.6%
Institutional grants total	$8,258.20	$116.90	$9,729.30	$239.20	$1,471.10*	15.1%

*p-value < 0.05

4. Conclusions

Overall, the estimates between NPSAS:16 and NPSAS:18-AC are very similar. Comparing the estimates of poststratification aid variables, we see that, in general, more students are receiving aid and that the average amount of aid for each aid type is also increasing. The estimates for other variables such as STEM major, enrollment status, and citizenship are very similar; these are variables that are more likely to be obtained through administrative sources such as institution student records and financial aid applications. The greatest differences occur in variables such as employer-aid recipient and marital status which traditionally are confirmed or collected during the survey which was not a data source in NPSAS:18-AC. Estimates of these variables using NPSAS:18-AC are less reliable due to the lack of survey-data.

Based on this experience, we gained knowledge on how to develop converging weight adjustment models when the model is complex. We learned to split a nonconverging full model into separate smaller models for subsets of the sample in order to achieve convergence and then combine these smaller models to create the full model. When reducing a model, we consider the prioritization of the model variables to guide our model-refinement decisions.

NPSAS:20, which is a traditional NPSAS with a survey component, included an increased undergraduate sample size for administrative collection and state-representativeness. NPSAS:20 has two weights - one weight to be used for national estimates for the students who were surveyed and a second weight for undergraduates in the larger sample for whom we collected administrative data. This second weight is analogous to the NPSAS:18-AC weight and will be used for state- and sector-level estimates.

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