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Decomposing financial inequality across U.S. higher education institutions

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\textbf{ABSTRACT}

The level of financial inequality among U.S. higher education institutions has important implications for students and society, yet few scholars have examined this topic using established methods for measuring inequality. This paper updates and extends previous work while introducing decompositions that shed light into key trends that we observed for the 2004–2017 period: increasing inequality in total expenditures and decreasing inequality in per-student expenditures. The results of our decomposition highlight how these opposing trends related to rising differences in enrollments and an increasingly positive correlation between an institution's enrollment level and its expenditures per student. Our decomposition results also show that both between-group differences and within-group differences contributed to the observed trends. Further examination of within-group differences reveals that inequality patterns differed meaningfully by institutional type, with doctoral universities and private baccalaureate colleges possessing higher levels of inequality and a more positive correlation between per-student expenditures and enrollments than master's institutions and public associate's colleges.

\textbf{1. Introduction}

The disparities in financial resources across U.S. colleges and universities are vast and important. For example, the higher education institutions with the 25 largest endowments hold over half of all endowment assets (Milton & Ehrenberg, 2013). Recent books with striking titles such as Unequal Colleges in the Age of Disparity and Unequal Higher Education compellingly describe the implications of organizational financial inequality for students and for society (Clotfelter, 2017; Taylor & Cantwell, 2019). Furthermore, many worry that this form of inequality is growing, with prominent institutions like the Delta Cost Project suggesting that “[r]ich institutions are getting richer, and poor institutions are getting poorer” (Desrochers and Wellman, 2011).

Despite the importance of this topic, only a few academic studies have examined it using established methods for measuring inequality (Davies & Zarifa, 2012; Lau & Rosen, 2016). Our collective understanding of how to study organizational financial inequality in the higher education industry is consequently underdeveloped, as is our empirical understanding of the levels and trends that exist for this form of inequality. This study advances the literature by describing levels and trends in overall inequality for the period spanning the 2004–2017 fiscal years and then decomposing those levels and trends. Our description updates and extends previous estimates; our decomposition makes a more fundamental contribution by introducing to the higher education literature a decomposition method that illuminates key questions pertaining to organizational inequality.

Our decomposition method helps us to better understand differences in inequality trends that depend upon whether dollars are measured in total or on a per full-time-equivalent (FTE) student\textsuperscript{1} basis. Lau and Rosen (2016) noted that because colleges and universities provide students with a mix of rival and non-rival goods and services, the optimal measure of finances is unknown but would fall somewhere between the extremes of total dollars and dollars per student. They consequently suggested examining trends for both measures and noted that clear conclusions can be reached when trends in inequality are consistent across these two measures, which it was for the time period they examined.

They left open the question of how to interpret findings when trends differ across these measures, a question of importance because our period of study experiences opposing trends. To understand the source of these differential trends, we employed a technique that is used in labor economics to decompose total earnings inequality into wage inequality, hours of work inequality, and a term measuring the correlation of wages and hours of work (Checchi, García-Peñalosa, & Vivian, 2017).

\textsuperscript{1} For the sake of brevity, we will simply use the term “per student” rather than “per FTE student” for the remainder of the paper even though we mean the latter. As we will discuss in our data section, we weight graduate enrollments by a factor of two when calculating total enrollments to account for the higher costs associated with graduate instruction. So, our estimates of expenditures per student are actually estimates of expenditures per weighted FTE student.

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for per-student expenditure inequality, enrollment inequality, and a term measuring the correlation between per-student expenditures and enrollments. We extended this decomposition so that each term is further divided into shares associated with between-group and within-group inequality, which allowed us to examine important variation relating to an institution’s control (public and private non-profit) and Carnegie type (doctoral, master’s, baccalaureate, and associate’s).

Our description and decomposition of organizational financial inequality reveal a number of important findings. For a data set drawn from the Integrated Postsecondary Education Data System for the full-population of non-profit Title IV eligible U.S. higher education institutions, we report a range of inequality indices. These indices indicate that total expenditure inequality increased over the 2004–2017 period while per-student expenditure inequality declined. Our decomposition highlights how these differing trends related to rising differences in enrollments and an increasingly positive correlation between an institution’s enrollment level and its expenditures per student. Our extended decomposition shows that both between-group differences and within-group differences contributed to these patterns. Our results are partially driven by the presence of high research spending at large universities but remain present when more narrow measures of expenditures, that exclude research and service, are used.

Our work has important implications for understanding inequality in organizational finances. Our findings highlight how measures of organizational expenditures and revenues relate to enrollment levels, a relationship that will become increasingly important given demographic trends stemming from the “birth dearth” since the Great Recession that could lead to enrollment declines at many institutions (Grawe, 2018). The COVID-19 pandemic may create a further set of demographic challenges. Because some revenue sources (e.g. endowments, state appropriations) and expenditure types (e.g. campus infrastructure) do not decline commensurately with enrollments, per-student expenditures could remain steady or even rise at institutions with worsening financial situations and declining enrollments. Yet scholars regularly use per-student revenue or expenditure measures to capture the state of a higher education institution’s finances. Although no perfect measure of expenditures or revenues exists, our paper highlights key factors shaping differences between alternative measures.

2. Previous literature

Only two studies have used established methods for measuring inequality to examine whether the distributions of revenues and expenditures across higher education institutions have become more or less unequal over time. Both Davies and Zarifa (2012) and Lau and Rosen (2016) examined Gini coefficients for large numbers of U.S. higher education institutions, but they differed in a number of regards. The former study used data for a longer period (1971–2006) but only examined four-year institutions and a smaller set of measures (per-student measures of revenues and expenditures). The latter used data for a shorter period (2002–2010) but also included two-year institutions and measures of total revenues and expenditures. The studies also differed in how they measured revenues, as Davies and Zarifa (2012) did not include realized or unrealized capital gains on endowment portfolios for most of their sample period, while Lau and Rosen (2016) included this form of income.

The studies both found that the Gini coefficient for expenditures per student increased over time, but the studies interpreted the increases differently. For example, the analysis in Davies and Zarifa (2012) revealed an increase in the Gini coefficient from 0.427 to 0.467 for the 1971–1996 period, while the analysis in Lau and Rosen (2016) showed an increase from 0.341 to 0.370 between 2002 and 2010. The latter increase was more substantial given that it occurred over an 8-year period rather than a 25-year period. Yet Lau and Rosen concluded that their observed change was not a significant increase in expenditure inequality during their period of study, while Davies and Zarifa generally interpreted their observed increases as consequential.

The findings from these two studies also differed by the level of inequality and the differences by sector. For the 2006 fiscal year, the one year held in common for both studies, Davies and Zarifa (2012) reported Gini coefficients for total expenditures per student of 0.579 for the public sector and 0.460 for the private sector. In contrast, Lau and Rosen (2016) reported Gini coefficients of 0.264 for publics and 0.366 for privates. These varying results likely relate to one additional difference between the studies: Davies & Zarifa included institutions with a special focus classification within the Carnegie classification system while Lau and Rosen omitted these institutions. Special focus institutions often produce extreme outliers for per-student measures due to high revenues and low enrollments. Boxplots reported by Davies and Zarifa confirm that their data set contains a number of extreme outliers. In the analysis that follows, we will report Gini coefficients for expenditures per student that are much closer to the results from Lau and Rosen (2016) than the results from Davies and Zarifa (2012), which is not surprising because we also exclude special focus institutions.

3. Data

Similar to previous studies, we used data from the Integrated Postsecondary Education Data System (IPEDS), which is an annual census of postsecondary institutions in the United States. IPEDS is the only publicly-available data set that contains detailed revenue and expenditure figures for both public and private higher education institutions. Our study period spans the 2004 through 2017 fiscal years. The 2004 fiscal year is the first one in which all public institutions reported data using the new Governmental Accounting Standards Boards (GASB) reporting standards.

(footnote continued)

2 Our population does not include institutions with a special focus Carnegie classification. Special focus institutions offer degrees in a single field or a set of related fields, which sometimes leads to very atypical combinations of enrollments and expenditures. Examples of special focus institutions include seminaries, medical centers, law schools, and art schools. We do not include these institutions in order to eliminate outliers and focus attention on institutions with more broad-based offerings.

3 Other studies examined related topics. Desrochers & Wellman (2011) examined trends in expenditures per student between 1999 and 2009 for different Carnegie classification and institutional control groupings. They reported growing between-group inequality as average expenditures per student increased more rapidly at private institutions than at public institutions and more rapidly at four-year public institutions than at two-year public institutions. Winston (2004) examined institutional subsidies per student for the 1986/87–1995/96 period. The subsidy equals the difference between the cost associated with producing the education and the amount the student paid for it. Winston found growing between-sector inequality in subsidies as the gap between public and private institutions grew over the period. He also found varying trends in within-sector inequality: the Gini coefficient for public institutions fell from 0.189 to 0.176, and the Gini coefficient for private institutions increased from 0.299 to 0.338.

4 These studies also differed in that Lau and Rosen (2016) focused on linear time trends based upon data for every year of their sample, while Davies and Zarifa (2012) focused on differences between the beginning year and ending year of the period. When using linear time trends, Lau and Rosen (2016) estimated a smaller difference of 0.020 rather than 0.029 for their time period. The use of linear time trends, however, does not explain the differing conclusions as an increase of 0.020 over eight years is still more impressive than an increase of 0.040 over 25 years.

5 Although consistent reporting standards were generally used over our selected period, reporting standards did change slightly over the period. The treatment of maintenance, depreciation, and interest (MDI) expenses changed for those institutions following the GASB standards. During FY2007 and earlier...
Unlike previous studies of organizational financial inequality, we prepared IPEDS data using the recommendations provided by Jaquette and Parra (2016). Consequently, we examine Title IV institutions. Title IV institutions provide postsecondary education and are eligible to enroll students receiving Title IV federal financial aid (Congressional Research Service, 2007). In order to obtain Title IV status, an institution must obtain accreditation by an approved accrediting agency and satisfy requirements, including annual completion of the IPEDS survey, stipulated in the Program Participation Agreement (PPA) contract with the U.S. Department of Education. A Title IV institution may be a single-campus institution or a multi-campus institution. Because multiple campuses from the same Title IV institution sometimes report data separately, we aggregate data from separate campuses in order to create a Title IV institution-level data set. Our aggregation uses digits 2-6 of the Office of Postsecondary Education Identification (OPEID) as recommended by Jaquette and Parra (2016). During the aggregation, we used the values for the PPA holder (i.e. main campus), which is identified by a value of “00” for digits 7-8 of the OPEID, when calculating categorical variables. For continuous variables that count items like dollars and students, we summed across all UNITID-level observations that share the same PPA.

We constructed our data set with aggregation procedures performed separately for each academic year. One limitation of this approach is that the composition of PPAs changed over time so that identical groupings were not used across years. To determine whether or not changes to the composition of PPAs affected our results, we repeated the analysis for a data set that employed identical groupings across years. We achieved identical groupings by further aggregating observations to account for the movement of UNITID-level observations across PPAs. Our results did not meaningfully differ when this alternative data set was used.

We examined institutions that meet the following criteria: (a) not-for-profit; (b) Title IV eligible; (c) two-year or four-year institutions; (d) residing within the 50 U.S. states or Washington D.C.; (e) degree granting; (f) not system offices unaffiliated with other IPEDS observations; (g) not missing finance or enrollment data; and (h) possessing enrollment levels of at least 100 students. We then added another criterion via the Carnegie classification by only keeping institutions classified as doctoral, master’s, baccalaureate, or associate’s institutions. This decision primarily results in the omission of institutions classified in the special focus classifications, which contain types of institutions (e.g. seminaries, medical centers) that produce extreme outliers for per-student measures due to high revenues and low enrollments. Another reason for this omission lies with the motivation for the paper, which primarily centers around policy questions pertaining to more general types of higher education institutions.

A range of potential measures of total expenditures and total revenues exist, and each measure offers drawbacks and advantages. Although our tables only include findings for one revenue measure and one expenditure measure, we examined findings for a number of alternatives to ensure that our findings are robust. Our primary measure of total revenues includes tuition, government appropriations, grants and contracts, donations, and investment return. This measure excludes revenues generated by auxiliary enterprises, hospitals, sales of educational services, independent operations, and those revenues categorized as “other” in IPEDS financial tables. To maintain consistency with our revenue measure, we used education and general (E&G) expenditures as our primary measure of total expenditures. E&G expenditures include instruction, academic support, student services, institutional support, research, public service, and scholarship expenses, but exclude costs of auxiliary enterprises, hospitals, independent operations, and expenses categorized as “other” in IPEDS.

To check for sensitivity of our results, we repeated our analysis using alternative measures of revenues and expenditures. First, we examined a more restrictive measure of expenditures—education and related (E&R) expenditures—which differs from E&G expenditures in that direct and indirect expenditures associated with research and public service are not included. Our inequality estimates, especially those examining between-sector differences, were lower when E&R expenditures were used. Second, we examined measures that incorporated all sources of revenues and expenditures including auxiliary, hospital, independent operations, and other categories. We observed a slight increase in the magnitude of inequality when we employed these more expansive measures. However, our primary findings pertaining to changes over time or disparities between total and per-student measures of inequality were not substantially altered by the use of more restrictive or more expansive measures of organizational finances.

To measure enrollment, we used 12-month enrollment rather than Fall enrollment so that we can account for enrollment over an entire year and provide a more complete picture of the number of students that benefit from the financial resources of the institution. We replaced 12-month enrollment data with an adjusted figure based on Fall enrollment when 12-month enrollment data was missing or problematic. Our enrollment measure is weighted with graduate separate Title IV institutions in later years. For the alternative data set containing identical groupings over time, UC-Merced and UC-Davis data are combined into one observation for all years in our study period.

The measure of education and related (E&R) expenditures was introduced by the Delta Cost Project. They described it as “instruction + student services + (education share “(academic support + institutional support + operations and maintenance”)), where education share = (instruction + student services)/(instruction + student services + research + public service)” (DCP, 2011, p. 17).

The median difference between 12-month enrollment and Fall enrollment
enrollments receiving a weight of two, because graduate education is more expensive to provide. Although our measure captures weighted FTE enrollments, we use the term “expenditures per student” rather than “expenditures per weighted FTE student” for brevity’s sake when describing results for expenditures measures that were normalized by our enrollment measure.

To check for robustness, we incorporated alternative enrollment measures based on Fall enrollments or unweighted calculations. We observed a slight decline in the magnitude of inequality measures when we used Fall enrollment rather than 12-month enrollment. We detected a slight increase in inequality indices when we used unweighted, rather than weighted, enrollment. As was the case with revenue and expenditure measures, the use of alternative enrollment measures did not substantially alter our primary findings pertaining to changes over time or disparities between total and per-student measures of inequality.

4. Methods

We sought to measure the level of financial inequality across U.S. higher education institutions and decompose the observed inequality into factor components. Researchers have identified a substantial number of inequality indices, each containing both drawbacks and merits (Cowell, 2011; Hao & Naiman, 2010). For this study, we primarily used the mean log deviation (MLD) to measure inequality. We also examined overall trends using the Gini, Thiel Index, and Atkinson index ($\epsilon = 1$) to demonstrate that the observed trends are not specific to the MLD.

The MLD contains a number of desirable properties. It belongs to the generalized entropy family of inequality indices, and like other members of this family, the MLD is independent of scale and population size and satisfies the strong principle of transfer (Cowell, 2011). An important feature of the MLD for the purposes of this study is its decomposability. Like many other measures, the MLD can be used to decompose total inequality into a portion due to inequality between constituent subgroups and a portion due to inequality within the subgroups. The MLD can also be used to decompose two terms of interest that have a multiplicative relationship, a trait that is rare among inequality indices (Checchi et al., 2016).

This last consideration is important for the purposes of our paper, because we are interested in the relationship between total expenditures and expenditures per student, which can be summarized as:

$$T_i = S_i E_i$$

where $T_i$ represents total expenditures, $S_i$ represents expenditures per student, and $E_i$ represents enrollment. A similar equation can be stated for revenues and revenues per student. This relationship between total expenditures, expenditures per student, and enrollments is identical in structure to the relationship between total earnings, hourly wages, and the number of hours worked. Checchi et al. (2016) decomposed the MLD for this latter set of variables, and we employed a similar approach for our measures of organizational finances.

The decomposition highlights how inequality in total revenues can be expressed as the sum of three components: inequality in expenditures per student, inequality in enrollment, and a component capturing the correlation between expenditures per student and enrollments. This relationship can be described more formally as:

$$I_T = I_S + I_E + \rho$$

where $I_T$, $I_S$, and $I_E$ represent the MLD of total expenditures, the MLD of expenditures per student, and the MLD of enrollments, respectively, and $\rho$ is a term relating to the correlation between per-student expenditures and enrollments. The MLD is defined as the difference between the log of the average of a variable and the average of its log, so the MLD of total expenditures is

$$I_T = \frac{1}{N} \sum_{i=1}^{N} \ln \frac{T_i}{T}$$

Both $I_S$ and $I_E$ are defined similarly.

Checchi et al. (2016) note that the term representing the correlation between expenditures per student and enrollments is defined as

$$\rho = \ln \left( 1 + \frac{T - SE}{SE} \right)$$

The covariance between expenditures per student and enrollments can be shown to be given by the numerator of the second term in the parenthetical of Eq. (4). The sign of the covariance determines the sign of the correlation term.

