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Towards reasonable efficiency in degree production: A method for benchmarking the educational expenditures of postsecondary institutions

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Abstract

Institutional efficiency is frequently measured as a ratio between input and output (e.g., expenditures per credential), but differences in cost structures preclude attempts to accurately compare and benchmark performance across institutions. This study thus compares actual and predicted educational expenditures while accounting for variation in institutional mission, degree production profiles, faculty employment, and the cost of living. Longitudinal data were obtained from IPEDS for both public and private not-for-profit four-year institutions (*n*=1,496). The Regional Price Parities index was used to adjust expenditures for differences in the cost of living. Panel regression was used to predict educational expenditures from the number of credentials by award level and discipline, the proportion of full-time faculty, the student-faculty ratio, and average professor salary. An educational expenditures index was then computed as the standardized, three-year average difference between actual and predicted expenditures. Cross-sector comparisons revealed that the prevalence of public four-year institutions with higher-than-expected expenditures ranged from 19 to 25 percent, compared to 36 to 40 percent of private institutions.

Keywords : Educational Expenditures Index, Institutional Efficiency, Panel Regression, 4-Year Institution, Regional Price Parities Index

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Introduction

A central objective of public accountability in higher education is to ensure that colleges and universities produce graduates with high-quality credentials at a reasonable cost (St. John, Kline, & Asker, 2001). The ideal of efficient degree production − minimizing expenditures for a specific level and type of output without sacrificing quality − has become particularly pressing as states attempt to meet future demands for a highly educated workforce. In the United States, approximately 65 percent of all jobs in 2020 will require some level of postsecondary education (Carnevale, Smith, & Strohl, 2013). And yet, current degree production trends suggest that only 48 percent of adults nationwide will hold an associate degree or higher by 2025 (Lumina Foundation, 2013). Moreover, most states have not significantly increased funding for public postsecondary institutions to improve degree production rates (State Higher Education Executive Officers Association [SHEEO], 2015). State and local appropriations decreased between 2000 and 2010 among public bachelor's colleges (-20 percent), master's universities (-24 percent), and research universities (-24 percent), while enrollment increased by 23 to 30 percent at these institutions (Kirshstein & Hurlburt, 2012). Colleges and universities are thus confronted with a politically-imposed necessity of doing more with less.

Despite the importance of promoting efficiency in the production of postsecondary degrees, the question of whether a particular level of institutional expenditures is defensible remains difficult to ascertain and communicate. Several measurement challenges stem from the fact that postsecondary institutions are "multi-product firms (that is, they produce multiple kinds of services); inputs and outputs of the productive process are heterogeneous, involve nonmarket variables, and are subject to quality variation and temporal change; and measurement is impeded by gaps in needed data" (National Research Council, 2012, p. 37). Nonetheless, many organizations have resorted to using overly simplistic efficiency indicators that are prone to capturing variation in cost structures rather than differences in resource management (Toutkoushian, 1999), including total educational expenditures per academic credential (Chronicle of Higher Education, 2012), expenditures per student (College Measures, 2015), and credentials per $100,000 of state appropriations (National Governors Association, 2013). Such indicators fail to inform policymakers and institutional leaders whether expenditures are reasonable given the peculiarities of degree production. The current study thus presents an approach to benchmarking expenditures that accounts for variation in institutional mission, degree production profiles, faculty employment, and the cost of living.

Defining educational expenditures

The expenditures of interest are those most closely linked with the instructional mission of colleges and universities. Institutional expenditures are currently reported through the Integrated Postsecondary Education Data System (IPEDS) within several broad categories: instruction; research; public service; academic support (e.g., academic administration, curricular development); student services (e.g., admissions, counseling, student activities); institutional support; operation maintenance of plant; scholarships and fellowships; auxiliary enterprises, such as residence halls and parking (i.e., operations funded through user fees); hospital services; independent operations; and other expenses (National Center for Education Statistics [NCES], 2013). While many of these categories may be at least indirectly associated with positive student outcomes, past research has variously demonstrated a positive relationship between student outcomes and three expenditure categories: instruction, student services, and academic support (Astin, 1993; Bailey, Calcagno, Jenkins, Leinbach, & Kienzi, 2006; Chen, 2012; Gansemer-Topf & Schuh, 2006; Pike, Kuh, McCormick, Ethington, & Smart, 2011; Ryan, 2004; Smart, Ethington, Riggs, & Thompson, 2002; Toutkoushian & Smart, 2001; Webber & Ehrenberg, 2010).

Conceptual framework

Cost functions are commonly utilized to model educational expenditures (Cohn & Cooper, 2004). A cost function is "obtained by finding the input levels that minimize expenditures subject to a given level of production and technology" (Toutkoushian & Paulsen, 2016, p. 259), and it is expressed as $Cost=f\,(Q, X)$, where cost includes fixed (e.g., buildings) and/or variable costs (e.g., faculty salaries); Q indicates a set of output variables; X indicates a set of non-output factors affecting costs; and $f\,(\,)$ is a mathematical function illustrating how these factors are associated with costs.

Several analytical techniques can be used to estimate cost functions in higher education, including ordinary regression (e.g., Cohn, Rhine, & Santos, 1989; de Groot, McMahon, & Volkwein, 1991; Toutkoushian, 1999; see also Horn & Lee, 2016; Powell, Gilleland, & Pearson, 2012), data envelopment analysis (e.g., Eckles, 2010), and stochastic frontier analysis (e.g., Agasisti & Belfield, 2014; Johnes, 2006). Each method produces a performance score based on the deviation or ratio of the institution's performance relative to an expected mean performance or actual top performance. In the case of regression, the method of the current study, expenditure residuals are computed as the difference between actual and predicted expenditures.* Values that approximate or fall below zero would indicate that educational expenditures are as expected or lower than expected, and values above zero would indicate that educational expenditures are higher than expected. Approximations to or negative deviations from zero, then, would reflect greater efficiency, ceteris paribus. In contrast, stochastic frontier analysis measures cost efficiency as the ratio between the institution's actual expenditures and the minimum possible expenditure on the stochastic frontier (ranging from zero to one).

Exemplifying the traditional regression-based approach, Toutkoushian (1999) estimated cost functions in U.S. higher education with a sample of over 800 four-year institutions. His model predicted total expenditures from several variables that reflected institutional costs (e.g., average professor salary), outputs in terms of total student

* An alternative approach is to utilize expenditures per credential as a dependent variable, but this may unnecessarily introduce error into efficiency estimates by treating credentials as a monolithic construct.

enrollment, and non-output factors, such as geographic region. Toutkoushian recommended that the results from such models be used to inform policymaking through comparisons of actual and predicted expenditures, noting that institutions with seemingly high expenditures are not necessarily inefficient.

The conceptual framework in the current study draws upon Toutkoushian's (1999) cost function model while providing an alternative specification of outputs. Specifically, given the recent interest in performance-based funding (e.g., Horn & Lee, 2017), the current study uses a credential-oriented model to account for an institution's mission, degree production profile, faculty employment profile, and cost of living differences.

Institutional mission. A central feature of higher education in the U.S. is the extensive diversity of institutional missions, which variously emphasize undergraduate and graduate instruction, professional development, research, public service, and technology transfer (Bogue & Aper, 2000; Geiger, 2004). The commonly used Carnegie classification system represents differences in institutional mission according to the highest level of degrees awarded (see Center for Postsecondary Research Indiana University School of Education, 2015). Total expenditures per full-time equivalent (FTE) student vary by institutional type in relation to instruction, student services, research, public service, and academic support (Desrochers & Wellman, 2011). Differences are most salient when comparing research universities with other types of institutions or when comparing four-year institutions with two-year colleges. These institutional groups are thus analyzed separately in this study while omitting two-year colleges to help establish homogeneity of cost structures.

Degree production profile. The award level of credentials spans undergraduate and graduate instruction, comprising undergraduate certificates, associate degrees, bachelor's degrees, post-baccalaureate certificates, master's degrees, post-master's certificates, professional doctoral degrees, and research doctoral degrees. Bachelor's degrees constituted 48 percent of all degrees conferred in 2010-11 (NCES, 2012a), followed by associate degrees (27 percent), master's degrees (21 percent), and doctoral degrees (5 percent). Variation in the level of awards is a significant source of differences in educational expenditures (Conger, Bell, & Stanley, 2010; Johnson, 2009). Johnson's (2009) regression model of educational expenditures at 504 public four-year institutions revealed that each doctoral degree was associated with $451,781 in marginal costs, compared to $30,780 for bachelor's degrees. Similarly, in their cost study of public colleges and universities in four states, Conger et al. (2010) observed that higher levels of instruction were generally associated with greater instructional expenditures. However, since 80 percent of all credit hours were completed at the undergraduate level, they found that undergraduate instruction accounted for over half of total instructional expenditures (66 percent).

Another feature of an institution's degree production profile pertains to the disciplines within which credentials have been conferred. Approximately 68 percent of bachelor's degrees conferred in the United States represented eight fields: business, social sciences and history, health professions, education, psychology, visual and performing arts, biological and biomedical sciences, and communication and journalism (NCES, 2014). There is considerable variation in the costs of instruction in these disciplines (Belfield, Crosta, & Jenkins, 2014; Conger et al., 2010). For instance, Conger et al. (2010)

analysis of public four-year institutions in Florida, Ohio, and Illinois revealed that the cost per credit hour at the undergraduate level was frequently lower in psychology but higher in the visual and performing arts, engineering, and the physical sciences. At the graduate level, they found that the cost was relatively low in business and education but high in the physical sciences and the visual and performing arts. Therefore, whereas degrees conferred within such fields as psychology and education should predict lower total educational expenditures, degrees within the physical sciences and visual and performing arts should be associated with higher educational expenditures.

Faculty profile. The third dimension of the model accounts for the employment status, compensation, and relative number of faculty. The majority of educational expenditures can be attributed to the cost of instruction (ranging from 45% to 66% of expenditures, Desrochers & Wellman, 2011), and thus employing fewer total faculty or more part-time faculty may be pursued as a cost-containment strategy. The prospects for cost-savings are substantial: a part-time instructor with a full course load (8 courses) earns between $18,000 and $30,000 per year, compared to the average salary of $47,500 for full-time, non-tenure-track faculty members (Curtis & Thornton, 2013). Many institutions appear to have taken advantage of these cost savings, as the proportion of part-time instructional faculty in higher education has increased over the past three decades from 34 percent in 1980 to 50 percent in 2011 (NCES, 2012b).

Although hiring fewer total faculty or increasing the relative share of part-time faculty may increase cost savings, educational quality may consequently suffer. Umbach (2007) observed that, relative to full-time tenured and tenure-track professors, part-time instructors were less likely to use active and collaborative pedagogies, had lower expectations for students' academic effort, and spent less time on course preparation. Exposure to part-time faculty or the percentage of part-time faculty has been associated with lower frequency of both casual and substantive faculty-student interactions (Cox, McIntosh, Terenzini, Reason, & Quaye, 2010), lower odds of first-year persistence (Eagan & Jaeger, 2008), and lower graduation rates (Ehrenberg & Zhang, 2005). To be sure, these findings are consistent with research demonstrating the crucial role of student-faculty interactions in promoting intellectual development, self-reported learning, and persistence, particularly when the interactions revolve around academic courses and plans (Kuh & Hu, 2001; Pascarella & Terenzini, 2005). Therefore, the institution's faculty profile is included in the expenditures model to prevent the incentivization of faculty hiring decisions that may detrimentally affect educational quality.

Cost of living. The prices of goods and services are widely known to vary by degree of urbanization, state, and region. For example, consumer expenditures in such domains as housing tend to be higher in urban than in rural areas, which is arguably attributable to the combination of higher consumer demand and greater scarcity of land in urban areas (Hawk, 2013). Furthermore, the average family income differences among cities, states, and regions can change considerably after adjusting for differences in the cost of living (Aten, Figueroa, & Martin, 2012; Berry, Fording, & Hanson, 2000; Curran, Wohlman, Hill, & Furdell, 2006). In their examination of the Regional Price Parities index, for instance, Aten et al. (2012) found that the interstate per capita income range decreased from $39,741 to $26,447 after adjusting for price differences in goods and services. The present study makes a similar adjustment to reduce extraneous variation in educational expenditures.

Accordingly, the above conceptual framework informs a regression-based approach for benchmarking educational expenditures. Longitudinal, institution-level panel data are analyzed to predict educational expenditures at baccalaureate colleges, master's universities, and research universities. The regression models are then used to generate an expenditures index that reflects the extent to which educational expenditures deviate from an expected mean level. Longitudinal data are used to produce three-year average estimates of the expenditures index, thereby reducing the potential effect of measurement error in any particular year.

Method

Data source

IPEDS data were obtained for all colleges and universities in the nation with the following characteristics: (a) Title IV participating and degree-granting; (b) public or private not-for-profit four-year or above; (c) full-time, first-time undergraduate students are present; and (d) Basic Carnegie Classification: research university, master's university, and baccalaureate college. These restrictions yielded an initial sample of 1,496 four-year institutions.

Variables

Data were retrieved for educational expenditures, number of credentials by award level, number of credentials by discipline, faculty profile, and geographic region. Table 1 provides descriptive statistics.

Table 1

Descriptive statistics

	M	SD	M	SD	M	SD
Dependent variable		2006		2007		2008
Educational expenditures($1,000's)	$76,621	$150,682	$82,501	$162,449	$90,357	$179,790
Number of credentials conferred		2010		2011		2012
Associate degrees	45.68	168.58	49.57	182.31	50.37	188.60
Bachelor's degrees	998.86	1412.07	1037.18	146.09	1071.92	1506.88
Master's degrees	383.93	646.96	404.76	678.86	416.39	711.69
Doctoral degrees (research)	33.97	107.40	35.58	111.18	36.89	113.83
Doctoral degrees (professional)	46.40	133.77	48.05	135.31	49.91	138.01
Doctoral degrees (other)	.44	4.94	.41	3.50	.43	3.81

	M	SD	M	SD	M	SD
Less-than-one-year certificates conferred	6.09	42.12	6.38	43.80	7.47	49.98
Less-than-two-year certificates conferred	4.84	29.06	5.29	28.82	5.18	25.35
Less-than-four-year certificates conferred	.94	15.15	.96	16.02	1.19	18.31
Post-baccalaureate certificates	17.46	105.09	18.86	96.83	19.27	83.09
Post-master's certificates	11.24	49.37	10.96	46.30	10.71	44.83
Number of credentials conferred by discipline		2010		2011		2012
Ethnic and cultural studies	7.50	26.64	7.76	27.38	8.01	28.03
Biological sciences	68.39	140.89	71.10	145.91	75.73	152.39
Business	308.72	449.63	314.55	462.04	314.28	467.74
Communication and journalism	59.48	121.82	61.11	125.69	61.46	124.22
Education	195.47	314.60	197.10	296.77	194.57	288.98
Engineering	76.38	241.04	81.83	254.50	86.45	269.64
Foreign languages	18.11	45.78	18.09	44.77	18.22	44.03
History	26.37	44.45	26.25	43.68	26.32	42.63
Protective services	29.24	74.09	30.85	78.25	33.76	83.06
Liberal arts	46.97	127.31	49.42	139.62	49.74	143.10
Natural resources and conservation	9.68	29.08	11.12	33.26	12.65	37.14
Parks, Recreation, and Leisure Studies	26.06	58.44	28.16	63.12	30.56	66.51
Physical sciences	22.88	47.44	24.20	50.57	25.72	52.33
Public administration	39.32	86.36	41.27	90.26	44.65	97.63
Social sciences	101.53	210.01	105.07	216.42	106.51	216.61
Visual and performing arts	61.83	131.12	62.89	134.00	64.18	135.24
Faculty profile		2006		2007		2008
Student-faculty ratio	16.77	6.01	16.72	6.66	16.66	6.23
Proportion full-time faculty	.61	.20	.60	.20	.60	.20
Average professor salary	7.70	2.12	7.99	2.24	8.24	2.38
Region						
New England	.09		.09		.09	
Rocky Mountains	.03		.03		.03	
Southwest	.07		.07		.07	
Reference category (Far West, Great Lakes, Mideast, Plains, Southeast)	.81		.81		.81	

Note. Due to space limitations, only variables that appear in the final models are shown here.

Educational expenditures. Total educational expenditures were computed as the sum of instructional, student services, and academic support expenditures. Educational expenditures were adjusted for inflation to 2012 dollars, and the Regional Price Parities (RPP) index for 366 metropolitan statistical areas and the remaining non-metropolitan areas was used to adjust for cost of living differences (Aten et al., 2012). The RPP is based on data from the Consumer Price Index, Consumer Expenditure Survey, and the American Community Survey, which were used to develop weighted estimates of price differences for multiple goods and services in the categories of rents, food, transportation, housing, recreation, education, apparel, medical, and other (see Aten et al., 2012). The data years of 2006, 2007, and 2008 provide a four-year lag with degree production in 2010, 2011, and 2012, respectively.

Number of credentials by award level. Eleven potential variables reflected different types of credentials conferred at four-year institutions: associate degrees, bachelor's degrees, master's degrees, doctoral degrees (research, professional, and other), certificates of less than one year, certificates of at least one year but less than two years, certificates of at least two years but less than four years, post-baccalaureate certificates, and post-master's certificates.

