

# Current cost per student and academic performance in Brazilian federal universities

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## Abstract

**Objective:** To identify the relationship between the level of current cost per student in federal universities and undergraduate students' academic performance.

**Method:** The sample comprises data from 62 federal Higher Education Institutions (HEIs) from 2010 to 2019, comprising 428,175 students. Multiple regression with panel data was used. The score obtained in the Enade was adopted as a proxy for the student's academic performance and the HEIs' expenditures were measured through current cost without University Hospital (UH).

**Results:** No statistically significant relationship was found between current cost per student and academic performance. However, the following sociodemographic variables appear related to student performance: race, sex, age, marital status, maternal education, and income.

**Contributions:** This study is expected to contribute to the development of public education policies implemented by the Federal Government. Additionally, based on data available, HEIs can identify alternatives to establish policies and decision-making to balance efficiency and efficacy. We consider this study's contribution as no significant relationship was found between current cost and performance. Nonetheless, this study is expected to contribute to society as a means of social control of the level of costs among public HEIs.

**Keywords:** University spending, Academic performance, Federal public universities.

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## 1. Introduction

Investment in human assets is paramount for a country's economy. Among the aspects to be invested in human assets is formal education; the higher an individual's education, the more one contributes to economic performance (Schultz, 1960). Such contribution may occur through increased individual productivity or greater chances for individuals to ascend socially (Lins, 2013).

Regarding the Brazilian educational context, Law No. 9,394/96, known as *Lei das Diretrizes e Bases da Educação Nacional* [Law of Guidelines and Bases of National Education], provides in Art. 21 that school education is composed of early childhood education, primary education (including middle school), high school, and higher education. In the last decades, the latter has expanded and gained prominence. According to the 2017 Higher Education Census, conducted by the National Institute of Educational Studies and Research Anísio Teixeira (Inep), private higher education institutions grew 53.1% between 2007 and 2017, while public higher education grew 41.7% in the same period.

Higher education is intended to: i) promote development and scientific studies; ii) train individuals and grant degrees in the most diverse fields; iii) encourage scientific research and investigation; iv) promote the dissemination of knowledge; and v) awaken a desire for constant improvement (Law No. 9,394/96, Art. 43). However, for all these goals to be achieved, the government needs to invest resources in public universities.

One way to determine whether resources invested in universities were efficiently implemented is to analyze students' academic performance. Previous studies discuss the impact of resources on education, especially in primary education. However, this topic is seldom explored among higher education institutions, while results diverge, considering that the relationship between institutional expenditure and student performance is complex (Pike, Smart, Kuh & Hayek, 2006; Dahlvig, Dahlvig & Chatriand, 2020).

According to Hedges, Laine, and Greenwald (1994), universities' expenditure was ignored by the literature as a factor determining students' academic performance. Currently, international studies include the level of resources available for universities as an explanatory variable for student performance (Pike *et al.*, 2006; Webber & Ehrenberg, 2010; Pike, Kuh, McCormick, Ethington & Smart, 2011; Powell, Gilleland & Pearson, 2012; Rutherford & Rabovsky, 2014; Hong & Zimmer, 2016; Dahlvig *et al.*, 2020).

There is not a consensus in the Brazilian context regarding a direct relationship between educational expenditure and academic performance in higher education. However, there is an indirect positive relationship between the quality of an institution's infrastructure and student performance, considering that the resources invested in a university are essential to improve its physical capital (Barbosa, Freire & , 2011; Ferreira, 2015; Lemos & Miranda, 2015).

In this sense, considering the scarcity of resources available to federal universities and the need of these institutions to fulfill their educational goals, this study aimed to identify the relationship between current cost per student in federal universities and undergraduate student performance.

A university is a social institution and, therefore, expresses the structure and way of functioning of the society as a whole (Chauí, 2003). Hence, this study is justified because it addresses the resources applied in teaching institutions and their reflexes on academic performance and society by verifying whether institutions with higher levels of resources effectively present higher performance. According to Dahlvig *et al.* (2020), institutional choices concerning the investment of resources are correlated to undergraduate students' success and persistence. Additionally, studies analyzing the relationship between how universities spend their resources and how these impact students' trajectory reveal this is a relevant topic considering these institutions' responsibility (Dahlvig *et al.*, 2020). Therefore, this study's relevance lies in investigating whether federal universities correctly manage their resources to promote student academic performance.

This study's results are expected to contribute to the development of public education policies on the part of the Federal Government, considering that great effort is expected from these institutions to manage increased resources properly. Additionally, public higher education institutions themselves can identify ways to establish policies and decision-making intended to balance efficiency and efficacy, according to the amount of resources available (Dahlvig *et al.*, 2020). Additionally, this study is expected to contribute to society as a means to control and supervise Brazilian public higher education institutions' level of expenditure.

## 2. Literature Review

### 2.1 Academic performance and higher education institutions' expenditure

Academic performance can be defined as an assessment of students' performance and development; that is, it is an analysis method that enables appraising how well students achieve academic goals (Braga & Franco, 2004).

In Brazil, measures such as the institution's **Índice Geral de Cursos Avaliados (IGC) [General Index of Courses]** and **Taxa de Sucesso na Graduação (TSG) [Undergraduate Success Rate]**, both at an institutional level or yet, the **Conceito Preliminar de Curso (CPC) [Preliminary Program Concept]** **at the level of specific programs, are intended to assess the quality of higher teaching institutions** (INEP, 2020). Another measure of student performance and institutional performance is the *Exame Nacional de Desempenho dos Estudantes (Enade)* [National Student Performance Exam].

At the national level, the *Sistema Nacional de Avaliação da Educação Superior (Sinaes)* [National Higher Education Assessment System] is intended to assess the quality of education. It annually implements the Enade to assess students according to their respective programs' curricular guidelines (Law No. 10.861/2004). Enade is intended to measure different fields of knowledge by performing triennial evaluations. This examination's objective is to assess specific knowledge regarding the programs' fields, as well as knowledge from other general training fields. The exam includes a questionnaire asking students about their impressions regarding the test, student profile, and a questionnaire directed to the programs' coordinator, intending to assess, among other aspects, whether the program is aligned to its pedagogical project (Law No. 10.861/2004).

Student performance accrues from various aspects directly or indirectly linked to the students' characteristics. The primary aspects influencing student performance include: i) aspects related to the students' individual characteristics such as intelligence, skills, and competence; ii) sociodemographic factors such as age, sex, family income, and whether previous education was obtained from public or private institutions; iii) aspects linked to the university's infrastructure like the quality of the library's collection, and access to the Internet; iv) aspects concerning the quality of teaching such as the faculty members' academic qualification, updated knowledge, and different teaching techniques (Magalhães & Andrade, 2006; Araújo, Camargos, Camargos & Dias, 2013; Miranda, Lemos, Pimenta & Ferreira, 2015).

For a university to maintain an appropriate infrastructure and a qualified faculty body over the years, higher levels of public expenditure with higher education are required. A lack of this increase may result in universities' inferior overall performance and an excessive number of students per classroom. Additionally, students' poor performance also impacts the continuity of programs, possibly leading students to drop out of the program or delay studies, resulting in a feeling of frustration (Fagundes, Luce & Espinar, 2014).

The Brazilian Higher Education Census (INEP, 2017) shows that the offering of graduate programs among federal public universities by 7% from 2014 to 2016. Such a fact highlights the importance of investing in these institutions to maintain the number and quality of programs and student performance.

Data regarding the level of expenditure of Brazilian public universities presented by the World Bank (2017) indicate that students from public universities cost two to three times more than students in private universities. Data provided by the “*Revisão das Despesas Públicas*” [Public Expenditure Review] report shows that from 2013 to 2015, the annual average cost per student in profit and non-profit private universities was approximately R\$12,600 and R\$14,850, respectively. This report also shows an average of R\$40,900 among federal universities. This cost among state universities was R\$32,200, while the cost per student in federal institutes was approximately R\$27,850. The report also indicates a possibility of limiting the cost per student at the level of expenditure of the most efficient Brazilian universities (Banco Mundial, 2017).

However, public higher education institutions may have expenses that do not apply to private institutions, such as inactive personnel or university hospitals, among others. Additionally, public universities implement research activities, an expense most private universities do not have. According to Moura (2019), more than 95% of the Brazilian scientific production in international centers is performed by public universities. Hence, comparing cost per student within the same group of institutions seems more coherent.

HEIs include several processes that use different resources to fulfill their purposes. These resources are used with material for use and consumption, infrastructure, and labor costs, resulting in knowledge in professional training and scientific and technological production (Reis & Reis, 2013). Therefore, to fulfill its purpose, a higher education institution needs an organizational structure, investments, and maintenance aligned to good resource management to ensure its sustainably and attain academic, economic, and social goals (Reis & Reis, 2013).

Additionally, the resources of public higher education institutions are financed by society through taxes. Hence, the managers of HEIs have the responsibility to allocate resources efficiently and efficaciously to maintain these institutions functioning and fulfilling their commitment to academic and social development (Chiau & Panucci-Filho, 2014).

## 2.2 Previous studies relate student performance and educational expenditure

Empirical studies seek to investigate the relationship between academic performance and educational expenditure. Pike and Robbins (2019) note that various studies report factors that may be related to student performance such as sex, race, socioeconomic status, high school grades, type of institution (public or private), academic and social engagement, and whether students have a paid job during the undergraduate program. The authors also suggest that the program’s duration, the institutions’ size (number of students), and whether there is also a Master’s or doctoral program may also influence student performance. The studies that stand out in Brazil are listed below.

Barbosa *et al.* (2011) analyzed potential relationships between management indicators and student performance and verified that cost per student, the classification of graduate programs, and an index of the faculty members’ qualifications positively influence student performance. However, the authors found that a higher proportion of professors and employees to the number of students does not influence student performance.

Ferreira (2015) identified significant variables explaining the results obtained by Accounting Sciences students in the Enade 2012. The author indicated that mostly the students’ characteristics and attitudes determined student performance, and only approximately 10% depended on institutional variables (faculty members and HEI). She also highlights that this may be related to the fact that public institutions perform better in the Enade not merely because of its institutional conditions but mainly because of the profiles of the students entering a public HEI.

Lemos and Miranda (2015) identified which variables influenced student performance based on the Enade issues from 2009 and 2012 of the Accounting Sciences program. The authors highlight that the central aspect in which higher education institutions should invest to obtain better results are: qualification of the faculty body (degree and pedagogical training), infrastructure, and increasing the number of full-time professors.

Rocha and Fontal (2019) assessed the relationships between school costs, the organization of school supply, and the performance of public schools by using the *Exame Nacional do Ensino Médio (Enem)* [National High School Exam]. The authors report a significant oscillation between the units' school costs, with unequal distribution of financial resources. However, school costs provide little explanation to the results obtained by schools in the Enem, indicating signs that a greater amount of resources does not necessarily translate into better results in terms of school performance.

In the international context, Pike *et al.* (2011) emphasize the importance of higher education institutions' accountability in the efficient use of resources to promote the results in terms of student performance. The study addressed data from 171 public higher education institutions in the United States and verified a relationship between education expenditure, student engagement and performance. The results revealed that the level of expenditure was moderately related to students' learning. However, this relationship presented a higher effect among first-year students and a more modest effect among senior students.

Rutherford and Rabovsky (2014) sought to analyze the efficacy of educational policies as a mechanism to improve undergraduate persistence and success in more than 500 American higher education institutions throughout 18 years. The results revealed a negative relationship between the students' race (Afro-American and Hispanic) and student performance.

Hong and Zimmer (2016) assessed the impact of infrastructure expenditure on student performance from 1996 to 2009 among schools located in Michigan, United States, and found that infrastructure expenditure levels influenced student performance. However, the effect is not perceived in the short term; at least four years are needed to observe it.

Pike and Robins (2019) investigated the effect of institutional characteristics, students' characteristics, and institutional expenditure on graduation rates in 326 American higher education institutions from 2002 and 2006. The authors found a positive relationship between expenditure with teaching and the percentage of female students graduating in these institutions. The authors also found a negative relationship between the percentage of Afro-American students and graduation rates.

Dahlvig *et al.* (2020) examined correlations between the expenditure of 135 American higher education institutions and student retention and graduation rates. The results showed that expenditure with the faculty body, with supporting activities (laboratory maintenance, library, and administrative expenditure), and research, were highly correlated to graduation rates.

Note, however, that there is not a consensus in neither the Brazilian or international literature regarding the role of expenditure on undergraduate student performance. Therefore, this study aimed to contribute to the discussion on the topic, presenting new evidence regarding the relationship between current cost per student and student performance. Thus, given the discussion above considering previous studies, the following hypothesis is proposed:

H1: Public universities with higher current costs per student tend to perform better in the Enade.



Even though the studies indicate that social factors tend to influence student performance more strongly, this hypothesis is expected to be confirmed due to the importance of investing resources in maintaining a university's activities to achieve higher levels of student performance.

### 3. Methodology

According to this study's objective, it classifies as a descriptive study. Regarding the procedures used, this study classifies as documentary research (Martins & Theóphilo, 2009), considering that secondary data were used. Also, a quantitative approach was adopted, and statistical methods were used to develop the econometric models.

Considering that various factors influence student performance, an exact measure can hardly be established. For this reason, a proxy is needed for analysis (Miranda *et al.*, 2015). Therefore, the scores obtained by students in the Enade were used here to measure student performance, and the responses provided to the questionnaire were used to characterize the sociodemographic profile of students from Brazilian federal universities.

The sample was composed of the annual data of 62 Brazilian federal universities from 2010 and 2019. Data concerning the students' performance and sociodemographic profile are provided by the Enade reports available on the Inep website. Data were treated using Excel. Students who did not take the test, did not obtain a valid result, did not answer the sociodemographic questionnaire or obtained a grade equal to zero were excluded from the sample. Hence, data represent the responses of 428,175 students who took the test in the period of analysis. Data concerning current costs (without a UH) per equivalent student were collected from the HEIs' annual reports available at the Federal Court of Accounts (TCU) website. Due to the effect of inflation in annual current costs, the variable current costs without UH were deflated according to the *Índice Nacional de Preços ao Consumidor Amplo (IPCA)* [Broad National Consumer Price Index]. This index was chosen because it comprises a more significant portion of the population, showing variation on the average living costs of families with a monthly income from 1 to 40 times minimum wage (IBGE, 2020). IPCA related data were collected from the IBGE website.

Data analysis included descriptive statistics to verify the mean, standard deviation, and coefficient of correlation of undergraduate student performance, and mainly of the resources invested in federal public universities to analyze whether there is considerable discrepancy among Brazilian universities' expenditures.

The standard index technique was used to verify the level of resources used by HEIs and the performance obtained in the Enade to compare the results of a given institution with the others' standards, verifying whether the institution is above, at the same, or below the standards of the category to which it belongs (Matarazzo, 2008). The quartiles for student performance were divided into 1<sup>st</sup> quartile: unsatisfactory; 2<sup>nd</sup> quartile: regular; 3<sup>rd</sup> quartile: good; and 4<sup>th</sup> quartile: excellent. The quartiles for the variable current cost without UH per equivalent student were distributed as 1<sup>st</sup> quartile: very low; 2<sup>nd</sup> quartile: low; 3<sup>rd</sup> quartile: moderate; and 4<sup>th</sup> quartile: high.

Finally, multiple regression analysis with panel data was performed to verify the impact of the universities' expenditures on the students' academic performance. Additionally, control variables that characterize the sociodemographic profile of senior students from federal universities who took the Enade in the period under analysis were considered. The variables employed in the model, as well as respective proxies, are described in Figure 1. The model was estimated using STATA.

Groups	Variables	Proxies
1. University performance at ENADE	Dependent Variable (ENADE)	Simple mean scores obtaining by graduating students in the ENADE
2. Current cost without university hospital per student	Current cost (COSTS)	Current cost without university hospital (deflated according to the IPCA) divided by the number of equivalent students.
	Age (AGE)	The average age of students (in years) when they took the ENADE
	Students' sex (SEXFEM)	Percentage of female students graduating from college.
	Marital Status (SINGLE)	Percentage of students reporting being single out of the institution's total number of students who took the ENADE
	Students according to race (RACE)	Percentage of race of the university's total number of students who took the ENADE.
3. Control variables	Maternal education/high school (HIGHSCHOOL) Maternal education/college degree (COLLEGE)	The proportion of graduating students allocated according to the following maternal educational levels: complete high school, but did not finish college (HIGHSCHOOL); college degree (COLLEGE).
	Students' family income (INCOMEUP1.5)	The proportion of students graduating from college with a family income classified according to the following: Up to 1.5 times the minimum wage (MW) (INCOMEUP1.5); from 1.5 to 3 times the MW (INCOME1.5TO3); from 3 to 4.5 times the MW (INCOME3TO4.5); from 4.5 to 6 times the MW (RENDA4.5TO6)
	Students' family income (INCOME1.5TO3)	
	Students' family income (INCOME3TO4.5)	
	Students' family income	

**Figure 1.** Description of the variables used in the regression models

Source: adapted from Rocha and Funchal (2019).

According to Pike *et al.* (2011), regarding university expenditure at the institutional level, many attributes, such as educational expenses, are positively related to student engagement and learning. Additionally, Hong and Zimmer (2016) highlight that teaching institutions with higher costs can provide safer, cleaner, more spacious, and well-lit facilities, which favor concentration and promote greater commitment and disposition among students and professors. The authors also mention that professors value institutions with better facilities so that these institutions would hire the best professors, which in turn, contribute to student performance. Hence, an institution's total cost is expected to be positively correlated with student performance.

Note that current costs without UH per student are used as a proxy for resources spent in the university (Figure 2). The explanation is that this indicator considers current expenses (maintenance and functioning) of all managing units, representing the volume of financial resources applied in federal universities to generate teaching, research, and extension activities. Therefore, capital expenditures were not considered, as these generate benefits in the long term, impacting future students' performance.

**CURRENT COSTS WITHOUT UH (UNIVERSITY HOSPITAL)**

- (+) University's current costs within all management units, including university hospitals, if any
- (-) 100% of total current expenses of university hospital(s) and maternity hospital(s)
- (-) Retirements and Reforms of the University
- (-) University's pensions
- (-) University's legal actions
- (-) Expenses with assigned staff–University's faculty members
- (-) Expenses with assigned staff– University's technical-administrative staff
- (-) Expenses with professors on leave (e.g., visiting universities abroad)
- (-) Expenses with technical-administrative staff on leave (abroad)

**Figure 2.** Formula of current cost without HU

Source: adapted from TCU (2010).

Regarding the age variable, a positive relationship is expected between age and performance, considering that older students tend to perform better in the Enade (Santos, 2012). Additionally, Eikner and Montondon (2006) state that age is a maturity indicator. Thus, older students would concentrate better, and consequently, perform better than younger students. The authors believe that older students have accumulated prior knowledge and can relate it to the knowledge acquired during undergraduate studies, which can impact the results of academic tests.

Concerning race, Ferreira (2015) stresses that it impacts student performance when a country does not enable all races to access education equally. Brazil fits this profile as there is a predominance of Caucasians with a college degree or attending an undergraduate program. Therefore, Caucasian students are expected to perform better than students from other races.

The educational level of a student's mother can also influence student performance. According to Bandeira, Rocha, Freitas, Del Prette, and Del Prette (2006), the parents' education can be considered an indicator of social status, as families with higher incomes are more likely to invest in education and improve their educational levels. Consequently, parents with undergraduate or graduate studies are more capable of advising their children to pursue higher education and dedicate themselves the best they can.

Regarding marital status, Ferreira (2015) highlights that single students tend to perform better than married students, while Santos (2012) reports a negative relationship between being single and academic performance. She notes that single students may make choices that restrict their time available to studies due to their maturity level compared to married students. On the other hand, Andrade and Corrar (2008) found that single students perform better than married students, while Masasi (2012) reports that marital status does not influence student performance. Thus, as Miranda *et al.* (2015) noted, results regarding the relationship between marital status and student performance diverge.

Regarding family income, Santos (2012) argues that higher income levels impact performance. Additionally, as the students' income increases, their performance also improves. Ferreira (2015) suggests that students with high family income levels tend to perform better than students with lower family income levels.

Regarding sex, Rangel and Miranda (2016) and Pike and Robins (2019) indicate that female students tend to perform better than male students. Brandão, Silva and Loureiro (2017) note that women seek to facilitate their academic performance as a strategy to deal with a context of gender inequality. The authors also note that this fact occurs in undergraduate programs in human, exact, and biological sciences.



Considering the variables proposed here, multiple regression with panel data is represented by 1:

$$ENADE_{it} = \beta_0 + \beta_1 COSTS_{it} + \beta_2 AGE_{it} + \beta_3 SEXFEM_{it} + \beta_4 SINGLE_{it} + \beta_5 RACE_{it} + \beta_6 EDUCATION_{it} + \beta_7 INCOME_{it} + u_i + \varepsilon_{it} \quad (1)$$

Were:

- $ENADE_{it}$ : model's dependent variable;
- $\beta_0$ : regression's slope coefficient;
- $CUSTOS_{it}$ : current cost without UH of university  $i$  at time  $t$ ;
- $IDADE_{it}$ : age of students from university  $i$  at time  $t$ ;
- $SEXFEM_{it}$ : female students from university  $i$  at time  $t$ ;
- $SOLTEIRO_{it}$ : single students from university  $i$  at time  $t$ ;
- $RACA_{it}$ : race of students from university  $i$  at time  $t$ ;
- $ESCOLARIDADE_{it}$ : Education of mothers of students from university  $i$  at time  $t$ ;
- $RENDA_{it}$ : family income of students from university  $i$  at time  $t$ ;
- $u_i$ : specific non-observable individual effect (fixed effects error); and
- $\varepsilon_{it}$ : usual regression error.

Some tests were run after estimating the pooled model to verify the model's adequacy. First, the Variance Inflation Factor (VIF) was used to assess multicollinearity between the explanatory variables used in the model. Then, the model's functional form was verified using the Ramsey test, as known as RESET. Finally, the Doornik-Hansen test assessed residual normality, in which the null hypothesis assumes that residuals are normally distributed.

Afterward, tests were performed to select the most suitable panel data model for this study: the Chow, Breusch-Pagan, and Hausman tests. After determining the best model, autocorrelation and heteroscedasticity were assessed using the Wooldridge test, which admits as a null hypothesis the non-existence of first-order autocorrelation and likelihood ratio, with  $H_0$  that errors are homoscedastic.

Regarding the treatment of outliers, the winsorization technique was applied, in which outliers are not excluded; instead, they have their values replaced by the last acceptable value within the acceptance region. Hence, very small values are replaced by the smallest value not considered an outlier, and very high values are replaced by the highest value not considered an outlier.

## 4. Results

### 4.1 Descriptive Statistics

To characterize the sample, the database was divided according to the fields of knowledge evaluated. The entire data represent the three groups of the Enade's evaluation cycles, according to fields of knowledge. According to Table 1, the most representative group in the sample was undergraduate programs (bachelor's degree) in exact sciences, related areas, and teaching programs, totaling 210,596 students. The expressive number of students in this group is possibly due to the scope of the programs within this group and because the teaching programs from the HEIs addressed here offer many slots.

Table 1

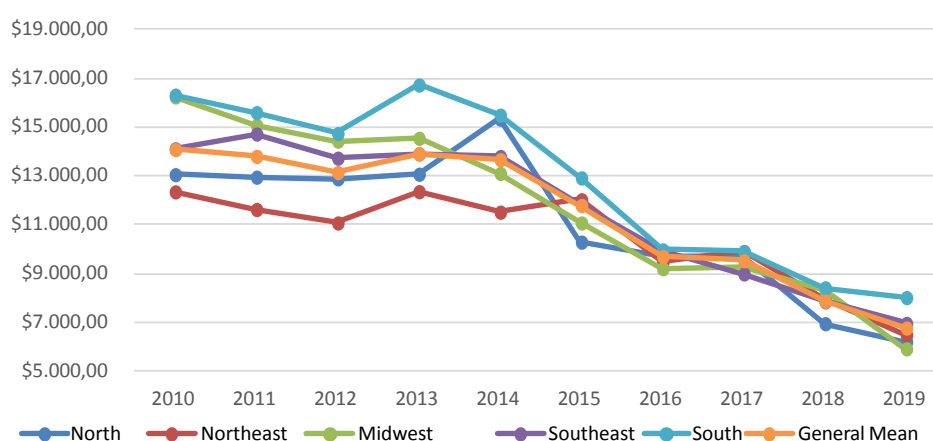
**Students according to the groups assessed in the ENADE from 2010 to 2019**

ENADE assessment group	Total students per group
Bachelor's degree in the fields of Health, Agricultural and related fields (years included in the sample: 2010, 2013, 2016, and 2019)	121.595
Bachelor's degree in Exact sciences and related fields, and teaching program (years included in the sample: 2011, 2014, and 2017)	210.569
Bachelor's degree in Applied Social Sciences, Human sciences and related fields (years included in the sample: 2012, 2015, and 2018)	96.011
<b>Total</b>	<b>428.175</b>

Source: Study's data.

Analysis of the variable current cost without HU per equivalent student (see Figure 3) showed that, on average, the current cost per student was higher among the HEIs located in the south. The highest mean in the period analyzed was found in 2013 (R\$16,729.01). Additionally, the actual current cost per student (deflated) has decreased over the years. In 2010, the mean cost per student totaled R\$14,087.04, and an expressive drop was verified from 2014 on, reaching R\$6,785.55 in 2019. The decrease in cost per student may be related to an increase in the number of undergraduate students. This fact also indicates that investment in higher public education has decreased in Brazil and does not accompany the growth in the number of students attending higher education programs.

Another potential reason for decreased costs per student is Constitutional Amendment No. 95/2016, which sets limits on the Federal Budget and Social Security Budget expenditure. Oliveira, Correa, Alencar, Crisóstomo, and Catrib (2018) stress that the expenditure correction rule, based on the total of paid expenses in the year before corrected according to the IPCA in the period, make HEIs operations unfeasible in the short term. Projections for the years between 2018 and 2022 indicate that, due to the growth in personnel expenses, the limits established by the amendment would not even allow recomposing the inflation of the period for the costing and investment expenses. Hence, as shown in Figure 3, the downward trend in costs per student may continue in the coming years, impacting the quality of federal higher education in Brazil.


**Figure 3.** Development of current cost without UH per equivalent student

Source: study's data.

To characterize the Brazilian universities' profile in the sample, Table 2 presents the descriptive statistics of the variables proposed for the panel data model, comprising from 2010 to 2019 for the 62 HEIs. Note that not all the HEIs presented data for the entire period, which resulted in unbalanced panel data. The data shown represent the results after adjusting the outliers using the windsorization technique.

First, the model's dependent variable, measured by the students' mean score in the Enade (according to each HEI), was analyzed. On average, the students scored 51.01 points in the Enade; data dispersion was low, with a variation coefficient of 11%. Considering that the maximum score is 100 points, the students obtained low scores, representing only 51% of the exam's total score. Even the highest mean score obtained in the Enade (68.77) cannot be considered high.

Regarding current costs without UH per student, a mean of R\$11,109.93 was found. Therefore, each student would cost this amount per year on average, while this figure does not consider the costs with university hospitals, retirements, or pensions, according to the variable's description. Also, the costs were deflated according to the IPCA to reflect the actual value of costs over the years. Note that the cost per student obtained a higher standard deviation, showing federal universities with distinct levels of cost per student.

Regarding the students' age, the highest mean was 26 years old, while 58% were female students and 42% were male. Historically, most undergraduate students were men. However, this profile has changed, and women are gaining space in universities. In the last decade, women's representativeness in universities has been as high as men's (Gil, 2018). Hence, the cultural paradigm that women should be restricted to specific spaces is being broken over the years, as they have gradually entered the most diverse social contexts. From the observation that most of the sample in this study is composed of women, it becomes evident the female historical trajectory in achieving equal rights and successfully put these rights into practice.

Table 2

**Descriptive statistics of variables, data from 2010 to 2019**

Variable	Obs.	Mean	Standard deviation	Coefficient of variation	Minimum	Maximum
University performance (ENADE)	558	51,01	5,51	0,11	41,29	60,71
Current cost w/o UH (COST)	558	R\$ 11.109,93	R\$ 3.403,31	0,31	R\$ 5.932,02	R\$ 18.966,59
Age (AGE)	558	26,14	1,60	0,06	23,85	29,68
Female (SEXFEM)	558	0,58	0,09	0,16	0,41	0,75
Marital status Single (SINGLE)	558	0,84	0,09	0,10	0,65	0,93
Race (CAUCASIAN)	558	0,54	0,23	0,42	0,04	0,96
Race (AFRO)	558	0,08	0,05	0,64	0,01	0,23
Mother's education (HIGHSCHOOL)	558	0,34	0,05	0,14	0,25	0,43
Mother's education (COLLEGE)	558	0,22	0,08	0,34	0,10	0,36
Income (INCOMEUP1.5)	558	0,17	0,10	0,56	0,04	0,39
Income (INCOME1.5TO3)	558	0,23	0,07	0,31	0,10	0,36
Income (INCOME3TO4.5)	558	0,17	0,04	0,21	0,10	0,24
Income (INCOME4.5TO6)	558	0,12	0,03	0,27	0,06	0,18

Source: study's data.

Regarding the student's marital status, 84% of the sample was single, and 11.7% was married. Other statuses such as separated, divorced, or widowed totaled 4.3%. The expressive number of single students is since most students were young, as many entered the university immediately after concluding high school.

Concerning the students' race, the highest mean of self-report race was Caucasian, with 54% of the students, followed by mixed-race students, with 33%. Those who self-reported being Afro-Brazilians totaled 8.7%. Students who self-reported being Asian or Indigenous or did not report their race totaled approximately 4.3%.

Additionally, the analysis of the three groups of knowledge fields evaluated in the Enade shows that Caucasian students stood out in the 2010 to 2012 period, with 60.7%, followed by mixed-race students with 30%, and Afro-Brazilians with 6.78%. In the 2017 to 2019 period, Caucasian students totaled 48.05%, mixed-race 35.17%, and Afro-Brazilians 10.66%. Hence, the percentage of Caucasian students decreased in the period under analysis while Afro-Brazilian and mixed-race students increased. It may represent a trend of greater diversity and the potential positive effect of affirmative action policies on students' profiles from federal public universities.

This observation is aligned with affirmative action policies for adopting quotas to admit undergraduate students in federal public universities, which considers the students' ethnic-racial origin, income, and whether the candidate studied in a public high school. Given this context, Law No. 12,711, from August 29th, 2012, and later Law 13,409, from December 28th, 2016, which ensures that 50% of the slots per program and period in federal universities and federal institutes in the fields of education, science, and technology are subdivided into half for students from public schools with a gross family income equal to or below 1.5 times the minimum wage *per capita*, and a half for students with a gross family income above 1.5 times the minimum wage. In both cases, a minimum percentage that corresponds to the sum of Afro-Brazilian, mixed-race and Indigenous students, according to the last demographic census reported by the Brazilian Institute of Geographic and Statistics (IBGE), is also considered.

In 2018, according to the IBGE (2019), 50.3% of the undergraduate students reported being Afro-Brazilians or of mixed-race, which shows the potential results from affirmative actions, even though Afro-Brazilian and mixed-race individuals are still underrepresented, as they compose 55.8% of the population (IBGE, 2019). Therefore, public policies directed explicitly to groups historically and socially excluded due to some characteristics should be valued because these aspects are an integrating part of our society.

Regarding the relationship with maternal education, the largest portion of students reported that their mothers had completed high school (34%), followed by college (22%). Regarding the students' income, most students (23%) reported from 1.5 to 3 times the minimum wage, 17% reported up to 1 time the minimum wage, and another 17% reported from 3 to 4.5 times the minimum wage. The group with a family income from 4.5 to 6 times the minimum wage totaled 12% of the sample. The analysis of students classified according to each level of family income shows that students with a family income up to 1.5 times the minimum wage represented 14.92% of the students from 2010 to 2012, and those with an income from 1.5 to 3 times the minimum wage totaled 20.39%. Together, these students represented 35.31% of the students that took the Enade. From 2017 to 2019, this group grew to 47.17%, while 22.2% of these reported up to 1.5 times the minimum wage, and 24.79% reported an income from 1.5 and 3 times the minimum wage. Hence, there was an increase in the number of students with a family income of up to 3 times the minimum wage in the period. As it happened with race, these results may reflect affirmative action policies adopted by HEIs to include students with a low family income in higher education programs.

Descriptive statistics showed that most of the students from federal public universities who took the Enade from 2010 to 2019 were Caucasian, young, single, female, whose mother concluded high school, and with a family income from 1.5 to 3 times the minimum wage. The analysis also revealed that HEIs should implement policies to improve the students' scores obtained in the Enade, encouraging and sensitizing students to the importance of this examination, which they often considered irrelevant. Additionally, although the percentage of Afro-Brazilian students increased in HEIs, this figure is still low compared to Caucasian and mixed-race students, reinforcing the need for affirmative actions to promote access to Afro-Brazilian students in higher education programs.

## 4.2 Standard index analysis of performance and current cost without UH

The mean of the data observed in each HEIs concerning the scores the students obtained in the Enade (performance) and those concerning total current cost without UH per student was used for the standard index analysis. The HEIs were classified according to the students' performance as excellent, good, regular, or satisfactory. The total current cost without UH was classified as high, moderate, low, and very low. Note that data are deflated.

As shown in Figure 4, the HEIs with excellent performance did not present a uniform behavior regarding the level of costs. For instance, UFCSPA, which presented the highest performance in the sample, showed a very low cost per student. In turn, UFTM and UFRGS, which also presented excellent performance, showed different levels of costs, high and moderate, respectively. Dispersed costs were presented by the remaining HEIs that presented excellent performance; six (37.5%) out of the 16 HEIs classified in this group presented a very low cost per student.

The universities' level of costs with good performance was not constant; 33.3% presented a high level of costs, 20% moderate level, 33.3% presented a low level, and 13.3% presented a very low level of costs.

A low level of costs per student predominated in the group of institutions with regular performance (33.3% of the HEIs in this group); the remaining HEIs represented 26.4% in each of the high and moderate levels, and 13.3 were classified at a low level.

Regarding the HEIs with unsatisfactory performance, a very low level of cost per student predominated, representing 37.5% of the 17 HEIs in this group. Additionally, the group included 18.8% of the HEIs with a high level of cost, 31.2% with regular, and 12.5% with a low level of cost per student.

IES	Performance	Cost per student	HEIs	Cost per student	Cost per student
	Classification	Classification		Classification	Classification
UFCSPA	Excellent	Very low	UFES	Regular	Low
UFTM	Excellent	High	FURG	Regular	Low
UFRGS	Excellent	Moderate	UFF	Regular	High
UFMG	Excellent	Low	UFVJM	Regular	Low
UNB	Excellent	High	UFCG	Regular	Moderate
UFABC	Excellent	High	UFRRJ	Regular	High
UFJF	Excellent	Moderate	UFMT	Regular	Moderate
UNIRIO	Excellent	Low	UFOB	Regular	High
UFSCAR	Excellent	Moderate	UFPB	Regular	Moderate
UNIFEI	Excellent	Low	UFERSA	Regular	Very low
UFV	Excellent	High	UFMS	Regular	Low
UFLA	Excellent	Very low	UNIR	Regular	Moderate
UFC	Excellent	Very low	UNIPAMPA	Regular	High
UFPR	Excellent	Very low	UFGE	Regular	Low
UFCA	Excellent	Very low	UFS	Regular	Very low
UNIVASF	Excellent	Very low	UFRB	Unsatisfactory	Moderate
UFOP	Good	Low	UFRR	Unsatisfactory	High
UFBA	Good	Very low	UFAM	Unsatisfactory	Very low
UFSM	Good	Moderate	UFRPE	Unsatisfactory	Moderate
UFRN	Good	Moderate	UFPI	Unsatisfactory	Very low
UFFS	Good	High	UNILAB	Unsatisfactory	High
UTFPR	Good	Low	UNIFAP	Unsatisfactory	Moderate
UFSC	Good	Moderate	UFPA	Unsatisfactory	Very low
UFRJ	Good	High	UFAC	Unsatisfactory	Very low
UNIFAL	Good	Very low	UFAL	Unsatisfactory	Very low
UFPE	Good	Low	UFRA	Unsatisfactory	Low
UNIFESP	Good	High	UFT	Unsatisfactory	Low
UFG	Good	Low	UNIFESSPA	Unsatisfactory	Moderate
UFU	Good	Low	UFSJ	Unsatisfactory	Very low
UFPEL	Good	High	UNILA	Unsatisfactory	High
UFMA	Good	High	UFOPA	Unsatisfactory	Moderate

**Figure 4.** Classification of standard index according to performance and current cost without UH per student  
 Note: data from 2010 to 2019.

Source: study's data

Data from Figure 4 were aggregated for analysis and interpretation, but analysis of the database considering performance obtained in each year and current cost per student showed that the university that obtained the best score was the Universidade Federal de Ciências da Saúde de Porto Alegre (UFCSPA), with a mean score of 69 points in 2018, in which this HEI had a current cost of R\$7,477.96.



On the other hand, the worst score among the HEIs was obtained by the Universidade Federal da Integração Latino-Americana (Unila) in 2015, with a mean of approximately 28 points. Note that, even though it obtained the worst score in the Enade among the universities in the sample, in the same year, Unila had a current cost without UH per student of R\$19,452.96. The high level of costs per student may be explained by the low number of students enrolled in this university, as this HEI was funded in 2010, which would explain the low number of students, which in 2015 totaled only 870 students.

According to the standard index analysis, the behavior between performance and level of cost per student was not homogeneous despite some standouts. Most of the HEIs classified with unsatisfactory performance in the Enade presented a very low level of cost per student. However, even though HEIs with excellent performance were expected to present a higher level of costs, a low level of cost per student prevailed in this group. It may be related to the fact that these HEIs presented the best performance in the Enade, not only due to their institutional conditions but also due to the profile of their students (Ferreira, 2015). Other factors could also be related to levels of costs and performance, such as efficient management and application of resources or even students' engagement when taking the examination.

### 4.3 Empirical regression model with panel data

The first step to specify the regression model with panel data was to perform adequacy tests according to the Ordinary Least Squares (OLS) model. Multicollinearity was within the parameters accepted by Hair, Anderson, and Tatham (2005), from 1 to 5, i.e., moderate collinearity. The RESET and normality tests indicated that the functional form was incorrect or some relevant variable was missing, and also that the distribution of the residuals was not normal. However, the model is suitable for interpretation; since it is a model, there is no way to capture all the variables that impact undergraduate student performance. Regarding the normality of residuals, the central limit theorem was assumed, which establishes that data tend to normality at the limit.

Afterward, tests were performed to verify which model would be the most suitable for the sample: pooled, fixed effect, or random effects. The best model was the fixed effects. Subsequently, the tests confirmed the existence of heteroscedasticity and autocorrelation. Hence, the regression model with panel data was estimated with fixed effects, considering the existence of heteroscedasticity and autocorrelation by generalized least squares (GLS). The results found in the tests and the estimated model are presented in Table 3.

The variable of interest in this study, the costs of the universities measured according to current cost without UH per equivalent student (COSTS), was not statistically significant, indicating that student performance is not related to current costs of the HEIs included in the sample. The result found diverge from the relationship expected and from the results reported by Dahlvig *et al.* (2020), Rutherford and Rabovsky (2014), Pike *et al.* (2011) and Pike and Robbins (2019), in which a positive effect was found in relation to the level of expenses. Barbosa *et al.* (2011) found similar results in Brazil, i.e., a positive relationship between student performance in the Enade and cost per student. However, this study's results are in line with those reported by Rocha and Funchal (2019), in which no statistical significance was found between student performance and public expenditure, though in this case the analysis concerned the expenditure of high schools. Additionally, