IES Institute of Education Sciences

APPENDIXES

Regional Educational Laboratory Southwest

At American Institutes for Research

An Examination of the Costs of Texas Community Colleges

See https://ies.ed.gov/ncee/rel/Products/Publication/100875 for the full report.

Appendix A. Texas' Student Success Points performance-based funding system

In 2013, the 83rd Texas Legislature adopted the Student Success Points performance-based funding system as an outcome-based funding model in an effort to improve institutional performance and college completion rates at the state's 50 community colleges. The intent of the Student Success Points system—which is currently used to distribute state dollars to Texas community colleges—is to encourage those institutions to take steps to improve student outcomes.[1] This funding model awards approximately 12 percent of state funds to community colleges based on those outcomes, whereas the remaining state funds are awarded primarily based on the number of instructional hours (Texas Association of Community Colleges, 2020). The milestones included in the Student Success Points system comprise both traditional and more nuanced measures of student progression and achievement (table A1). Each milestone is given a weight, which is applied to student counts and added up to determine the number of success points a given community college earns. The total success points are multiplied by a success points dollar value that is factored into each institution's annual funding apportionment.

[1] For a detailed description of the Success Points system used to award funding to Texas community colleges, see the primer developed by the Texas Higher Education Coordinating Board at http://www.thecb.state.tx.us/DocID/PDF/9595.PDF.

Table A1. Success points milestones included in Texas's Student Success Points performance-based funding system

Milestone	Weight
Becoming college ready (place out of remedial coursework) in	
Reading	0.50
Writing	0.50
Mathematics	1.00
Successfully completing (by earning a letter grade of A–C) the first college-level course in	
Reading	0.50
Writing	0.50
Mathematics	1.00
Successfully completing the first 15 semester credit hours	1.00
Successfully completing the first 30 semester credit hours	1.00
Transferring to a four-year college after successfully completing 15 semester credit hours	2.00
Earning a degree or certificate in any field	2.00
Earning a degree or certificate in a critical field[a]	2.25

a. Critical fields include science, technology, engineering, or mathematics or an allied health major in one of the following Classification of Instructional Program codes: 11, 14, 15, 27, 40, 3001, 5102, 5106, 5107, 5108, 5109, 5110, 5118, 5123, 5126, 5127, 5131, 5132, 5133, 5134, 5138, 5139, 4102, 4103, or 4703.

Source: Authors' compilation based on Texas Higher Education Coordinating Board, 2019. See http://www.thecb.state.tx.us/DocID/PDF/9595.PDF.

Reference

Texas Association of Community Colleges. (2020). *Texas Success Points model*. https://tacc.org/sites/default/files/documents/2020-02/texas_success_point_model.pdf

Appendix B. Data and methods

This appendix describes the study data, data preparation, and analysis methods used.

Data sources

The study used a combination of publicly available data from the Texas Higher Education Coordinating Board publicly available from the Texas Higher Education Accountability System, the U.S. Department of Education's College Scorecard, the National Center for Education Statistics' Integrated Postsecondary Education Data System, and the School Finance Indicators Database. In addition, the study used student-level data provided by the Texas Higher Education Coordinating Board via the University of Texas at Dallas Education Research Center (table B1). The study team then aggregated the data to the institution level.

Table B1. Data sources

Data source	Years	Data element	Research questions
Texas Higher Education Coordinating Board, publicly available from the Texas Higher Education Accountability System	2014/15-2019/20	Unweighted success points for all 11 categories	1, 3-5
	2014/15-2019/20	Expenditures per full-time equivalent student	2, 3-5
	2014/15-2019/20	Percentage of students who are older than 24 years	1-5
	2014/15-2019/20	Percentage of students who are enrolled in dual-credit programs	1-5
	2014/15-2019/20	Total full-time equivalent enrollment	1-5
	2014/15-2019/20	Percentage of students who are enrolled in technical degree programs	1-5
	2014/15-2019/20	Percentage of authorized taxes levied	3-5
Texas Higher Education Coordinating Board, provided by the Texas Education Research Center	2014/15-2019/20	Percentage of students who are first-generation college students	1-5
	2014/15-2019/20	Percentage of students who are academically disadvantaged (in need of remediation)	1-5
	2014/15-2019/20	Percentage of students who are English learner students	1-5
College Scorecard[a]	2014/15-2019/20	Percentage of students in various household income categories	1-5
Integrated Postsecondary Education Data System[b]	2014/15-2019/20	Faculty salary in the local labor market (at comparable schools within 25 miles)	2, 3-5
	2014/15-2019/20	Herfindahl index (enrollment shares for comparable schools within 25 miles)	3-5
	2014/15-2019/20	Unduplicated student enrollment	1-5
	2014/15-2019/20	12-month undergraduate credit hours attempted	3-5
	2014/15-2019/20	Longitude of institution	3-5
	2014/15-2019/20	Latitude of institution	3-5
	2014/15-2019/20	Carnegie basic classification	3-5
	2014/15-2019/20	Percentage of students enrolled exclusively online	2, 3-5

Data source	Years	Data element	Research questions
School Finance Indicators Database[c]	2014/15–2019/20	Median housing unit value	3–5
	2014/15–2019/20	Median household income	3–5
	2014/15–2019/20	Population density (population per square mile)	2, 3–5
	2014/15–2019/20	Percentage of K–12 students receiving special education services	3–5

a. The College Scorecard is available at https://collegescorecard.ed.gov/.
b. The Integrated Postsecondary Education Data System is available at https://nces.ed.gov/ipeds/.
c. The School Finance Indicators Database is available at https://www.schoolfinancedata.org/.
Source: Authors' compilation.

Texas Higher Education Coordinating Board data, downloaded from the Texas Higher Education Accountability System website. The Texas Higher Education Coordinating Board provides aggregate, institution-level data for all public colleges and universities through its Texas Higher Education Accountability System website.[2] Their reporting tool includes more than 50 data tables available for download, allowing users to download aggregated student demographic information, enrollment metrics, and a variety of student outcomes. This dataset was the source for the outcomes of interest: student success points milestones earned per full-time equivalent student and expenditures per full-time equivalent student.[3] It also includes student characteristics data. The study team used the following student need factors from these student characteristics data in all models: percentage of students older than 24 years[4] and percentage of students enrolled in dual-credit programs. The study team used total full-time equivalent enrollment as an institutional contextual factor and percentage of students enrolled in a technical degree program as a covariate in regression models.

Texas Higher Education Coordinating Board data, made available by the University of Texas at Dallas Education Research Center. The Texas Higher Education Coordinating Board datasets contain records of students' background characteristics, college enrollment, and degree and certificate attainment for all community college students in the state. The Education Research Center houses student-level records that were not publicly available (first-generation college student status, enrollment in remedial education, and English learner student status). These characteristics were aggregated to the community college level and the following student need factors were then exported for use in the study: the percentage of students who were first-generation college students, the percentage of

[2] The Texas Higher Education Accountability System website is http://www.txhigheredaccountability.org/AcctPublic/InteractiveReport/AddReport.

[3] Although the success points milestones are available on the Texas Higher Education Accountability website, not all years needed were accessible. The study team contacted the Texas Higher Education Coordinating Board directly to request all years of available success points data to ensure the information used for the primary outcome of interest was accurate.

[4] The older than 24 years category is the most common category used when researchers are trying to look at the group of students who did not matriculate directly from high school. This category is one of the triggers for being deemed an independent student (versus dependent) for financial aid purposes (although it is older than 24 years by January 1 of the school year you are planning to enroll in). The category the study team obtained through IPEDS and the Texas Higher Education Coordinating Board is 22 to 24 years. This category was combined with the prior age categories in the current analyses to create the older than 24 years category.

students who were academically disadvantaged (in need of remedial education), and the percentage of students who were English learner students.

College Scorecard. The College Scorecard, an online tool created by the U.S. Department of Education, allows consumers to compare the cost and value of higher education institutions in the United States. The reporting tool includes institution-level data containing aggregate data for each institution pertaining to institutional characteristics, enrollment, student aid, costs, and student outcomes. This study used the percentage of students in various household income categories.

Integrated Postsecondary Education Data System. The Integrated Postsecondary Education Data System (IPEDS) is a system of surveys conducted annually by the U.S. Department of Education's National Center for Education Statistics. IPEDS gathers information from every college, university, and technical and vocational institution that participates in federal student financial aid programs. The institution-level data collected through IPEDS and used in this study include: 12-month undergraduate credit hours attempted, unduplicated student enrollment, longitude of institution, latitude of institution, and Carnegie basic classification. These data elements were used to create two variables—the average faculty salary in the local labor market (at comparable schools within 25 miles) and the Herfindahl Index (enrollment shares at comparable schools within 25 miles)—described in the next section.

School Finance Indicators Database. The School Finance Indicators Database is a collection of school finance measures that include information on state and local revenue, wealth, income, and taxes. It is updated annually by a team of researchers at the Albert Shanker Institute by compiling publicly available data into district, county, and state-level measures to make school finance measures more accessible to researchers and policymakers alike. The study team used these data to capture measures of population density, median home values, household income, the percentage of authorized taxes levied, and the incidence of students in K-12 school districts receiving special education services.

Data preparation

The study team took the following steps to prepare the data for analysis.

Texas Higher Education Coordinating Board data from the Texas Higher Education Accountability System website. To prepare the data for analysis, the study team used college identifiers to link data across years.

Texas Higher Education Coordinating Board data from the Education Research Center at the University of Texas at Dallas. The Education Research Center provided masked student-level data that were not publicly available, including first-generation college status, participation in remedial education, and English learner student status. The data were aggregated to the college level by year to create the following measures: the percentage of students who were first-generation college students, the percentage of students who were academically disadvantaged, and the percentage of students who were English learner students.

College Scorecard. College Scorecard data were merged with the study data using a crosswalk of Texas Higher Education Coordinating Board institution codes and federal institution identifiers.

Integrated Postsecondary Education Data System. IPEDS data were merged with the study data using a crosswalk of Texas Higher Education Coordinating Board institution codes and federal institution identifiers.

The study team derived the Herfindahl index and input prices based on local faculty labor markets using the following process. First, the study team used the Stata package *geodist* and latitude and longitude measures from IPEDS to measure the distance between each of the 50 Texas community colleges and every postsecondary institution that reports to IPEDS. Second, the study team determined which colleges were within 25 miles of each Texas community college to define the local competitive markets within which to calculate both the Herfindahl Index and local average faculty salary at comparable institutions.

The study team then derived the Herfindahl index by summing the squared enrollment shares across colleges within a given local market and that were competitors, defined as those colleges offering similar credentials or degrees using Carnegie classifications.

Finally, the study team derived the average faculty salary for those comparable institutions (defined as offering similar credentials or degrees using Carnegie classifications) within the local labor market (that is, within a 25-mile radius), not including the salaries paid to faculty members at the community college of interest.

School Finance Indicators Database. The School Finance Indicators data are reported at the K–12 district level, which were then mapped to the county and service areas for each Texas community college. The study team mapped the percentage of K–12 students receiving special education services to those communities contiguous to the community college of interest. As such, this variable represents the incidence of students participating in special education services in neighboring communities.

Study sample

The study included the population of the 50 public community colleges in Texas, which serve almost 750,000 students (Texas Association of Community Colleges, 2020). The data used span from 2014/15 (the year the Student Success Points performance-based funding system was implemented in Texas) to 2019/20 (the most recent year for which data are available). Each model and the subsequent tables and figures use all six years of data for the 50 community colleges that comprise the sample, resulting in 300 college-by-year observations. Summary statistics on the variables used in the analyses are in table B2.

Table B2. Characteristics of study sample, 2014/15–2019/20

Variable	Mean	Standard deviation
Outcome		
Success points milestones earned per full-time equivalent student	2.26	0.24
Expenditures per full-time equivalent student ($)	9,806.65	1,891.76
Instrument		
Percentage of students in K–12 special education in the county	0.09	0.01
Need factor		
Percentage of students who are first-generation college students	0.52	0.06
Percentage of students who are from households earning less than $30,000	0.60	0.12
Percentage of students who are academically disadvantaged	0.27	0.20
Percentage of students who are older than 24 years	0.26	0.07
Percentage of students who are English learner students	0.03	0.08
Percentage of students who are enrolled in dual-credit programs	0.15	0.07
Contextual factor		
Fewer than 4,001 students enrolled	0.01	0.12
4,001–30,000 students enrolled	0.32	0.47
Local population density	11.05	9.84
Price of inputs		
Monthly faculty salary ($10,000s) in local market	0.91	0.23
Efficiency controls		
Herfindahl index	0.43	0.31
Median housing value ($10,000s) in local market	15.47	5.56
Household income ($10,000s) in local market	5.86	1.35
Percentage of authorized taxes levied	0.30	0.22
Additional controls		
Percentage of students enrolled in technical programs	0.22	0.09
Percentage of students enrolled exclusively online	0.15	0.08
Number of observations	*300*	

Note: Data include 50 community colleges in 2014/15 through 2019/20, resulting in 300 college-year observations. The data are weighted by student enrollment.

Source: Authors' analysis of institution-level data collected by the Texas Higher Education Coordinating Board, the College Scorecard, the Integrated Postsecondary Education Data System, and the School Finance Indicators Database.

Analysis methods

The study team applied three sets of regression analyses to these data, which collectively explored the relationships among institutional spending, student outcomes (number of success points milestones earned per full-time equivalent student), student need factors, and institutional contextual factors.

Specifically, the study estimated the following: the degree to which student need factors are associated with risks of not achieving success points milestones, the equity with which community colleges are resourced given their student needs and institutional contexts, and the relative difference in spending necessary to provide an equal opportunity for students with a particular need to earn success points milestones and an otherwise similar student without this need.

Research question 1. The study team conducted a needs analysis to answer the first research question. The needs analysis estimated the relationships between independent variables (student need factors and institutional contextual factors) and the number of success points milestones earned per full-time equivalent student (dependent variable).

The needs analysis, an exploratory precursor to the cost function analysis, identified student need factors that may influence earning success points milestones, with an emphasis on identifying those characteristics that best predict variation in this outcome. The study team began by running pairwise correlations between hypothesized need factors of interest and the outcome: success points milestones divided by full-time equivalent student enrollment. The pairwise correlations for the need factors chosen for the needs analysis model are shown in the main report.

The needs analysis regression model is specified as follows:

$$Outcome_{it} = \alpha + \sum_1^j \beta_j Need_{j,it} + \vartheta_t + \varepsilon_{it} \quad (1)$$

Outcome is an institution-level measure of success points milestones earned divided by full-time equivalent student enrollment. *Need* includes the percentages of students who are first-generation college students, economically disadvantaged, academically disadvantaged, older than 24 years, English learner students, and enrolled in dual-credit programs. The parameter ϑ represents a year-specific fixed effect to account for changes during the academic years included in the study period (2014/15 through 2019/20) and ε is the error term. The subscripts i and t denote institution and year, respectively.

Research question 2. The study team conducted an equity analysis to estimate relationships between independent variables (student need factors and institutional contextual factors) and institutional spending. This analysis identified candidate factors for inclusion in the cost function analysis used to address research question 3.

Following guidance from recent research on funding for both K–12 schools (Atchison et al., 2020; Baker et al., 2020; Kolbe et al., 2019) and community colleges (Baker & Levin, 2017; Kolbe & Baker, 2019), a statistical model was used to evaluate whether spending variation across Texas community colleges was positively associated (related in a "progressive" manner) with student need factors, controlling for other exogenous factors affecting costs, including scale of operations (enrollment size), prevailing wage levels in the local labor market, and population sparsity of the surrounding community.

This equity analysis was performed using a regression analysis showing the degree to which variation in institutional spending is explained by cost factors associated with student need factors, labor market wage levels, scale of operations, and population density as follows:

$$Spending_{it} = \alpha + \sum_1^j \beta_j Need_{j,it} + \gamma Wage_{it} + \sum_1^k \vartheta_k IScale_{k,it} + \mu Sparsity_{it} + \vartheta_t + \varepsilon_{it} \quad (2)$$

where

- *Spending* is the institutional spending per full-time equivalent student.
- *Need* represents a matrix of student need factors.
- *Wage* denotes the competitive wage level in the labor market in which the institution is located, as measured by faculty salary at other geographically proximate (within a 25-mile radius) institutions with similar missions, as defined by Carnegie classifications.
- *IScale* is a matrix of indicator variables denoting categories of institution size (enrollment).
- *Sparsity* is a measure of population sparsity (inhabitants per square mile) associated with the area served by the institution.
- ϑ represents a year-specific fixed effect (for 2014/15 through 2019/20).
- ε is the error term.
- i and t are subscripts denoting institution and year, respectively.

Research question 3. The study team conducted a cost function analysis to answer research question 3. The cost function analysis estimated the respective relationships between independent variables (number of success points milestones earned per full-time equivalent student, student need factors, institutional contextual factors, and controls for inefficiency) and institution spending per full-time equivalent student.

The education cost function approach is extensively documented and discussed in the education finance literature (Duncombe & Yinger, 1999, 2011). The features of this approach include the following:

- The dependent measure is a measure of operating spending per student.
- The student outcome measure is treated as "endogenous" or simultaneously determined with spending, requiring an instrumental variables procedure to isolate only the exogenous variation in the outcome.
- An attempt is made to control for inefficiency in the form of institutional spending that does not directly drive the observed outcome (in this study, institution-level success points milestones achieved per full-time equivalent student). This task is done by including in the cost function model measures related to spending on unobserved outcomes such as the competitive environment within which the institution is operating (competitive context), the ability of the local taxing district to raise revenue for community colleges (fiscal capacity), and the degree to which the use of public dollars is scrutinized (public monitoring of spending and outcomes).[5]

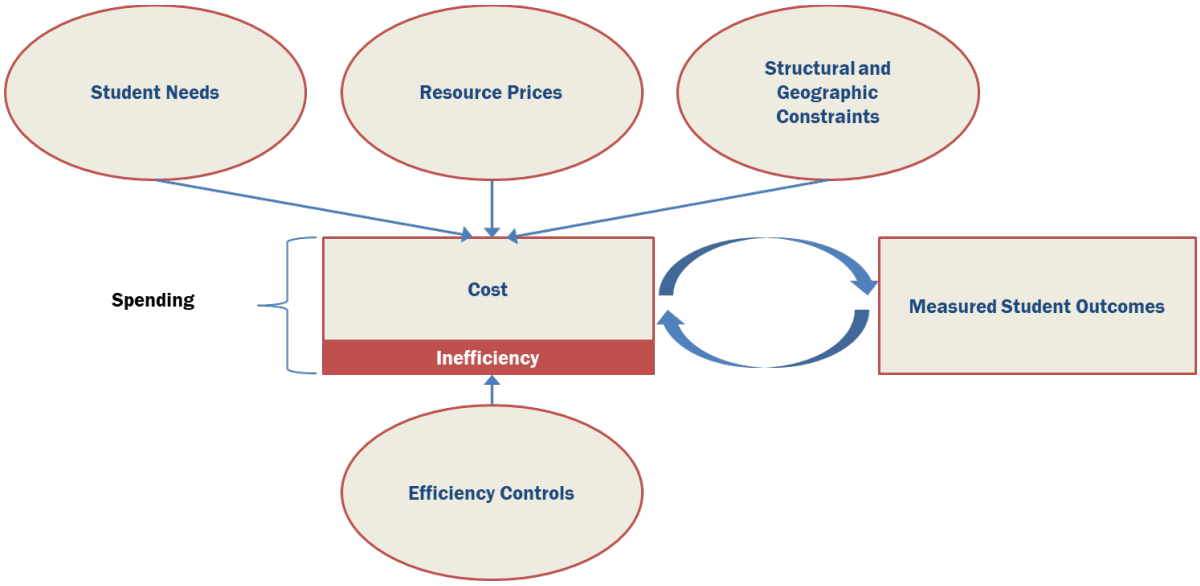
The objective of the cost function analysis is to isolate the statistical relationship between variation in spending and outcomes, with respect to differences in student need factors and other exogenous

[5] The current study includes the Herfindahl index to account for the competitive context, the percentage of the allowable property tax levy used by local taxing district to account for fiscal capacity, and the level of income and property wealth to account for public monitoring of spending and outcomes.

factors affecting costs. The policy goal is to use this information to determine the different levels of spending needed for each institution, given their students and context, to achieve common measures of success such as college credits and credentials earned in the community college context. That is, the models estimate how much adjustment in funding is needed to support success for students with different characteristics, who are learning in different contexts.

The components of the education cost function model are in figure B1. Across the top of the figure are factors that affect the costs associated with achieving outcomes, including risk factors pertaining to student backgrounds (student need factors), factors associated with differences in competitive wages for faculty and other employees (resource price levels), and other structural and contextual factors such as economies of scale (enrollment size) and population sparsity. These factors will be considered as funding adjustments for driving differential state aid to institutions.

Figure B1. Components of the education cost model



Source: Reprinted with permission from Atchison et al. (2020, p. 63).

The dependent variable in the education cost function model is institutional spending per student. Outcomes are among the independent variables, but the relationship between the two is simultaneous (endogenous). Conceptually, spending levels are set at least in part based on the outcomes desired, but changes in spending also influence outcomes. As such, the appropriate statistical treatment for an educational cost function model is an instrumental variables approach that attempts to address this endogeneity by isolating the exogenous variation in the endogenous variable (in this case, success points milestones earned per student). This is done by identifying one or more exogenous measures, or instruments, that are significantly associated with the endogenous variable (instrument strength) but are not significantly correlated with the error term of the main spending equation (instrument validity).

The study team considered a host of candidate instruments that meet these criteria, including those related to the sociodemographic composition of students in those K-12 districts within the county

served by the community (for example, the percentages of students who are economically disadvantaged and the percentages of students in racial/ethnic minority groups). Although all the candidate instruments were found to be significantly associated with the endogenous outcome of interest, one was deemed most compelling in terms of meeting the instrument validity criterion: the percentage of students receiving special education services among the K-12 districts within the county served by the community college.

Conceptually, the incidence of students receiving special education services at K-12 districts would be expected to influence the outcomes of students in the community colleges they feed into, while having a negligible relationship with spending at these colleges. Specifically, our hypothesis is that the outcomes of community colleges may be driven at least in part by those students with disabilities who enroll from K-12 districts within the county. Indeed, there is a significant association between success points milestones per student and the within-county percentage of students receiving special education services (*p*-value is less than 0.001). In addition, there is no formal funding adjustment for the incidence of students with disabilities in the current community college funding mechanism. In turn, regardless of any association between the incidence of students with disabilities at community colleges and at K-12 districts within the county, there is no expectation of a significant relationship between spending and the percentage of students with disabilities at the community college level, especially after controlling for additional factors such as the local economic context, input prices, competition, and student need factors. Although there is no formal test for whether an instrument (percentage of K-12 students with disabilities) has a direct effect on the second-stage outcome (spending), the study team ran as an informal check the correlation between community college spending per student and our instrument, both with and without accounting for additional controls. Neither revealed a statistically significant relationship between the instrument and outcome.[6]

Another issue is the circumstance that not all institutional spending is efficient. Efficient spending is spending that contributes directly to the measurable outcomes included in the model. In any given institution, some part of current spending contributes directly to the measured student outcomes used in the model, given the students served; the salaries of faculty and staff; and the structure, size, and location of the institution. The objective of the cost function is to identify the levels of spending associated with achieving specific outcome levels across student populations with varied needs attending colleges with different contextual characteristics, holding factors associated with inefficiency constant.

