DIVERSITY PROGRAM CONSORTIUM

Supported by the National Institutes of Health

COORDINATION & EVALUATION CENTER

Technical Report

BUILD Program Evaluation: Identification of Comparator Institutions

March 2019

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INTRODUCTION

Funded by the National Institutes of Health (NIH), BUILD (BUilding Infrastructure Leading to Diversity) is a set of experimental training awards designed to learn how to attract students from diverse backgrounds into the biomedical research workforce and encourage them to become future contributors to the NIH-funded research enterprise. There are 10 primary BUILD grantees that include 11 institutions.

As part of the evaluation of the BUILD programs, BUILD institutions will be compared to comparable institutions not in the BUILD program on "hallmarks of success." Hallmarks measure characteristics of students, faculty, and institutions which contribute to academic biomedical career progress, or are markers of that progress. To conduct these evaluations, it is necessary to find suitably matched institutions that are not BUILD grantees.

This technical report describes the procedures used to identify comparator institutions for each of the BUILD institutions and reports the number and characteristics of the matched institutions. In particular, we describe (1) the formation of the candidate pool of potential comparator institutions; (2) the institutional characteristics used as matching variables; (3) the use of a matching procedure called coarsened exact matching to identify potential comparator institutions matched to BUILD schools; (4) refinement of the comparator list based on qualitative review; and (5) the final list of BUILD and comparator institutions. Due to confidentiality concerns, names or other identifying information of the comparator institutions are not provided.

METHODS

Candidate pool of institutions

As part of the BUILD program evaluation, the BUILD and comparator institutions will be compared using student survey data collected through the Higher Education Research Institute (HERI). To facilitate these comparisons, the candidate comparator pool was restricted to institutions that administered The Freshman Survey (TFS), a survey housed at HERI, in both 2015 and 2016. The data from these years represent "baseline" data for the BUILD program.

In order to be eligible for BUILD funding, institutions had to have at least 25% of their undergraduate students receiving Pell grants and have received less than $7.5 million in NIH research project grant funding in 2013. We considered restricting the candidate comparator pool to institutions that met BUILD eligibility criteria. However, because otherwise suitable comparison schools might deviate somewhat from these criteria, we relaxed these criteria and restricted the candidate comparator pool to institutions with at least 12.5% of students receiving Pell grants and less than $15 million in NIH research funding in 2013.

Matching variables

We sought to find comparator institutions that were similar to BUILD institutions on the following characteristics:

(1) Public versus private;
(2) Percent of undergraduate students from underrepresented minority (URM) groups; URMs are defined as Black or African American, Latino/Hispanic and Native American/Alaska Native;
(3) Percent of undergraduates receiving a Pell grant;
(4) Percent of applications deemed admissible;
(5) Mean efficiency score (Titus and Eagan, 2016) for all STEM fields;
(6) 6-year graduation rates for URM. These rates were based on the cohort entering school in Fall 2008, whose 6-year graduation rate was calculated as of 2014.

We considered using total number of undergraduates as a matching variable. However, we found that including this variable greatly constrained the number of potential matches due to the small number of large schools in the candidate comparator pool, and we therefore dropped this variable as a matching factor.

We did not use level of NIH research funding as a matching variable because the pool was already restricted to institutions with under $15 million in NIH research funding. Although we also restricted the comparator pool based on Pell grant percentage, we kept this variable as a matching variable, given that there was still substantial variability in student Pell grant receipt among the institutions.

Procedures for identifying comparator schools

Comparator institutions were identified using coarsened exact matching (CEM) (Iasuc, King and Porro, 2012; King and Nielsen, forthcoming) implemented using the user-contributed Stata command cem (Blackwell et al., 2009). CEM is a method developed to improve estimation of causal effects from observational data by reducing imbalance in covariates between "treated" and "control" groups. In CEM, matching variables are coarsened into categorical variables and then exact matches of treated and control units are found based on the coarsened data. This method has some advantages over other methods such as matching on propensity scores in that it requires fewer assumptions, is not based on a model (which could be misspecified), ensures common empirical support (i.e., overlap of variable distributions between treated and control units) and is transparent. After matching, the analyst may use any statistical method or model that could have been applied without matching.

The CEM method requires coarsening of continuous matching variables according to user-defined cutpoints or an automatic binning algorithm. The coarsened variables are used to form strata. For example, if 3 variables are each coarsened by dichotomization, then there will be 2 x 2 x 2 = 8 strata with unique combinations of the coarsened variables. Treated and control units are then sorted into their respective strata. Control units in the same stratum as a treated unit serve as the potential comparators for that unit.

The method requires some iteration to find cutpoints that yield strata with acceptable numbers of both treated and control units. Using fewer cutpoints will result in fewer strata that are larger and less internally homogeneous. Using more cutpoints will results in more numerous strata that

are more homogeneous but can result in having treated units in strata without any control units. After exploratory analyses using different levels of coarsening, we opted to coarsen our five continuous matching variables by dichotomizing them at the median among the BUILD institutions. The categorizations are denoted as "above" or "below" this median. Institution type (public versus private) was not further coarsened.

Qualitative review

After obtaining potential comparator schools for each BUILD institution using CEM, we conducted a qualitative review of their suitability as comparator institutions. This review involved consideration of factors beyond the institutional characteristics used for CEM, such as historically black college and university (HBCU) status and religious affiliation. Some refinements to the comparators list were made based on these considerations.

RESULTS

After restricting the candidate comparator pool to institutions that administered the HERI TFS in both 2015 and 2016 and that met our Pell grant receipt and NIH research grant funding criteria, 129 institutions remained. Among this group, small selective private schools that were deemed not suitable matches for BUILD schools were overrepresented. We therefore removed private institutions with admission rates lower than 30% or undergraduate enrollments less than 1,100 (n = 29), yielding a pool of 100 potential comparator schools.

Table 1 summarizes characteristics of the BUILD institutions and the institutions in the candidate comparator pool. Figure 1 compares the distributions of the matching variables for BUILD and potential comparators graphically. While BUILD schools were mostly public institutions (9/11, 82%), most of the institutions in the candidate comparator pool were private (80/100, 80%). There was good overlap between BUILD and potential comparator schools on underrepresented minority percentage, Pell grant percentage, admission rate, STEM efficiency and 6-year graduation rates for underrepresented minorities.

The comparator pool included 32 institutions (32%) with Pell grant receipt percentages lower than the BUILD eligibility criteria of 25%; these percentages ranged from 13-24%. Only two potential comparator schools (2%) had NIH research project grant funding exceeding the BUILD cap of $7.5 million in 2013; these institutions had funding levels of $12.9 and $14.2 million and were distinct from the schools not meeting the Pell grant criterion. Thus overall, there were 34 schools in the comparator pool (34%) that did not meet the BUILD eligibility criteria.

Figure 2 compares the distribution of total undergraduate enrollment at BUILD and potential comparator institutions. Even after removing most small private schools, the comparator pool was comprised predominantly of institutions with smaller enrollments, with only a few exceeding 10,000 undergraduates.

Table 2 shows the values of the dichotomized matching variables for the 11 BUILD institutions. Because variables were dichotomized at the BUILD median, for each variable, about half of

BUILD institutions are "above" and half are "below" the median, as noted in the table. A few institutions had the same covariate patterns; in all, there were 8 unique covariate patterns among the 11 BUILD schools, defining 8 strata.

The next step was to identify comparator institutions matching the covariate patterns in each of these strata. However, when using these strata, we found that some BUILD schools were matched to only one comparator school, and one BUILD school had no matches. We therefore modified the matching criteria to require matching on admission rate (dichotomized at the BUILD median) only for the private BUILD institutions. This yielded a substantial increase in the number and quality of the matches.

As a final step, we conducted a qualitative review of the potential comparator schools. Based on this review, we eliminated two specialty institutions that did not offer a full range of undergraduate programs and were thus deemed not sufficiently comparable. We also noted that some potential comparators were not congruent with their BUILD institution on HBCU status and/or STEM efficiency. These institutions were kept as comparators but flagged to note these issues. We also found that University of Detroit Mercy was in a stratum with by far the largest number of potential comparators (11 schools). This provided an opportunity to narrow the matching criteria for this institution to find closer matches. The decision was made to add religious affiliation as a matching variable for this institution.

Table 3 provides the final listing of BUILD and comparator schools. Comparator schools are identified with a unique alphabetic code. Each BUILD school was matched to 2-5 comparator schools, and the total number of comparators was 24. Three of the comparators did not meet the BUILD eligibility criterion of at least 25 percent of undergraduates receiving Pell grants; these schools had Pell grant percentages ranging from 18-21%. Two exceeded the BUILD cap on NIH research project grant funding; these were the same two institutions that exceeded the cap in the pool of 100 potential comparators. Overall, 21% (5/24) of the selected comparators did not meet the BUILD eligibility criteria but met our more relaxed criteria.

DISCUSSION

Using a procedure that matched BUILD and potential comparator schools on important institutional characteristics by using categorical versions of these variables, we identified 2-5 comparator schools for each BUILD institution.

We encountered a number of challenges finding suitable comparator institutions for the BUILD schools. Because we plan to use HERI survey data for evaluation analyses, the pool of potential comparator institutions was restricted to schools that had administered the Freshman Survey in 2015 and 2016. Many such institutions were smaller, more selective schools that were not appropriate matches for BUILD institutions. The pool was further restricted by level of NIH research project grant funding and percentage of undergraduate students receiving Pell grants. Thus the size of the candidate pool was limited. Nevertheless, we were able to identify at least two comparator schools for each BUILD school and in some cases identified 4 or 5 comparators.

When the BUILD program was funded, eligibility was restricted to institutions with at least 25% of undergraduate students receiving Pell grants and less than $7.5 million in NIH research project grant funding in 2013. In order to increase the potential for good matches, we relaxed these criteria for potential comparators and allowed schools with Pell grant receipt as low as 12.5% and NIH research project grant funding up to $15 million into the potential comparator pool. This strategy was advantageous in that it enabled us to find additional matches. All matched schools had at least 18% of undergraduates receiving Pell grants in 2013, suggesting reasonable comparability on this criterion. Two of the 24 matched institutions (8.3%) had NIH research funding of about $13-$14 million in 2013, suggesting more research resources than a typical BUILD school. Concerns about lack of comparability on this characteristic can be addressed during future evaluation analyses using sensitivity analyses that omit these institutions.

In our final list, some BUILD institutions have the same set of comparator schools. This is an expected result given the coarsened exact matching procedure and is not expected to adversely affect any evaluation.

Every institution of higher education has its own unique characteristics. As a result, any comparisons among schools will have limitations. We addressed this issue in our matching process by seeking to identify at least two comparators for each BUILD school, with the awareness than any single comparator might have limitations. When conducting evaluations comparing BUILD and comparator schools, we plan to conduct sensitivity analyses that involve repeating analyses after omitting schools that may have distinctive characteristics that impact their suitability as comparators.

REFERENCES

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Iacus SM, King G, Porro G. (2012) Causal inference without balance checking: coarsened exact matching. Political Analysis 20(1):1--24. Copy available at http://j.mp/2nRpUHQ

King G, Nielsen R. Forthcoming. Why propensity scores should not be used for matching. Political Analysis. Copy available at http://j.mp/2ovYGsW

Titus MA, Eagan MK. (2016). Examining production efficiency in higher education: The utility of stochastic frontier analysis. Pp. 411-512 in MB Paulsen (Ed.), Higher Education: Handbook of Theory and Research. Vol 31. New York: Springer.