Number of credentials by discipline. A set of 38 variables was defined with the total number of credentials identified by each code of the Classification of Instructional Programs (CIP): agriculture, architecture, ethnic and cultural studies, biological sciences, business, communication and journalism, communications technologies, computer sciences, construction, education, engineering, engineering technologies, English, consumer sciences, foreign languages, health professions, history, protective services, legal professions, liberal arts, library science, mathematics, mechanic and repair, military, interdisciplinary, natural resources and conservation, parks, recreation, and leisure studies, personal and culinary services, philosophy, physical sciences, precision production, psychology, public administration, science technologies, social sciences, theology, transportation, and the visual and performing arts. Missing values for any particular category were recoded as zero.

Faculty profile. The institution's faculty employment profile was operationalized in terms of the proportion of employees with primarily instructional duties who hold full-time employment status; the average salary of full professors; and the student-faculty ratio.

Region. Eight regions were defined by the Bureau of Economic Analysis, including Far West (AK, CA, HI, NV, OR, WA), Great Lakes (IL, IN, MI, OH, WI), Mideast (DE, MD, NJ, NY, PA), New England (CT, ME, MA, NH, RI, VT), Plains (IA, KS, MN, MO, NE, ND, SD), Southeast (AL, AR, FL, GA, KY, LA, MS, NC, SC, TN, VA, WV), Rocky Mountains (CO, ID, MT, UT, WY), and Southwest (AZ, NM, OK, TX). According to preliminary analyses with dummy-coded variables, the final reference category consisted of Far West, Great Lakes, Mideast, Plains, and Southeast regions.

Data analysis

Repeated measures linear regression analysis was conducted with SPSS 22, which adjusts for non-independence of errors that may result from the longitudinal panel (Muthén & Satorra, 1995). Separate regression models of baccalaureate, master's, and research institutions were developed to maximize homogeneity of institutional mission. An exploratory analysis using multilevel regression found a non-significant state-level intercept ($p < .05$) and thus institutions are not treated as clustered within states. A parsimonious model for each institutional sample was developed by entering all variables as a single block and then dropping non-significant variables stepwise. A proxy for r-squared was computed by running the analysis with ordinary least squared regression.

Missing data, transformations, and nonlinearity

The problem of missing data did not exceed four percent of cases for any variable. A missing values analysis revealed that missingness was associated with most variables in the model. Missing data are considered here as if they were missing at random, and thus missing data were imputed with multiple imputation by chained equations over five data sets. All variables were included in the imputation model. However, the imputed values for the dependent variables were not used in the subsequent analysis stage in order to minimize the potential for bias (see von Hippel, 2007). Several variables were transformed to induce normality or reduce the influence of outliers. A logarithmic transformation was applied in most cases to correct positive skewness for the educational expenditures variable, the number of credentials conferred by type and discipline, and the student-faculty ratio. An examination of partial residual plots revealed some nonlinear relationships, which were subsequently modeled with centered quadratic terms. Finally, influential multivariate outliers identified through Cook's D and Mahalanobis distance were deleted to ensure stable solutions. These procedures yielded a final sample size of 557 baccalaureate colleges, 575 master's universities, and 249 research universities.

Results

Table 2 summarizes the regression results for baccalaureate colleges, master's universities, and research universities, respectively. Several variables within each rubric were statistically significant predictors of educational expenditures in each sample. Regarding the level of awards, the number of baccalaureate degrees was strongly associated with educational expenditures. For example, a one standard deviation increase in the number of bachelor's degrees was associated with a .73 standard deviation increase in educational expenditures among baccalaureate colleges. Among master's universities, the number of master's degrees was positively associated with educational expenditures (β=.14). Among research universities, the number of research doctoral degrees was the strongest predictor of educational expenditures (β=.31). Certificates exhibited the weakest relationship with educational expenditures among master's and research universities (β =.03 to .05).

Table 2
Panel eegression predicting educational expenditures (log)

	Baccalaureate Colleges (n=557)			Master's Universities (n=575)			Research Universities (n=249)		
	b	*SE*	β	*b*	*SE*	β	*b*	*SE*	β
Level 1 Intercept	5.55***	.05		7.46***	.03		7.61***	.11	
Time 1	-.02***	.00	-.05	-.03***	.00	-.08	-.02***	.00	-.05

	Baccalaureate Colleges (n=557)			Master's Universities (n=575)			Research Universities (n=249)		
Time 2	-.01***	.00	-.02	-.01***	.00	-.05	-.01***	.00	-.03
Number of credentials by award level									
Associate degrees (log)	-.07***	.01	-.16						
Associate degrees squared	.09***	.01	.26						
Bachelor's degrees (log)	.68***	.02	.73	.58***	.02	.70	.13**	.04	.12
Bachelor's degrees squared							-.31***	.05	-.14
Master's degrees (log)				.13***	.01	.14	.15***	.03	.13
Doctoral degrees (research) (log)				.10***	.02	.12	.27***	.03	.31
Doctoral degrees (research) squared				-.07**	.02	-.09	.09***	.03	.07
Doctoral degrees (professional) (log)				.00	.02	-.01	.10***	.01	.26
Doctoral degrees (professional) squared				.04***	.01	.14	.04**	.01	.09
Less-than-two-year certificates (log)				.03*	.01	.03	.06***	.02	.07
Number of credentials by discipline									
Biological sciences (sqrt)							.00**	.00	.06
Communication and journalism (log)				.02***	.00	.04			
Education (log)							-.02*	.01	-.03
Engineering (log)				.02***	.00	.05	.02*	.01	.05
Physical sciences (log)							.03**	.01	.05
Foreign language (log)	.02**	.01	.03						
History (log)	.02**	.01	.03						
Protective services (log)	-.02*	.01	-.03						
Natural resources (log)	.01*	.01	.02	.01**	.00	.02			
Leisure studies (log)	-.02**	.01	-.03						
Social sciences (log)	.03***	.01	.06				.00**	.00	.07
Visual and performing arts (log)	.03***	.01	.06	.03***	.01	.06			
Faculty profile									
Student-faculty ratio (log)	-.14***	.02	-.05	-.08***	.02	-.03	-.15***	.03	-.04
Proportion full-time faculty	.04**	.01	.03	.08***	.01	.06	.13***	.03	.06
Average professor salary	.02***	.00	.10	.02***	.00	.09	.02***	.00	.09
Region									
Rocky Mountain	-.09*	.04	-.24						
Southwest				-.12*	.02	-.03			
New England							.07*	.03	.16
df	16			17			19		
χ^2	1262.06***			1794.72***			899.32***		
OLS adjusted r-square	.90			.91			.94		

Note. The chi-square difference test compares the deviance statistics for a full and intercepts-only model.
**p*< .05, ***p*< .01, ****p*< .001

In the second category, reflecting the number of credentials conferred by discipline, positive associations with educational expenditures were observed in at least two institutional samples for natural resources (β=.02); social sciences (β=.06 to .07);

engineering (β=.05); and visual and performing arts (β=.06). Conversely, credentials conferred in protective services and leisure studies were associated with lower educational expenditures at baccalaureate colleges (β=-.03). A negative association was observed among research universities for credentials conferred in education (β=-.03).

In the third category, the student-faculty ratio was negatively associated with expenditures across institutional type (β=-.05 to -.03). As expected, the proportion of full-time faculty (β=.03 to .06) and average professor salary (β=.09 to .10) were positively associated with educational expenditures. Finally, being located in some regions was associated with lower or higher expenditures. For instance, being a master's university located in the Southwest predicted slightly lower expenditures than being located in the reference region (β=-.03).

Development of expenditures index

The expenditures index is expressed as *Index*(A) = ((y - ŷ) − M)/s, where A indicates the mission type of the institution according to the Carnegie Classification System; y denotes actual expenditures, and ŷ reflects predicted expenditures; M is the mean difference between actual and predicted expenditures within A; and s is the standard deviation of scores within A. The three-year mean residual values generated from the final regression model were used to develop the index. First, residual scores were set to zero if the predicted expenditures fell within the 95 percent confidence interval, which reduces the likelihood that deviations from actual expenditures are attributable to random error (see Porter, 2000). Approximately 5 to 14 percent of predicted expenditures did not differ significantly from actual expenditures.

Second, the residual values were converted into z-scores that more readily indicate the proximity of an institution to the average deviation between actual and expected expenditures (i.e., actual expenditures equal expected expenditures). In order to further minimize variation in programmatic costs, expenditure z-scores were calculated separately within each of the nine sub-types of four-year institutions identified by the Carnegie Classification system: Baccalaureate Colleges: Arts and Sciences; Baccalaureate Colleges: Diverse Fields; Baccalaureate/Associates Colleges; Master's Colleges and Universities (larger programs); Master's Colleges and Universities (medium programs); Master's Colleges and Universities (smaller programs); Doctoral/Research Universities; Research Universities (high research activity); and Research Universities (very high research activity). The final indicators approximated a mean of zero and a standard deviation of one: baccalaureate (*M*=.03, *SD*=1.03); master's (*M*=.02, *SD*=1.01); and research (*M*=.02, *SD*=1.03).

Correlations with unadjusted indicators

In order to determine whether the study was successful in creating an indicator that differs from traditional indicators, correlations with total educational expenditures and expenditures per credential were examined. The expenditures index was moderately correlated with total educational expenditures adjusted only for cost of living differences: baccalaureate colleges (*r*=.33), master's universities (*r*=.27), and research universities (*r*=.29). Similarly, the expenditures index was moderately correlated with total educational expenditures per credential among baccalaureate colleges (*r*=.54), master's universities (*r*=.49), and research universities (*r*=.41).

Defining expenditure benchmarks

The interpretation of the expenditure z-scores can be facilitated with a five-category system, which reduces the salience of trivial differences between similar institutions (see Volkwein & Grunig, 2005). The interval for "moderate" efficiency was defined as -.15 through .39, which captures approximately 27 percent of institutions. The asymmetry in this interval is intended to acknowledge that institutions with higher-than-expected expenditures may be investing in educational quality without a direct effect on degree production. Institutional expenditure scores equal to or greater than one standard deviation above the mean ($x \geq 1.00$) are rated "Very High," indicating that expenditures are much higher than expected. Scores within one standard deviation above the mean but above the "moderate" mark ($.39 < x < 1.00$) are rated as "High." Scores equal to or less than one standard deviation below the mean ($x \leq -1.00$) are assigned a rating of "Very Low." Scores that fall within one standard deviation below the mean and below the "moderate" mark ($-1.00 < x < -.15$) are assigned a rating of "Low."

As an example, Table 3 provides expenditure ratings for a selected group of top ranked universities in the United States according to the *Academic Ranking of World Universities* (Shanghai Ranking Consultancy, 2018). The resulting benchmarks can also be examined by institutional sector. For instance, 57 percent of public baccalaureate colleges received a low or very low expenditures index rating, compared to 31 percent of private counterparts.

Table 3
Expenditure ratings of selected top ranked U.S. universities

	Educational expenditures per FTE student (2008 dollars)	Expenditures index score	Expenditures Rating
Harvard University	$71,818	0.34	Moderate
Stanford University	$92,518	0.42	High
University of California, Berkeley	$21,274	-1.55	Very Low
Columbia University	$82,860	0.27	Moderate
University of Chicago	$73,141	1.5	Very High

	Educational expenditures per FTE student (2008 dollars)	Expenditures index score	Expenditures Rating
University of California, Los Angeles	$37,191	0.1	Moderate
Cornell University	$38,685	-0.31	Low
University of Washington	$27,196	0.29	Moderate
University of California, San Diego	$25,464	-0.08	Moderate
Washington University in St. Louis	$101,669	2.81	Very High
Northwestern University	$47,082	-0.84	Low
University of Michigan-Ann Arbor	$25,653	-0.63	Low
University of Wisconsin - Madison	$17,926	-0.55	Low
University of North Carolina at Chapel Hill	$30,463	-0.08	Moderate
University of Minnesota, Twin Cities	$21,672	-0.08	Moderate

Note. Institutions are ordered according to the Academic Ranking of World Universities.

Discussion

The purpose of this study was to develop an alternative approach to benchmarking educational expenditures that circumvents the shortcomings of simple cost-output ratios. Panel regression analyses were conducted with national samples of baccalaureate colleges, master's universities, and research universities. Consistent with past research (Conger et al., 2010; Johnson, 2009), the results of the current study confirmed that educational expenditures can be reliably predicted from an institution's degree production profile. For example, whereas the production of credentials in engineering, visual and performing arts, and the sciences predicted higher educational expenditures, credentials conferred in education predicted lower expenditures (though only at research universities). Each institutional sub-sample yielded a distinct set of predictive disciplines and credential levels. Also noteworthy, the proportion of full-time faculty was a strong predictor of educational expenditures, given the significant wage differential by employment status (Curtis & Thornton, 2013). These findings in particular present a cautionary note for measurement efforts that fail to account for differences in faculty employment status. Specifically, simple cost-output ratios may inadvertently reward institutions that hire a large share of part-time faculty, thereby potentially diminishing educational quality (e.g., Umbach, 2007). Finally, the regression results suggest that the potential gains in efficiency that can be obtained through more effective resource management may be small, for only 6 to 10 percent of the variance was left unexplained in our regression models.

Analysts can use the resulting regression models not only to better understand institutional cost structures but also to identify potentially (in)efficient institutions. To this end, the current study provided guidelines for benchmarking expenditures using standardized three-year average estimates of the difference between actual and expected educational expenditures. Consistent with earlier research (Toutkoushian, 1999), the expenditures index in this study may frequently lead to conclusions about institutional efficiency that are inconsistent with inferences from simple measures of total expenditures or cost-output ratios, given the imperfect correlations with unadjusted measures (r=.27 to .54). As shown in Table 3, for instance, the raw educational expenditures per student at Harvard University and the University of Washington differ greatly, but their index scores suggest similar levels of efficiency. In both cases, actual expenditures were moderately higher than expected, given the types of degrees produced, faculty employment attributes, and cost of living differences.

Moreover, analysts are encouraged to interpret an expenditures index in the context of additional measures of institutional performance, especially those gauging educational quality (see Horn & Tandberg, 2018). For instance, whereas the National Survey of Student Engagement (NSSE) Academic Challenge scale has not been a consistent predictor of graduation rates (Gordon, Ludlum, & Hoey, 2008; Pike, 2013), it has been positively associated with educational expenditures (Pike et al., 2011). The omission of such quality indicators from the regression model, particularly if time variant, may alter the residuals and therefore distort assessments of efficiency.

The expenditures index can also be used to examine differences in efficiency by institutional sector to inform funding allocation decisions. Overall, the results suggest that most public postsecondary institutions are relatively efficient. In particular, the prevalence of public four-year institutions with higher-than-expected expenditures ranged from 19 to 25 percent, compared to 36 to 40 percent of private institutions. Conversely, 48 to 57 percent of public institutions had an expenditures index rated as low or very low, compared to 26 to 36 percent of private institutions. This pattern of sector differences is consistent with Scott, Bailey, and Kienzi's (2006) Oaxaca decomposition results, which indicated that public colleges and universities tend to make more effective use of their resources and demographic inputs than their counterparts in the private sector.

Methodologically, some readers may question whether frontier regression or data envelopment analysis would be more appropriate for estimations of institutional efficiency. While the resulting performance scores from traditional and frontier regression are highly correlated (r=.67, Archibald & Feldman, 2008), the preference of one method over the other partly depends upon whether the production frontier should be defined by central tendencies or extreme scores. In the context of public accountability, modeling the expected mean is more defensible for various reasons. First, although average performance is rarely an ideal in any industry, approximation to or positive deviation from the mean (e.g., national average) is often an implicit expectation in accountability systems and benchmarking in higher education (e.g., University of Wisconsin, 2014). Second, in the absence of comprehensive and accurate data on output quality, there is considerable uncertainty about whether extreme cases (i.e., institutions with very low expenditures given their output levels) should be classified as outliers that are sacrificing investments in quality or veritable instances of efficiency. Consequently, frontier analyses are susceptible to creating unrealistic efficiency standards for the majority of institutions. Third, hypothesis testing is much easier when using traditional regression relative to data envelopment analysis (Johnes, 2006), thereby facilitating clear criteria for the inclusion of variables during model development.

Several limitations should be addressed in future research. First, this study only analyzed educational expenditures in relation to degree production and faculty variables, which precludes inferences about resource management in other arenas, such as administrative support, research, and operation/plant maintenance. Second, the omission of key time-variant predictors of educational expenditures could have distorted residuals in our fixed effects model. Third, data limitations did not allow an analysis of intra-institutional variation in efficiency. Data on faculty time and departmental expenditures, for instance, would enable the development of a more refined measure of efficiency (see University of Delaware, 2014). Fourth, low frequencies for some degree types may have resulted in the attenuation of correlations and biased regression weights. Future studies can address this problem by combining degree categories with similar cost structures. Finally, the current study intended only to elaborate an alternative method for estimating institutional efficiency. An assessment of current levels of efficiency naturally requires an analysis of the most recent data available.

Conclusion

In conclusion, the societal impact of colleges and universities in the United States is partly determined by how efficiently they utilize their resources. Attempts to measure and promote efficiency, however beset by obstacles, are arguably crucial to reaching the long-term educational attainment goals espoused within state and national public agendas. An accurate determination of whether taxpayer dollars are being efficiently used for educational purposes must account for variation in institutional cost structures, including degree production profiles, faculty employment, and the cost of living. This study demonstrated that comparisons of actual and predicted expenditures offer a distinctive alternative to using such common indicators as expenditures per credential. Higher education administrators and researchers at high-performing institutions should consider using an expenditures index to help articulate to the public the extent to which state appropriations and tuition dollars are being used responsibly. The resulting benchmarks should also incite further investigation of efficient practices through comparisons of low- and high-performing institutions.

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