We can use equations (2) through (4) to better understand factors that relate to the difference between inequality in total expenditures and inequality in expenditures per student.

$$I_T - I_S = I_E + \ln \left( 1 + \frac{T - SE}{SE} \right)$$

If the covariance between expenditures per student and enrollments is positive or equal to zero, then inequality in total expenditures will always be higher than inequality in expenditures per student. If the covariance is negative, then the relationship between total expenditure inequality and expenditure per student inequality will depend upon the magnitude of that correlation term relative to enrollment inequality. For example, when a negative value for the correlation term perfectly offsets the level of enrollment inequality, total expenditure inequality will equal expenditure per student inequality.

Checchi et al. (2016) note that Eq. (2) can be further decomposed into terms capturing between-group inequality and terms capturing within-group inequality. For example, when observations can be divided into J exhaustive groups, inequality in total expenditures, $I_T$, can be decomposed into between-group and within-group components

$$I_T = B_T + W_T$$

Eq. (6) can be further extended to provide details about each component

$$I_T = \sum_{j=1}^{J} p_j \ln \left( \frac{T_j}{E_j} \right) + \sum_{j=1}^{J} p_j I_j$$

(footnote continued)

was around 7% of Fall enrollment during our period of study, so Fall enrollment figures were multiplied by 1.07 to calculate 12-month enrollment when necessary. This replacement procedure was rarely used as less than 0.1% of observations possessed missing or problematic 12-month enrollment data. We identified problematic data using an algorithm that detected large one-year blips in 12-month enrollment data for an individual institution that were not matched by blips in Fall enrollment data.

In a study of higher education expenditures in four states, SHEEO (2010) found that the cost of producing a graduate student credit hour is 2-4 times as expensive as the cost of producing an undergraduate student credit hour. These estimates are similar to earlier studies by James (1978) and To (1987). Available estimates are very imprecise because cost researchers must allocate expenses across levels of study using a number of questionable assumptions due to data limitations. To be conservative, we use the lower end of the estimated range for our adjustment. Another factor driving our choice of weights is that full-time graduate students may enroll in fewer credit hours than full-time undergraduate students.

Hao and Naiman (2011) for a description of available inequality indices, their relative strengths and weaknesses, and their conceptual underpinnings. Hao and Naiman (2011) organize inequality indices into different categories, and we include indicators from each of the three categories with the most desirable properties. The Gini coefficient belongs to the category of indicators that are based on quantile functions and Lorenz curves. The Atkinson index is derived from social welfare functions, and the MLD and the Thiel Index are developed from information theory.
As noted in the data section, we obtained similar trends over time when we used alternative financial measures. Table 1 reports that the MLD of total E&G expenditures rose from 0.905 to 0.978 between 2004 and 2017, while the MLD of per-student E&G expenditures fell from 0.163 to 0.137. When E&R expenditures were used instead of E&G, the MLD of total expenditures again increased (from 0.725 to 0.796) and the MLD of per-student expenditures again declined (from 0.147 to 0.128). When all sources of expenditures were used, we again found an increase in the former (from 0.985 to 1.094) and a decrease in the latter (from 0.202 to 0.175) was again found.

5. Results

In this section, we present and discuss the results of our empirical analyses. We start by focusing on the decomposition of the difference between the MLD of total expenditures and the MLD of expenditures per student. The decomposition is then extended so that differences between and within organizational types can be examined. We conclude our results section by further examining two items highlighted by our results section by further examining two items highlighted by our results section by further examining two items highlighted by our analysis section.

5.1. Describing and decomposing inequality levels

Table 1 reports a range of inequality indices for total revenues, total expenditures, revenues per student, and expenditures per student for the 2004 and 2017 fiscal years. All of the indices reveal major differences between the first two measures and the latter two measures. The level of inequality was much greater for total revenues and total expenditures than for revenues per student and expenditures per student. The trends over time also differed, with inequality increasing for measures of total dollars and falling for measures of dollars per student.

These differences between total dollars and dollars per student were

held for all of our general inequality indices (MLD, Thiel, Atkinson, and Gini). With the exception of the trend in per-student revenues for private institutions, they persisted when analysis was conducted separately for public and private institutions.

Table 2 reports results solely for the MLD but adds findings for all years during the 2004–17 period and for two additional measures: enrollment inequality and the term measuring the correlation between per-student dollars and enrollments. The yearly figures indicate that changes over time in revenue measures were highly erratic while the trends for expenditures were relatively steady. For example, the MLD for total expenditures per student for the full set of institutions only differed by 0.029 (between 0.134 and 0.163) during the entire 14-year period. In contrast, the absolute magnitude of year-to-year changes in the MLD for total revenues per student exceeded 0.029 eleven times, with the largest being a reduction of 0.132 between 2011 and 2012. The fluctuations in revenue were primarily present in the private sector and related to the revenue categories related to investment income and private gifts, grants, and contracts. When these categories were removed from revenue calculations, the year-to-year changes in revenues per student became similar in nature to the corresponding changes in expenditures per student and only differed by 0.037 (between 0.075 and 0.111) during the entire 14-year period. Because revenue measures are volatile, we focus on expenditure trends for the remainder of this paper.

As described in our methods section (see Eq. (5)), one can decompose the difference between inequality in total expenditures and inequality in expenditures per student using the results in Table 2. For the full set of institutions between 2004 and 2017, the average MLD for total expenditures was 0.922 and the average MLD for expenditures per student was 0.148, so the average difference between these two measures was 0.774. This difference between measures was related to both inequality in enrollments and a positive correlation between enrollments and expenditures per student. The average magnitude of the former equaled 0.615 while the average magnitude of the latter equaled

Notes: The data sources are the finance and 12-month enrollment components in IPEDS. Except for several minor restrictions noted in the text, the data represents the full population of non-profit Title IV-eligible institutions with a Carnegie classification of doctoral, master’s, baccalaureate, or associate’s.

where \( p_j \) equals the proportion of observations belonging to group \( j \), \( \bar{Z}_j \) equals the mean expenditures of group \( j \), and \( I_{T} \) equals the level of inequality in total expenditures among members of group \( j \).