Table 1. Summary of characteristics of BUILD and potential comparator institutions

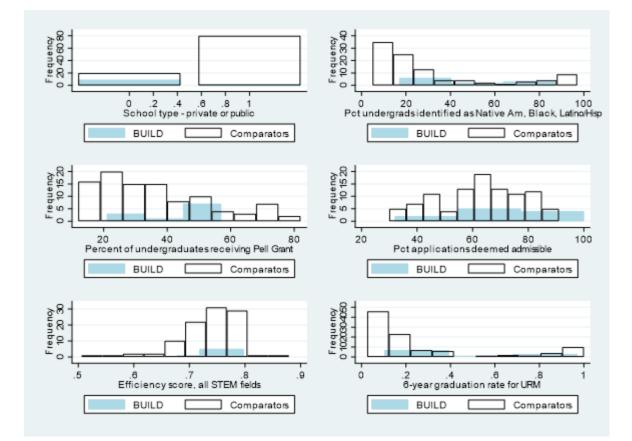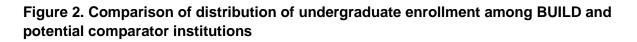|	BUILD institutions (n=11)	Potential comparator institutions (n=100)
School type		
Private	2 (18%)	80 (80%)
Public	9 (82%)	20 (20%)
Pell grant percent 2013		
Mean (SD)	45 (12)	36 (17)
Median	50	31.5
Range	27-58	13-78
NIH research project grant funding 2013		
Mean (SD)	$1,483,711 ($1,688,453)	$525,266 ($2,126,235)
Median	$917,964	$0
Range	$0 - $4,737,506	$0 - $14,232,801
Admission rate		
Mean (SD)	68 (19)	63 (15)
Median	68	64
Range	32-100	30-91
URM percent		
Mean (SD)	44 (28)	31 (27)
Median	34	18
Range	17-87	5-97
Undergraduate enrollment		
Mean (SD)	16,277 (11,912)	3,710 (3,999)
Median	16,728	2,249
Range	2,344 – 36,979	1,160 – 32,229
Efficiency, all STEM		
Mean (SD)	0.758 (0.032)	0.737 (0.055)
Median	0.755	0.753
Range	0.678-0.798	0.506-0.879
6-yr URM graduation rate		
Mean (SD)	0.44 (0.31)	0.27 (0.30)
Median	0.33	0.14
Range	0.10-0.97	0.026 – 1.00

URM, underrepresented minority

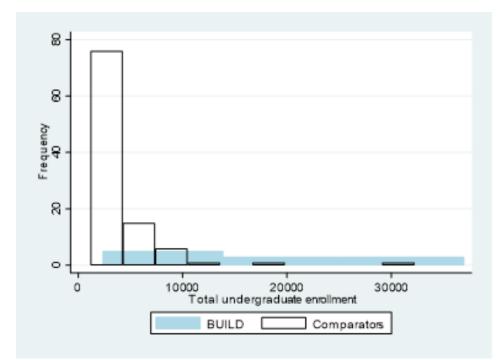**Figure 1. Comparison of distributions of matching variables among BUILD and potential comparator institutions**

Figure 2. Comparison of distribution of undergraduate enrollment among BUILD and potential comparator institutions

Table 2. Classification of BUILD institutions on matching variables

Institution name	School type	Pct URM	Pct Pell	Admit rate	Efficiency STEM	6-yr URM grad rate
California State University Long Beach	Public	Above	Above	Below	Below	Above
California State University Northridge	Public	Above	Above	Below	Above	Above
Morgan State University	Public	Above	Above	Below	Below	Above
Portland State University	Public	Below	Below	Above	Below	Below
San Francisco State University	Public	Below	Below	Below	Above	Below
University of Alaska Fairbanks	Public	Below	Below	Above	Below	Below
University of Detroit Mercy	Private	Below	Below	Above	Above	Below
University of Maryland-Baltimore County	Public	Below	Below	Below	Above	Below
University of Texas at El Paso	Public	Above	Above	Above	Below	Above
Wayne State University	Public	Below	Below	Above	Above	Below
Xavier University of Louisiana	Private	Above	Above	Below	Above	Above

Note: "Above" means above the BUILD median and "Below" means below the BUILD median on that matching variable (see Table 1)

Table 3. BUILD and comparator institutions with characteristics

Institution name	School type	Pct URM	Pct Pell	Admit rate	Effic'y STEM	6-yr URM grad rate
California State University Long Beach	Public	Above	Above	Below	Below	Above
Institution K	Public	Above	Above	Below	Below	Above
Institution L	Public	Above	Above	Below	Below	Above
Institution M*	Public	Above	Above	Below	Below	Above
California State University Northridge	Public	Above	Above	Below	Above	Above
Institution X	Public	Above	Above	Below	Above	Above
Institution N*	Public	Above	Above	Below	Above	Above
Institution J*	Public	Above	Above	Below	Above	Above
Institution O*	Public	Above	Above	Below	Above	Above
Morgan State University	Public	Above	Above	Below	Below	Above
Institution I	Public	Above	Above	Above	Below	Above
Institution J*	Public	Above	Above	Below	Above	Above
Portland State University	Public	Below	Below	Above	Below	Below
Institution A	Public	Below	Below	Above	Below	Below
Institution B	Public	Below	Below	Above	Below	Below
Institution C	Public	Below	Below	Below	Below	Below
Institution D	Public	Below	Below	Above	Below	Below
San Francisco State University	Public	Below	Below	Below	Above	Below
Institution E	Public	Below	Below	Above	Above	Below
Institution F	Public	Below	Below	Below	Above	Below
Institution G	Public	Below	Below	Below	Above	Below
Institution H	Public	Below	Below	Above	Above	Below
University of Alaska Fairbanks	Public	Below	Below	Above	Below	Below
Institution A	Public	Below	Below	Above	Below	Below
Institution B	Public	Below	Below	Above	Below	Below
Institution C	Public	Below	Below	Below	Below	Below
Institution D	Public	Below	Below	Above	Below	Below
University of Maryland-Baltimore County	Public	Below	Below	Below	Above	Below
Institution E	Public	Below	Below	Above	Above	Below
Institution F	Public	Below	Below	Below	Above	Below
Institution G	Public	Below	Below	Below	Above	Below
Institution H	Public	Below	Below	Above	Above	Below

University of Detroit Mercy	Private	Below	Below	Above	Above	Below
Institution P	Private	Below	Below	Above	Above	Below
Institution Q	Private	Below	Below	Above	Above	Below
Institution R	Private	Below	Below	Above	Above	Below
Institution S	Private	Below	Below	Above	Above	Below
Institution T	Private	Below	Below	Above	Above	Below
University of Texas at El Paso	Public	Above	Above	Above	Below	Above
Institution K	Public	Above	Above	Below	Below	Above
Institution L	Public	Above	Above	Below	Below	Above
Institution M*	Public	Above	Above	Below	Below	Above
Wayne State University	Public	Below	Below	Above	Above	Below
Institution E	Public	Below	Below	Above	Above	Below
Institution F	Public	Below	Below	Below	Above	Below
Institution G	Public	Below	Below	Below	Above	Below
Institution H	Public	Below	Below	Above	Above	Below
Xavier University of Louisiana	Private	Above	Above	Below	Above	Above
Institution U	Private	Above	Above	Below	Above	Above
Institution V	Private	Above	Above	Below	Above	Above
Institution W*	Private	Above	Above	Below	Above	Above

*These institutions were identified during qualitative review as having distinctive qualities that might impact their performance as a comparator school; such concerns will be addressed by conducting sensitivity analyses.

Note: "Above" means above the BUILD median and "Below" means below the BUILD median on that matching variable (see Table 1)