In the modeling approach, the study team included measures that the research literature identifies as predictors of differences in spending not directly associated with educational outcomes (that is, inefficiencies). These include a measure of regional institutional competition density,[7] measures

[6] The results of this informal check show that the simple relationship between spending and the within-county K-12 special education incidence (without controlling for additional factors) was not statistically significant at the conventional 5 percent level (the *p*-value was equal to 0.07). After controlling for the additional factors mentioned, the significance of this relationship became even less apparent (the *p*-value was equal to 0.19).

[7] The measure of competition density is a Herfindahl index based on the concentration of comparable postsecondary institutions as defined by the Carnegie classification within a 25-mile radius.

associated with the local public monitoring of public spending (the share of authorized taxes that are levied), and measures of local capacity (home value and household income). In statistical terms, correcting for inefficiency in a cost model is an omitted variables bias problem. Specifically, it involves identifying factors that explain differences in spending associated with neither legitimate cost differences (that is, the student characteristics or institutional contextual factors included in the model) nor with differences in the observed outcomes included in the model. Omitting these variables may bias the estimated relationship between the observed outcomes and spending. Setting the values of the inefficiency variables equal to a constant level (the statewide average) incorporates the influence of inefficiency on spending when projecting cost estimates.

The study team applied a similar approach for public community colleges in Texas—one of the few U.S. states that has a large number of such colleges spread across wide ranges of student need factors and institutional contextual factors. Using success points milestones per full-time equivalent student as the outcome of interest, the study team estimated the costs of achieving common rates of completion by institution using seven years of data. Modifying the basic form of the cost models applied in K–12 school and district analysis, the model is specified in equation 3:

$$Spending_{it} = \alpha + \beta Outcome^{*}_{it} + \sum_1^j \gamma_j Need_{j,it} + \sum_1^k \vartheta_k IScale_{k,it} + \mu Sparsity_{it} + \rho Wage_{it} + \sum_1^l \sigma_l Inefficiency_{l,it} + \theta_t + \varepsilon_{it} \quad (3)$$

* Outcomes are considered endogenous in the cost models.

where the equation terms follow the definitions described in the risk and equity analyses. That is, for institution i, the model includes annual (year = t) measures of spending per student, which is the dependent variable.

In the primary specification, the success points milestones earned per full-time equivalent student is included for each institution and year. The models also include additional regressors pertaining to student need factors (*Need*); institutional contextual factors related to scale, sparsity, labor market wage level (*Scale*, *Sparsity*, and *Wage*); factors that may affect spending but do not directly translate into the observable outcomes included in the model or may be otherwise controlled for (*Inefficiency*); and controls for year. Student outcomes are instrumented using the incidence of students receiving special education services in local K–12 districts.

Cost model estimates could be used directly in the determination of funding weights to provide aid to institutions. However, cost model estimation requires the use of measures that may be overly complex or less accessible for translation into funding formulas (which are typically legislated). Translation into policy becomes easier by adding a third step to the process, which allows the cost model to be converted into a set of simpler weights based on data and measures that may be more readily available for annual (or biennial) updates for calculating aid.

The third step involves identifying a reduced set of accessible annual measures of student need and institutional contextual factors that are sufficient for capturing the majority of variation in costs across institutions. To determine the weights, the study team fit a model of this reduced set of factors to the predicted costs from the estimated cost model. This model yields directly applicable funding weights

for each factor in the model, which can then be applied in a simulation model of need and cost-based aid for community colleges in support of formula development.

$$Predicted\ Costs = f(Student\ Characteristics, Institutional\ Context, Input\ Prices) \quad (4)$$

The cost factors included in the weights estimation may, in fact, be multiplicative. In other words, an increase in the percentage of first-generation college students may change costs differently, depending on the percentage of students older than 24 years being served in the same community college. As such, the study team used a Poisson model to estimate the weights to be used in the simulation tool.

The identification of the measures for which funding weights are to be estimated were guided by the following four criteria:

- The measures must be consistently and regularly collected on at least a biennial basis to allow for alignment with the frequency with which community college funding is determined in Texas.
- The measures must be publicly available, such that the formula built upon them is transparent and replicable.
- The measures must be understandable to policymakers.
- The measures must predict the vast majority of the explained variation in the dependent variable used in the education cost function model (spending).

Research question 4. The study team used projected costs from the weights model and actual expenditure data for every community college to calculate the adequacy gap for each community college. The adequacy gap is the difference between what colleges would need to spend to produce an adequate level of student outcomes (defined as the statewide average) and what they actually spent per full-time equivalent student.

After calculating the expected adequacy gap for each institution in 2020/21, each institution was sorted by the size of expected adequacy gap and categorized into five groups (quintiles) with roughly equal numbers of students served within each. The average success points milestones earned per full-time equivalent student was then calculated for institutions within each quintile to see if differences emerged across quintiles.

Research question 5. The study team used projected costs from the weights model and actual expenditure data for every community college to examine if colleges with larger shares of students with a given need factor tended to spend more or less than necessary to reach adequate levels of student outcomes. Community colleges were categorized into five groups (quintiles) with roughly equal numbers of students served within each quintile, with the first quintile having the smallest shares of students with a given need factor and the fifth quintile having the largest shares of students with that same need factor. The average amount of projected spending necessary to reach adequate outcomes and the amount spent were calculated within each quintile. The study team used the same approach to determine whether gaps between projected adequate cost and actual spending were larger or smaller for institutions with different student enrollments, the primary institutional context of interest.

Limitations

This study has three main limitations. First, the cost function approach estimates expected relationships among student need factors, institutional contextual factors, spending, and student outcomes. The estimated relationships provide no information about how dollars are spent or about best practices with respect to how resources should be allocated. Additional research is necessary to investigate these issues.

Second, the findings may not be generalizable to other state contexts. Although the sample for the proposed study is the population of community colleges in Texas—providing representation of the varied groups of students served and the circumstances under which these institutions operate within this state—the results may be limited in their application to other states. In particular, the results of this study may not be as generalizable to states that are much smaller and do not use a performance-based funding system such as the Texas Student Success Points system.

Third, the findings should not be interpreted as causal. Although the study team took steps to reduce bias in the analytic approach, spending and student outcomes were determined simultaneously, and institutional spending decisions may not be perfectly efficient, despite the study team's attempts to control for inefficiency. Studies employing cross-state research designs with more plausible sources of exogeneity may prove effective in providing causal answers to the questions posed in this work.

References

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Appendix C. Supporting analyses

This appendix provides supporting analyses for the findings in the report. Tables C1 and C2 show the full results for research question 3. Figures C1–C9 show results for research question 5.

Table C1. First-stage regression results for the cost function analyses in Texas community colleges, 2014/15–2019/20

Variable	Coefficient	Robust standard error
Instrument		
Percentage of students in K-12 special education in the county	6.407***	0.881
Need factor		
Percentage of students who are first-generation college students	-0.728**	0.256
Percentage of students who are from households earning less than $30,000	0.373*	0.147
Percentage of students who are academically disadvantaged	-0.138*	0.062
Percentage of students who are older than 24 years	-0.628***	0.183
Percentage of students who are English learner students	-0.340***	0.086
Percentage of students who are enrolled in dual-credit programs	0.238	0.194
Contextual factor		
Fewer than 4,001 students enrolled	0.018	0.056
4,001–30,000 students enrolled	-0.010	0.033
Local population density	-0.012***	0.002
Price of input		
Monthly faculty salary ($10,000s) in local market	0.280***	0.054
Efficiency controls		
Herfindahl index	-0.131*	0.051
Median housing value ($10,000s) in local market	0.013**	0.005
Household income ($10,000s) in local market	-0.013	0.014
Percentage of authorized taxes levied	-0.234***	0.051
Additional controls		
Percentage of students enrolled in technical programs	0.153	0.116
Percentage of students enrolled exclusively online	-0.325*	0.155
Constant	1.816***	0.232
Number of observations	300	
R^2	0.709	
F-test of excluded instrument $F(1, 277)$	52.85***	

* Significant at $p < .05$. ** Significant at $p < .01$. *** Significant at $p < .001$.

Note: Data include 50 community colleges in 2014/15 through 2019/20, resulting in 300 college-year observations. The outcome is success points milestones per full-time equivalent student. The model is weighted by student enrollment and includes year fixed effects.

Source: Authors' analysis of institution-level data collected by the Texas Higher Education Coordinating Board, the College Scorecard, the Integrated Postsecondary Education Data System, and the School Finance Indicators Database.

Table C2. Second-stage regression results for the cost function analyses in Texas community colleges, 2014/15–2019/20

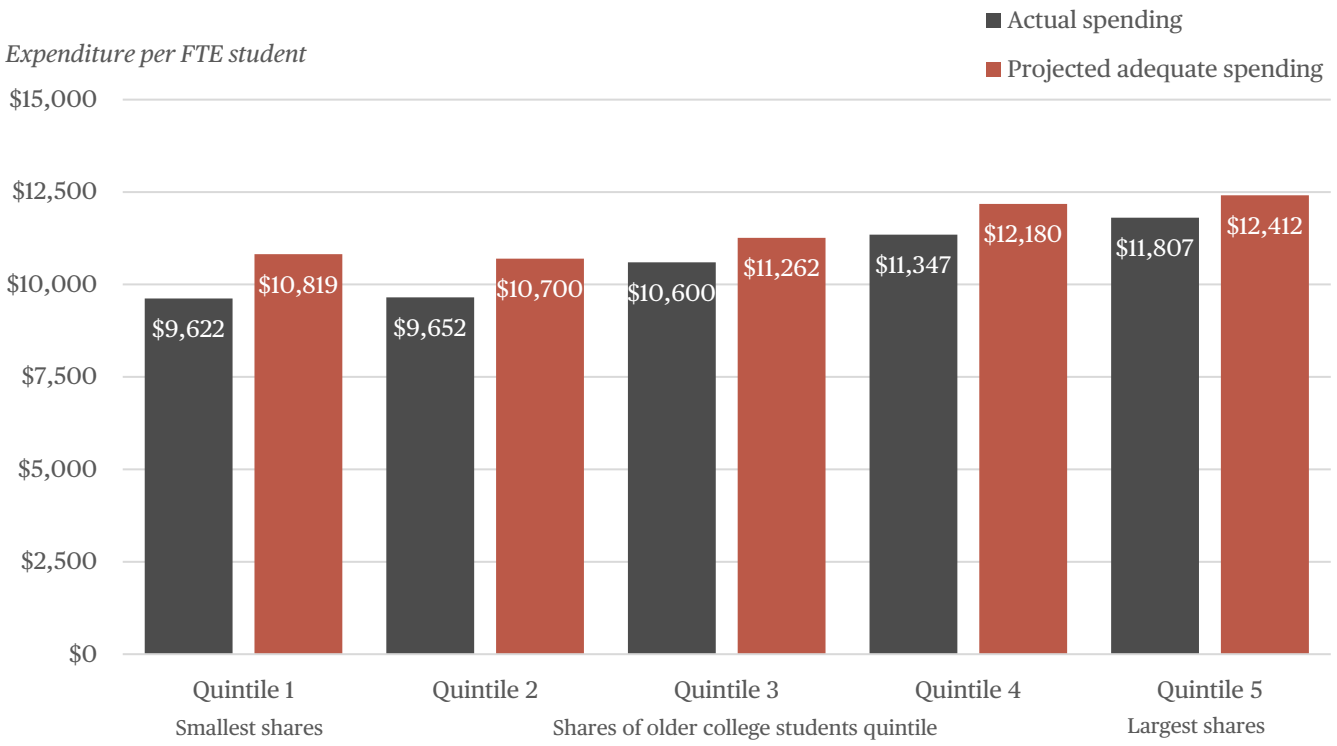
Variable	Coefficient	Robust standard error
Instrumented variable		
Success points milestones earned per full-time equivalent student	1,478.56	1,051.36
Need factor		
Percentage of students who are first-generation college students	9,039.07***	2,672.59
Percentage of students who are from households earning less than $30,000	4,274.65***	846.92
Percentage of students who are academically disadvantaged	-3,562.50***	486.41
Percentage of students who are older than 24 years	14,346.30***	1,675.38
Percentage of students who are English learner students	3,721.27*	1,131.16
Percentage of students who are enrolled in dual-credit programs	-3,626.67*	1,612.60
Contextual factor		
Fewer than 4,001 students enrolled	2,889.21***	458.44
4,001–30,000 students enrolled	2,056.97***	302.36
Local population density	-7.86*	26.84
Price of inputs		
Monthly faculty salary ($10,000s) in local market	103.23	721.71
Efficiency controls		
Herfindahl index	-786.51	479.25
Median housing value ($10,000s) in local market	213.55***	40.93
Household income ($10,000s) in local market	-499.07***	120.37
Percentage of authorized taxes levied	168.84	424.28
Additional controls		
Percentage of students enrolled in technical programs	-431.02	919.24
Percentage of students enrolled exclusively online	-713.43	1,290.84
Base per-student cost (constant)	-4,944.38	3,481.98
Number of observations	300	
R^2	0.569	
Hausman test (Chi-square)	0.095	

* Significant at $p < .05$. *** Significant at $p < .001$.

Note: Data include 50 community colleges in 2014/15 through 2019/20, resulting in 300 college-year observations. The outcome is expenditures per full-time equivalent student. The model is weighted by student enrollment and includes year fixed effects. The excluded instrument is the percentage of K-12 students receiving special education services in the county.

Source: Authors' analysis of institution-level data collected by the Texas Higher Education Coordinating Board, the College Scorecard, the Integrated Postsecondary Education Data System, and the School Finance Indicators Database.

Figure C1. Quintiles of students older than 24 years by projected adequate spending and actual spending in Texas community colleges, 2019/20

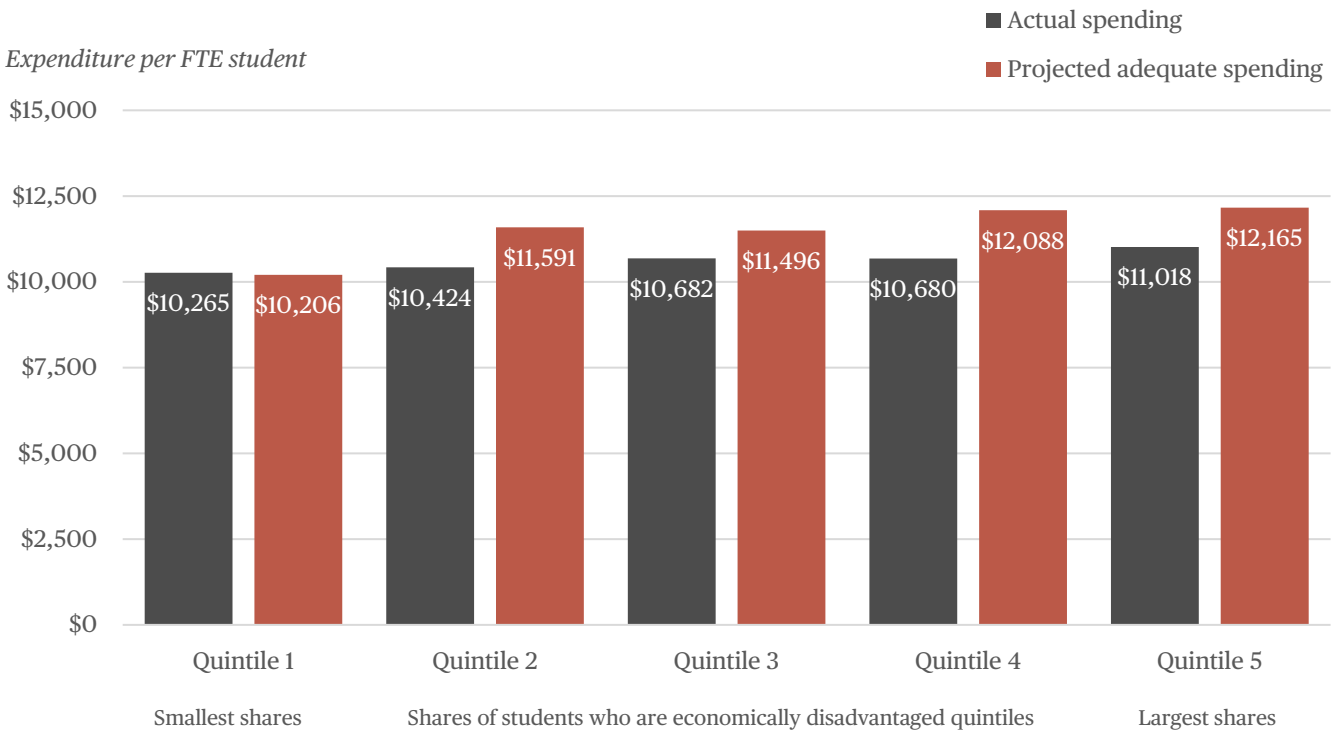


FTE is full-time equivalent student.

Note: Each quintile represents approximately 20 percent of the students in the state. Quintile 1 represents community colleges with the smallest shares of students older than 24 and quintile 5 the largest shares. All data represent student-weighted averages within quintiles in the last year of the data (2019/20).

Source: Authors' analysis of institution-level data collected by the Texas Higher Education Coordinating Board, the College Scorecard, and the School Finance Indicators Database.

Figure C2. Quintiles of students who are economically disadvantaged by projected adequate spending and actual spending in Texas community colleges, 2019/20

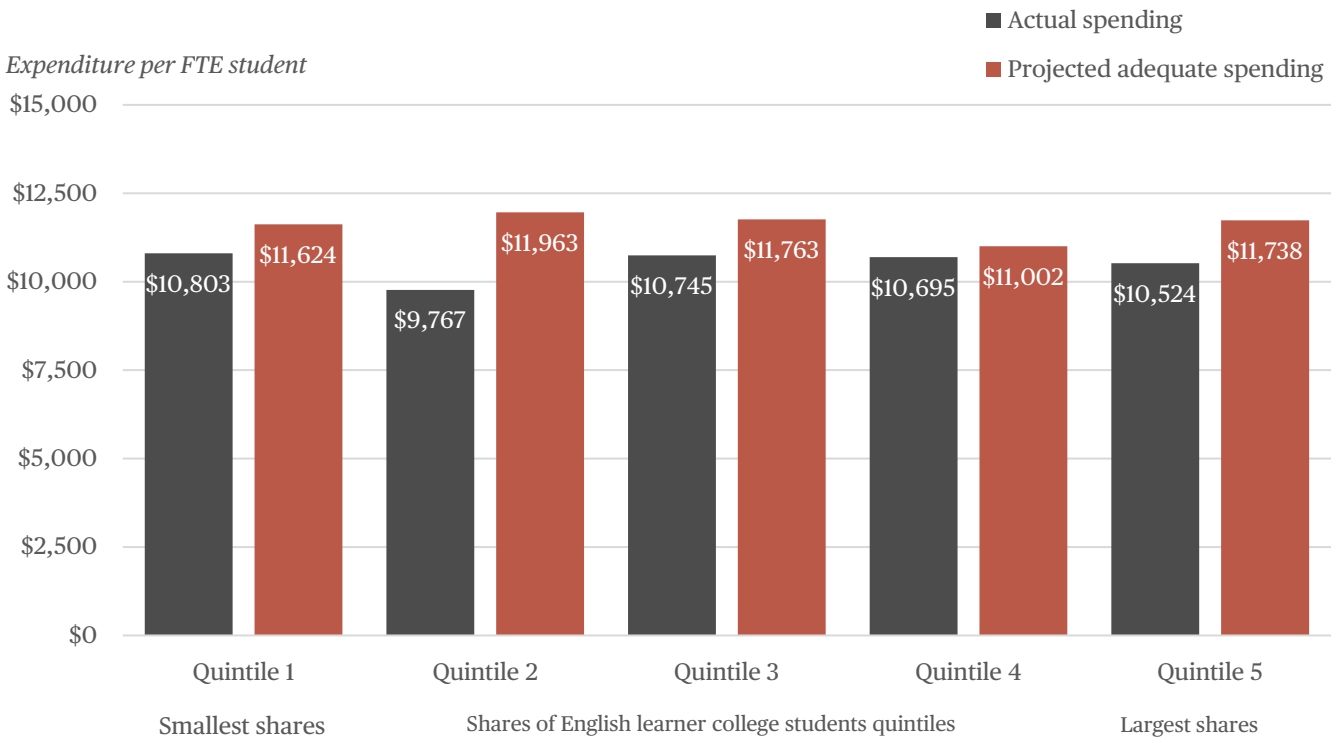


FTE is full-time equivalent student.

Note: Each quintile represents approximately 20 percent of the students in the state. Quintile 1 represents community colleges with the smallest shares of students who are economically disadvantaged and quintile 5 the largest shares. All data represent student-weighted averages within quintiles in the last year of the data (2019/20).

Source: Authors' analysis of institution-level data collected by the Texas Higher Education Coordinating Board, the College Scorecard, and the School Finance Indicators Database.

Figure C3. Quintiles of English learner students by projected adequate spending and actual spending in Texas community colleges, 2019/20

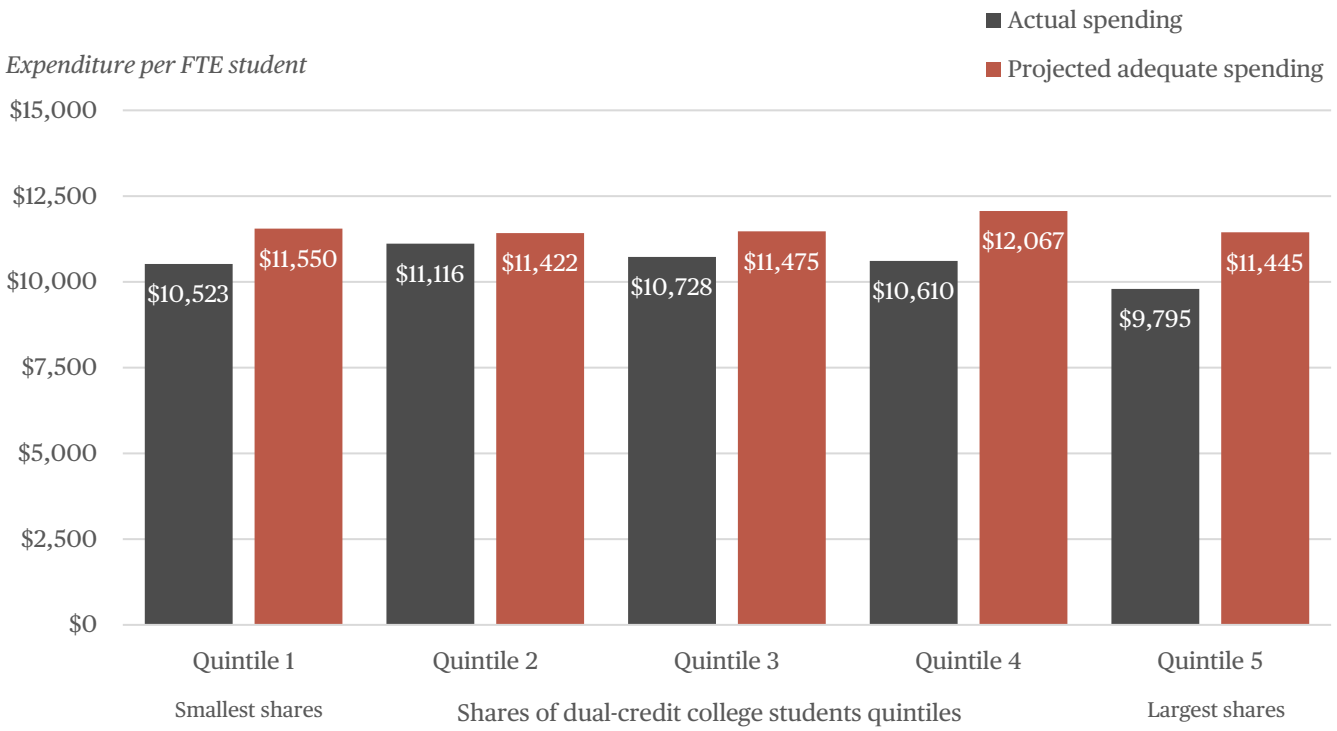


FTE is full-time equivalent student.

Note: Each quintile represents approximately 20 percent of the students in the state. Quintile 1 represents community colleges with the smallest shares of English learner students and quintile 5 the largest shares. All data represent student-weighted averages within quintiles in the last year of the data (2019/20).

Source: Authors' analysis of institution-level data collected by the Texas Higher Education Coordinating Board, the College Scorecard, and the School Finance Indicators Database.

Figure C4. Quintiles of students enrolled in dual-credit programs by projected adequate spending and actual spending in Texas community colleges, 2019/20



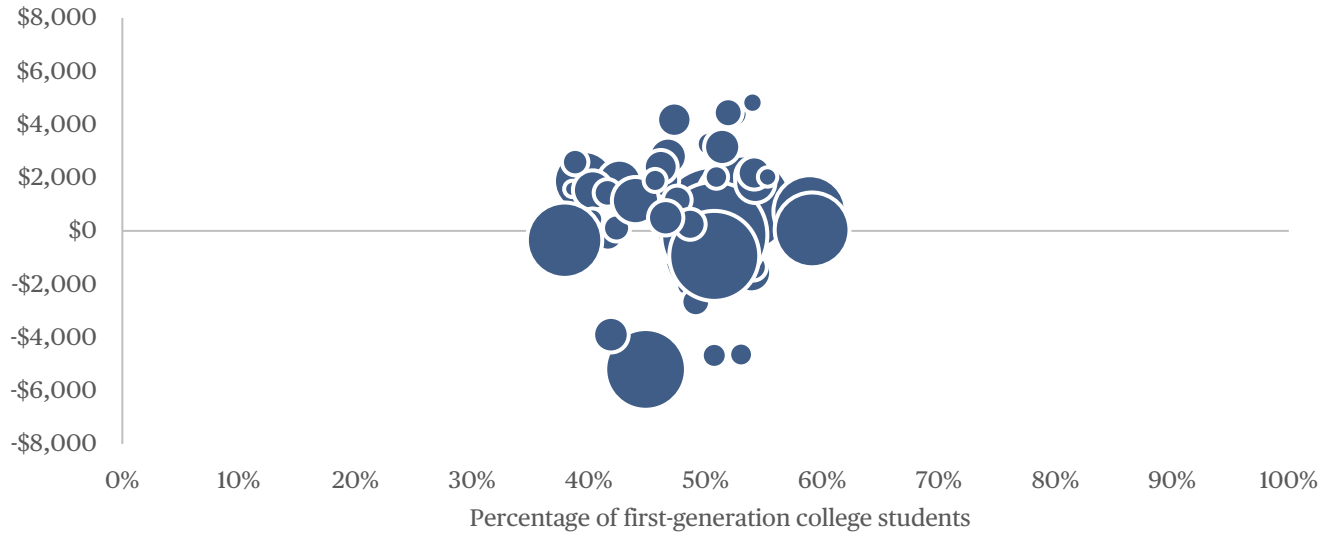
FTE is full-time equivalent student.

Note: Each quintile represents approximately 20 percent of the students in the state. Quintile 1 represents community colleges with the smallest shares of students enrolled in dual-credit programs and quintile 5 the largest shares. All data represent student-weighted averages within quintiles in the last year of the data (2019/20).

Source: Authors' analysis of institution-level data collected by the Texas Higher Education Coordinating Board, the College Scorecard, and the School Finance Indicators Database.

Figure C5. Scatterplot of first-generation college students and the gap between projected and actual spending in Texas community colleges, 2019/20

Adequacy gap per FTE student



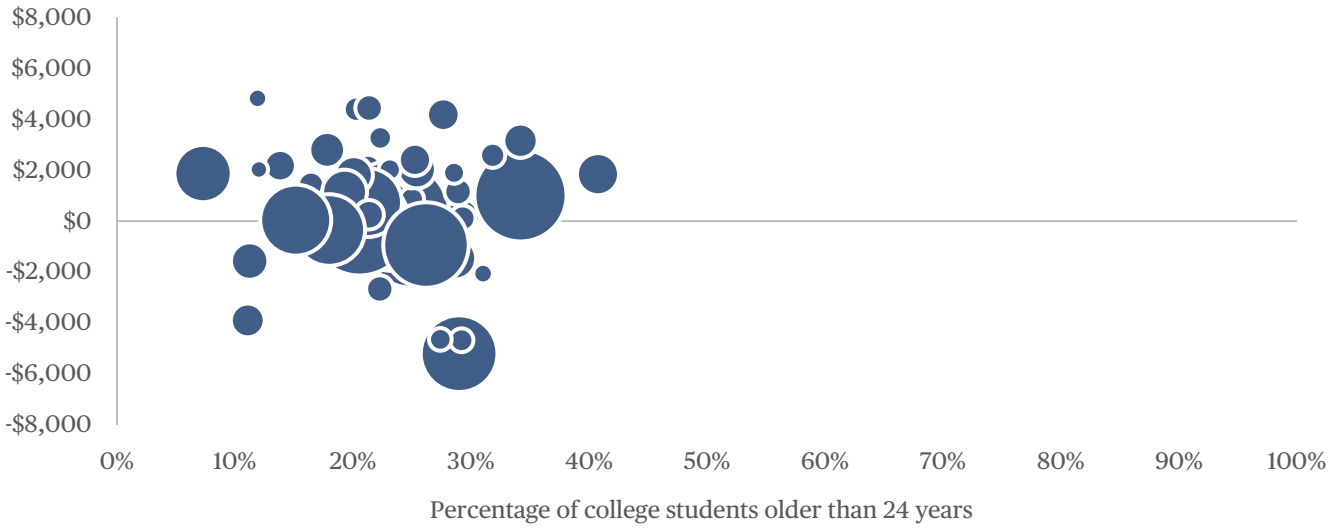
FTE is full-time equivalent student.

Note: The size of the plotted points is proportional to the FTE of all 50 community colleges in the sample.

Source: Authors' analysis of institution-level data collected by the Texas Higher Education Coordinating Board, the College Scorecard, and the School Finance Indicators Database.

Figure C6. Scatterplot of college students older than 24 years and the gap between projected and actual spending in Texas community colleges, 2019/20

Adequacy gap per FTE student

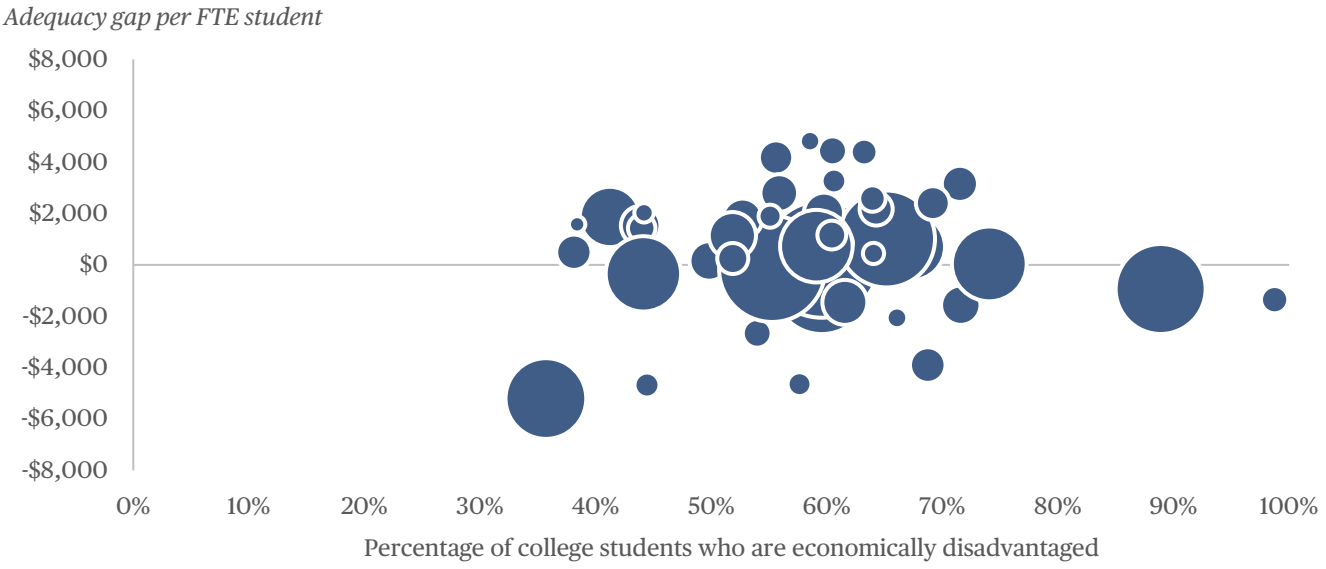


FTE is full-time equivalent student.

Note: The size of the plotted points is proportional to the FTE of all 50 community colleges in the sample.

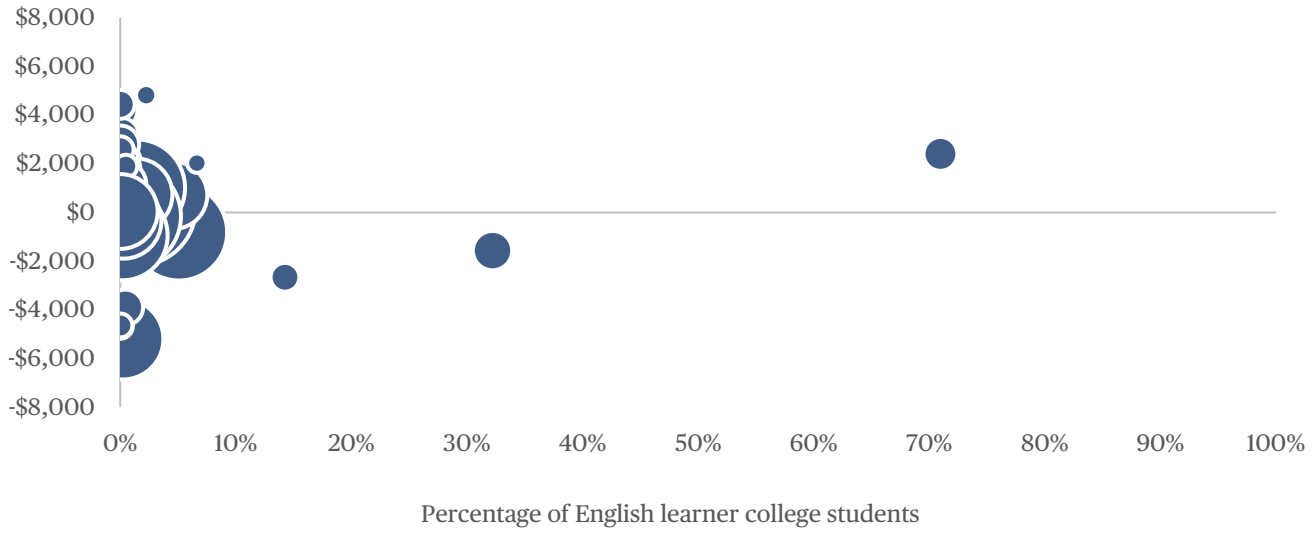
Source: Authors' analysis of institution-level data collected by the Texas Higher Education Coordinating Board, the College Scorecard, and the School Finance Indicators Database.

Figure C7. Scatterplot of college students who are economically disadvantaged and the gap between projected and actual spending in Texas community colleges, 2019/20



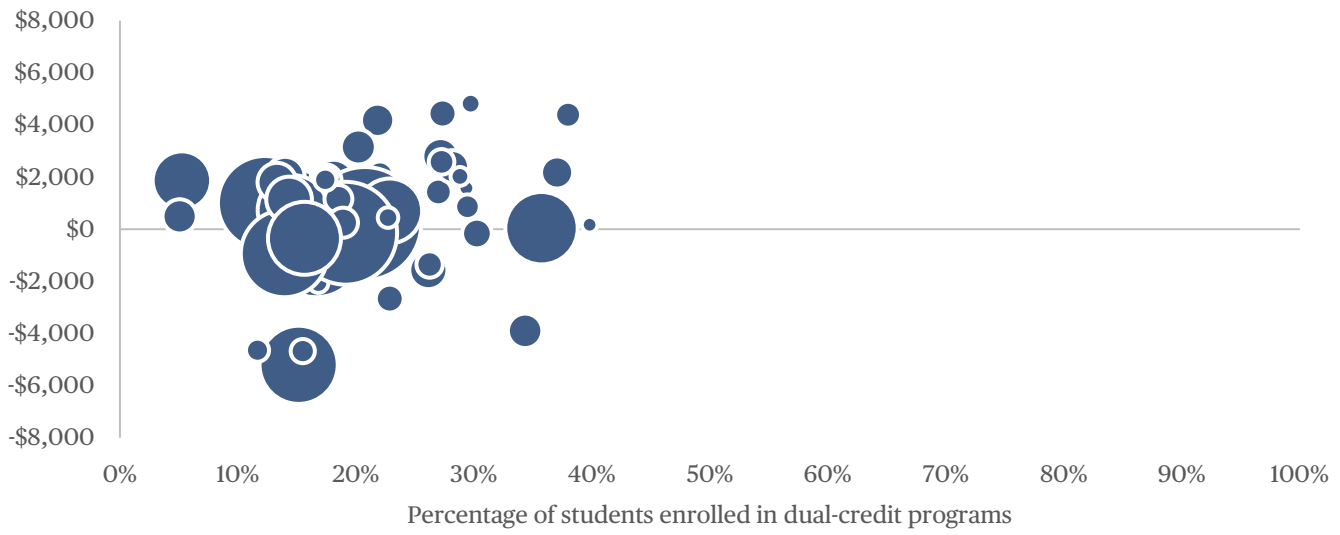
FTE is full-time equivalent student.
Note: The size of the plotted points is proportional to the FTE of all 50 community colleges in the sample.
Source: Authors' analysis of institution-level data collected by the Texas Higher Education Coordinating Board, the College Scorecard, and the School Finance Indicators Database.

Figure C8. Scatterplot of English learner college students and the gap between projected and actual spending in Texas community colleges, 2019/20



FTE is full-time equivalent student.
Note: The size of the plotted points is proportional to the FTE of all 50 community colleges in the sample.
Source: Authors' analysis of institution-level data collected by the Texas Higher Education Coordinating Board, the College Scorecard, and the School Finance Indicators Database.

Figure C9. Scatterplot of college students enrolled in dual-credit programs and the gap between projected and actual spending in Texas community colleges, 2019/20



FTE is full-time equivalent student.
Note: The size of the plotted points is proportional to the FTE of all 50 community colleges in the sample.
Source: Authors' analysis of institution-level data collected by the Texas Higher Education Coordinating Board, the College Scorecard, and the School Finance Indicators Database.

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