Similar decompositions can be performed for \( I_{E} \) and \( I_{P} \) so that Eq. (2) can be extended to

\[
I_{T} = B_{T} + B_{E} + W_{E} + W_{P}
\]

(8)

The terms \( B_{E} \) and \( W_{P} \) are not calculated directly but are instead calculated indirectly from the other components of Eqs. (6) and (8), so that \( B_{E} = B_{T} - B_{E} - B_{E} \) and \( W_{P} = W_{T} - W_{E} - W_{E} \) (Checchi et al., 2016).

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15 As we will note in our upcoming discussion of Table 2, revenue trends were affected heavily by the presence of revenues associated with private gifts and investment income, which fluctuated greatly from year-to-year. When these types of revenues removed, the trends for per-student revenues for private institutions turned negative and no longer differed from the trends observed for other financial measures.

16 Lau and Rosen (2016) also noted these patterns and that they indicate that higher education institutions smooth their spending in a manner that is consistent with the permanent income hypothesis.
The share of the difference that was associated with enrollment inequality dropped from 79% to 70-71% when analyses were conducted separately for the public and private sectors.18

5.2. Extending the decomposition

Table 3 extends the analysis by reporting the portion of each term that is due to differences between institutional types and the portion due to differences within institutional types. This extended decomposition employs eight institutional types, because we examined the intersection of institutional control (public, private) and Carnegie classification (doctoral, master's, baccalaureate, associate’s). The results indicate that a majority of inequality in total expenditures was due to differences between institutional types, while the majority of inequality in expenditures per student was due to differences within institutional type. For example, the between-group MLD for total expenditures was 0.617 in 2017 while the within-group MLD for total expenditures was 0.361, so 63% of total expenditure inequality was due to between-group differences. In contrast, the corresponding figures for expenditures per-student were 0.058 and 0.079, so only 42% of per-student expenditure inequality was due to between-group differences. These patterns are expected because organizational scale, which has a bigger impact on total expenditures than per-student expenditures, varies dramatically across different Carnegie classifications.

One implication of these patterns is that the gap between total expenditure inequality and expenditure per student inequality was greater for between-group measures than for within-group measures. In
2017, this gap equaled 0.559 (0.617–0.058) for between-group measures and 0.282 (0.361–0.079) for within-group measures. The difference between these two gaps related to variation in the term measuring the correlation between expenditures per student and enrollments. The between-group correlation term was positive (0.227), while the within-group correlation term was slightly negative (-0.043).

The differential trends over time for total expenditures and per-student expenditures that we observed for the overall measures in Tables 1 and 2 were mostly present for both the between-group and within-group measures in Table 3. For between-group, total expenditure inequality increased by 0.053 between 2004 and 2017 while per-student expenditure inequality essentially stayed the same, falling by only 0.007. For within-group, total expenditure inequality grew by 0.020 and per-student expenditure inequality fell by 0.020.

Due to these differential trends, the gap between total expenditure inequality and per-student expenditure inequality increased over time.

### Table 3
Two-Way Decomposition of the Mean Logarithmic Deviation of Organizational Expenditures.

|                  | All Institutions |          |          | Public Institutions |          |          | Private Institutions |          |          |
|------------------|------------------|----------|----------|---------------------|----------|----------|---------------------|----------|----------|
|                  | 2004             | 2017     | Chg.     | 2004                | 2017     | Chg.     | 2004                | 2017     | Chg.     |
| MLD Between - Total | 0.564           | 0.617    | 0.053    | 0.522               | 0.578    | 0.056    | 0.602               | 0.669    | 0.067    |
| MLD Between - Total/Enr. | 0.065           | 0.058    | -0.007   | 0.035               | 0.030    | -0.005   | 0.049               | 0.048    | -0.001   |
| MLD Between - Enrollment | 0.314           | 0.322    | 0.009    | 0.213               | 0.256    | 0.043    | 0.298               | 0.337    | 0.038    |
| MLD Between - Correlation | 0.185           | 0.227    | 0.042    | 0.275               | 0.291    | 0.017    | 0.255               | 0.284    | 0.029    |
| MLD Within - Total | 0.342           | 0.361    | 0.020    | 0.320               | 0.338    | 0.018    | 0.373               | 0.397    | 0.024    |
| MLD Within - Total/Enr. | 0.098           | 0.079    | -0.020   | 0.081               | 0.051    | -0.030   | 0.124               | 0.121    | -0.003   |
| MLD Within - Enrollment | 0.289           | 0.326    | 0.036    | 0.310               | 0.345    | 0.036    | 0.259               | 0.295    | 0.036    |
| MLD Within - Correlation | -0.046          | -0.043   | 0.003    | -0.070              | -0.058   | 0.012    | -0.009              | -0.019   | -0.010   |
| n                | 2,397            | 2,384    |          | 1,434               | 1,452    |          | 963                | 932      |          |

Notes: For each of the four terms, “MLD Between” represents the portion of the MLD that is attributable to differences between institutional types, as categorized by the intersection of institutional control and Carnegie Classification. “MLD Within” represents the portion of the MLD that is attributable to differences within institutional types. See the notes from Tables 1 and 2 for further information.
for both the between-group and within-group figures. For between-
group figures, the growing gap was associated with a slight increase in
enrollment inequality of 0.018 and an increase in the correlation term
for both the between-group and within-group figures. For between-
See the notes from Tables 1 and 2 for further information.

The specific findings for Table 3 discussed to this point relate to
analyses conducted for the full set of institutions. Table 3 also contains
results from separate analyses of the public and private sectors, and in
general, the patterns observed for the full set of institutions were mostly
present in each sector. To examine whether results vary by the inter-
section of institutional control and Carnegie classification, we turn now
to Table 4, which provides inequality figures for the six Carnegie-control
categories with large numbers of institutions.

Private doctoral universities possessed the highest levels of in-
equality. For these schools, the MLD in 2017 was 0.853 for total ex-
penditures and 0.322 for expenditures per student. Both of these figures
were more than twice as large as the corresponding figures for each of
the other institutional types. Private doctoral universities were also
atypical in regards to the correlation term between enrollments and
enrollments per student, which equaled 0.210 in 2017.

Public doctoral universities comprised the only other set of in-
stitutions that contained a positive correlation term, but the magnitude of
the correlation term (0.081) was much smaller. Despite the positive
correlation term and the third highest level of per-student expenditure
inequality, the MLD for total expenditures for public doctoral
universities was similar to others due to the low level of enrollment
inequality. Private baccalaureate colleges were akin to doctoral uni-
versities in that they possessed relatively high levels of per-student
expenditure inequality and a correlation term that was not mean-
fully negative.21 In contrast, public associate’s, public master’s, and
private master’s institutions had negative correlation terms and the
smallest levels of per-student expenditure inequality. Public associate’s
colleges still possessed fairly high levels of total expenditure inequality,
because these schools experienced high levels of enrollment in-
equality.22

In terms of changes over time, the results in Table 4 reveal some
variation across institutional types. The within-group increase in total
expenditure inequality was primarily driven by increased inequality
among private doctoral universities and private master’s institutions,
while the within-group decrease in per-student expenditure inequality
was primarily present among public doctoral universities and public
associate’s colleges. Each institutional type experienced a small or
moderate increase in enrollment inequality. In contrast, the trends as-
sociated with the correlation term were much more variable, with large
increases for public and private doctoral universities and small declines
for public master’s institutions and private baccalaureate colleges.

5.3. Rising enrollment inequality

For our period of study, the trends for total expenditure inequality
and expenditure per student inequality differed. Our decomposition
results highlight how these differing trends are related to rising en-
rollment inequality. In general, we should expect enrollment shifts to
have differing effects on total expenditures and expenditures per stu-
dent. Enrollment gains would generally lead to increased total ex-
penditures, because additional students bring additional net tuition
revenue and additional funding from entities, such as state govern-
ments, that relate funding levels to enrollment levels. Enrollment de-
clines would generally lead to decreased total expenditures for similar
reasons.

The effect of enrollment shifts on expenditures per student would
likely be different. Although institutional revenues increase with en-
rollment, they are unlikely to increase proportionally. Some revenue
sources, such as investment income, have little relationship to enroll-
ment levels. Other revenue sources, such as state appropriations, will
generally increase with enrollments but not by commensurate amounts.
So, revenues per student, and by extension expenditures per student,
will typically fall for individual institutions as their enrollments rise.
Similarly, enrollment declines will generally lead to increases in ex-
penditures per student.

These relationships are present in our data set. An institution’s
change in enrollment between 2004 and 2017 has a strong positive
relationship with its corresponding change in total expenditures and
a strong negative relationship with its corresponding change in ex-
penditures per student.21 To illustrate these relationships in a way that

| Public Doctoral | Private Doctoral |
|-----------------|------------------|
| 0.336 0.360 0.025 | 0.767 0.853 0.086 |
| 0.120 0.099 -0.031 | 0.527 0.522 -0.004 |
| 0.173 0.190 0.017 | 0.284 0.320 0.036 |
| 0.042 0.081 0.038 | 0.157 0.210 0.053 |
| 190 190 | 117 116 |

| Public Masters | Private Master’s |
|-----------------|------------------|
| 0.198 0.205 0.007 | 0.268 0.305 0.037 |
| 0.050 0.057 0.007 | 0.070 0.059 -0.012 |
| 0.194 0.209 0.015 | 0.269 0.315 0.045 |
| -0.046 -0.061 -0.014 | -0.071 -0.068 0.004 |
| 260 259 | 395 391 |

| Public Associate’s | Private Baccalaureate |
|-------------------|-----------------------|
| 0.366 0.382 0.016 | 0.355 0.360 0.005 |
| 0.080 0.040 -0.040 | 0.113 0.123 0.010 |
| 0.378 0.420 0.042 | 0.243 0.254 0.010 |
| -0.092 -0.077 -0.015 | -0.001 -0.017 -0.015 |
| 890 912 | 419 399 |

Notes: Results were estimated separately for each of the six listed institutional
types. See the notes from Tables 1 and 2 for further information.
The analyses by Bound and Turner (2007) do not provide direct insights into the effect of institutional enrollments and expenditures per student on the experiences and outcomes of college students. Bound and Turner (2007) examined this question at the state level and found that cohort size (i.e. the number of state citizens that are 18) is negatively related to college attainment. The available evidence suggests that this link may be even more pronounced when per-student expenditure reductions lead to lower levels of attainment. The available evidence suggests that this link may be even more pronounced when per-student expenditure reductions lead to lower levels of attainment. The available evidence suggests that this link may be even more pronounced when per-student expenditure reductions lead to lower levels of attainment. The available evidence suggests that this link may be even more pronounced when per-student expenditure reductions lead to lower levels of attainment. The available evidence suggests that this link may be even more pronounced when per-student expenditure reductions lead to lower levels of attainment.

From this perspective, one might conclude that student experiences improved between 2010 and 2017 at Lincoln, Mansfield, and other PASSHE universities experiencing enrollment declines, due to increases in expenditures per student. Students at these schools may increasingly experience smaller class sizes and greater opportunities to engage faculty and staff members directly. Yet, enrollment declines can also have negative impacts on the student experience, as they may harm campus morale and limit the ability of the institution to provide items that carry high fixed costs. The net effect of these considerations on student outcomes could vary by the institution's initial level of enrollment and the size of the enrollment decline.

Public finance economists and policymakers will be interested in the state funding questions raised by enrollment divergence. The president of West Chester, the PASSHE university experiencing the largest enrollment gains, recently highlighted conflicting goals of state policymakers that shape how they respond to varying enrollment trends (Fiorentino, 2020). State policymakers wish to expand college attainment and success, which would call for increasing (decreasing) funding for institutions with growing (declining) enrollments. But state policymakers also wish to ensure that no existing public college or university fails, as they fear the employment and economic impact of such an outcome. This latter concern might limit the extent to which state appropriations are redistributed in response to enrollment changes. These tensions will likely increase in the years ahead as states and higher education institutions navigate the lingering financial challenges associated with the COVID-19 pandemic and the expected decrease in the number of traditionally-aged college students stemming from low birth rates during the Great Recession (Grawe, 2018).

5.4. The correlation between enrollments and expenditures per student

Although an institution's expenditures per-student will typically rise as its enrollment declines, this does not mean that a similar relationship will be present when between-institution comparisons are made. Instead, institutions with above-average enrollments may also generally have above-average expenditures per student. Our decomposition indicated a positive between-institution correlation between enrollments and expenditures per student.

24 The analyses by Bound and Turner (2007) do not provide direct insights into the institution-level relationship between enrollments and expenditures per student. They examined the effect of cohort size rather than actual enrollments, so part of their observed effect could be due to students in a large cohort who never enroll. The enrollment shifts that are related to cohort size have impacts that move beyond within-institution changes in enrollments and expenditures per student. Bound and Turner (2007) found that rising cohort size leads to a shift in enrollments across institutional types, with students increasingly attending institutional types (e.g. two-year institutions) that spend less per student.

Fig. 2. Correlation between Enrollment Change & Expenditure Change, PASSHE universities (2010-2017). Note: Data are reported for all fourteen universities in the Pennsylvania State System of Higher Education System.
and expenditures per student. In this section, we examine how research activity and variation in institutional wealth and prestige both contribute to this relationship.

Research activity is worthy of consideration because Table 3 showed that differences across institutional types were driving the overall positive correlation between enrollments and expenditures per student. Furthermore, Table 4 revealed that the correlation between enrollments and expenditures per student is strongly positive for public and private research universities but not for other institutional types. Research activity could be partially or fully driving these results because our measure of expenditures—education and general expenditures—including research expenditures. In 2017, the Pearson correlation between research expenditures per student and enrollment was 0.343, which is very different than the 0.012 correlation between instructional expenditures per student and enrollment. The positive correlation for research expenditures was driven by differences between institutional types as research universities spent more on research and had larger enrollments. The positive correlation was also driven by differences within institutional types, as the Pearson correlation in 2017 was 0.357 for public doctoral universities and 0.233 for private doctoral universities.

To illustrate the degree to which research expenditures were driving the differences across institutional types highlighted in Table 4, we also calculated figures using education and related (E&R) expenditures, which do not include expenditures relating to research and public service. When this narrower measure of expenditures was used, the differences between doctoral universities and other types of higher education institutions were diminished. For 2017, the total expenditure MLD declined from 0.360 to 0.290 for public doctoral universities and from 0.853 to 0.679 for private doctoral universities. Per-student expenditure MLD declined from 0.089 to 0.060 for public doctoral universities and from 0.322 to 0.195 for private doctoral universities. The correlation term similarly declined from 0.081 to 0.040 for public doctoral universities and from 0.210 to 0.164 for private doctoral universities. In contrast, the figures for other institutional types were not meaningfully changed when E&R expenditures were used.

Thus, the positive correlation terms for doctoral universities observed in Table 4 are partially due to a positive relationship between enrollments and research expenditures per student. This relationship could relate to the joint production of instruction and research within U.S. universities. Perhaps U.S. research universities can only sustain large research capacity when they also enroll large numbers of students. High enrollments help universities maintain large numbers of faculty in a wide variety of fields, and this breadth and depth of faculty expertise may help a university attract substantial sums of research funding. An empirical test of this possibility would be a complicated and challenging task that would constitute a separate paper.

The results for doctoral universities remained very different from those observed for other institutional types even after the removal of research and service expenditures, so other factors were also driving differences by institutional type. Winston (1999) points to one potential explanation: institutional prestige and wealth are closely linked and lead to large differences in expenditures per student across higher education institutions. The top 10-20% of higher education institutions in the U.S. spend much more per student than other institutions, and the spending inequality even among the institutions located in the top two deciles is great (Winston, 1999).

The most prestigious and wealthy institutions are almost exclusively public doctoral universities, private doctoral universities, or private baccalaureate colleges.25 The distribution of endowments and private donations across colleges and universities is highly skewed, and these elite institutions capture a large share of endowments and gifts (Cheslock & Giannesschi, 2008; Milton & Ehrenberg, 2013). During our period of study (2004-2017), schools that are ranked among the top 25 national universities or the top 25 national colleges received 47% of the total private income26 generated by our population of institutions despite comprising only 2% of institutions and capturing 4% of enrollments. For those institutional types that contained these schools, the presence of elite institutions led to substantial inequalities in private income. The MLD of per-student private income in 2017 was 0.540 for public doctoral universities, 1.084 for private doctoral universities, and 0.765 for private baccalaureate colleges. The large sums of private income at elite institutions allowed them to simultaneously spend more per student and maintain larger enrollments than their counterparts of the same institutional type.27 Even though they spread their resources more thinly due to higher enrollments, elite institutions were still able to spend more per student due to their wealth advantage.

For both public and private doctoral universities, the relationship between enrollments and expenditures per student at these institutional types is no longer positive when controls for institutional wealth or prestige are added. Table 5 contains log-log regressions (with no control variables) that reveal similar relationships as the correlation terms from Table 4. The first and third columns of regression results again demonstrate that expenditures per student and enrollments are positively correlated for public and private doctoral universities and close to zero for private baccalaureate colleges. The second column of results reveals that that this relationship becomes very close to zero once per-student private income is included as a control variable. The final column of results shows that a similar pattern is present when the U.S. News peer assessment measure is instead included as a control variable.28 The results for the last regression are a bit more striking in that the relationship between expenditures per student and enrollments becomes negative. As a whole, the results in Table 5 indicate that variation in institutional wealth and prestige is closely intertwined with the positive correlation between per-student expenditures and enrollment.

6. Conclusion

We examined financial inequality across the full-population of non-profit Title IV eligible U.S. higher education institutions with a Carnegie classification of doctoral, master's, baccalaureate, or associate's. We

(footnote continued)

universities, or private baccalaureate colleges.

25 The U.S. News rankings of best national universities and best national colleges are a commonly used proxy for institutional prestige. For our set of institutions in 2017, all of the institutions that were in the top 25 of these two rankings were classified as private doctoral universities, public doctoral

26 Private income is the sum of investment income and private gifts, grants, and contracts. To calculate this for public institutions, we sum values from the following three IPEDS revenue categories: private gifts, investment income, and private operating grants and contracts. For private institutions, we use data from the following three categories: investment returns, contributions from affiliated entities, and private gifts, grants, and contracts.

27 In 2017, private doctoral universities in the top 25 had mean expenditures per student of $97,966 and mean enrollments of 25,099. The corresponding figures for private doctoral universities outside of the top 25 were $24,061 and 13,404. Among private baccalaureate colleges, the means were $63,772 and 2,339 for top 25 colleges and $24,779 and 1,604 for colleges outside of the top 25. Among public doctoral universities, the figures were $56,016 and 48,652 for top 25 universities and $25,331 and 28,287 for universities outside of the top 25.

28 Peer assessment scores are included in the formula used to determine U.S. News rankings. These scores are based on ratings for each higher education institution provided by presidents, provosts, and deans of admissions. Ratings are based on a scale of 1 (marginal) to 5 (distinguished). We use U.S. News peer assessment scores rather than U.S. News rankings because these scores provide a direct measure of prestige and the formula for rankings includes some measures of expenditures. The regressions in the last two columns of Table 5 are based on a slightly smaller data set because U.S. News did not report scores for some institutions.
conclude here by highlighting four key findings from our work and discussing their implications for future research. Our first finding of note is that inequality levels for total expenditures increased between 2004 and 2017 but fell for expenditures per student during the same period. These opposing trends prompt questions about the proper measure to use when examining financial inequality across higher education institutions.

Lau and Rosen (2016) noted that neither total expenditures nor per-student expenditures are ideal measures of the resources available at a specific college or university. If higher education institutions are providing a pure public good (that is non-rival in consumption), then a measure based on total expenditures is ideal. In contrast, a measure based on expenditures per student is ideal if these institutions are providing a pure private good (that is rival in consumption). Because the mix of goods and services provided by higher education institutions presumably falls somewhere between these two extremes, measures based on total expenditures and measures based on per-student expenditures will bracket the ideal measure (Lau & Rosen, 2016). When studying organizational finances, however, researchers often only examine one measure, which is typically the per-student measure.

Our second finding of note highlights how the differences in inequality patterns between the total expenditure measure and the per-student expenditure measure related to enrollment levels. Our decomposition results indicate that these differences were driven by growing inequality in enrollments across higher education institutions as well as an increasingly positive correlation between enrollments and expenditures per student. The logic underlying the decomposition implies that the future trends for these two measures will be affected by future changes to the distribution of enrollments across higher education insti-

Recent analyses by Grawe (2018) suggest that the distribution of enrollments will substantially change in the upcoming decades. The college-aged populations in most Northeast and Midwestern states will substantially decline, while the same populations in Mountain, Western North Central, and South Atlantic states will increase. Grawe's analyses also suggest that enrollment trends will vary by institutions' rankings in the U.S. News and World Report. As lower-ranked institutions in the Midwest and Northeast experience enrollment declines during the upcoming decades, their total expenditures will likely decrease dramatically but their per-student expenditures may not fall given that some revenue sources do not decline commensurately with enrollments. So, the use of multiple measures of organizational revenues and expenditures will become even more vital in the future.

Our third finding relates to our decomposition of inequality figures into the portions associated with between-group variation and the portions associated with within-group variation. Both components contributed to most of our general findings, especially those pertaining to changes over time. For example, the growth in total expenditure inequality, the decline in per-student expenditure inequality, and the growth in enrollment inequality were present in the results for both between-group and within-group variation. Findings relating to a point in time were more likely to vary across these two sources of variation. For example, the between-group correlation term for enrollments and per-student expenditures was positive while the corresponding within-group correlation term was negative. Previous research did not separately examine within-group inequality as it either examined inequality in general (Davies & Zarifa, 2012; Lau & Rosen, 2016) or examined between-group inequality by comparing means for different organizational groupings (Desrochers & Wellman, 2011).

Further analyses of within-group differences produced our fourth finding of note: inequality patterns vary across institutional control and Carnegie classification categories. We observed the greatest inequality in expenditures among institutional types that rely more upon private sources of funding. The private sector had greater levels of inequality than the public sector, and within-sector, inequality was higher for those Carnegie classifications that contain institutions with high levels of private income. Future research could further investigate how organizational financial inequality is shaped by the larger funding environment, which includes governmental policies that distribute public sources of funding to higher education institutions.

We found especially interesting variation in the correlation term between enrollments and expenditures per student, as this relationship was positive for private and public doctoral universities and negative for private and public master's institutions and public associate's colleges. In our results section, we discussed how these differences relate to research activity as well as institutional wealth and prestige. Future research could examine these relationships in greater depth. In this and other areas, this paper is not the last word on organizational financial inequality. We hope that the insights into this topic that we have provided can be built upon in the future.

CRediT authorship contribution statement

**John J. Cheslock:** Conceptualization, Methodology, Validation, Formal analysis, Writing - original draft, Writing - review & editing, Visualization. **Yahya Shamekhi:** Methodology, Software, Validation, Formal analysis, Data curation, Visualization.

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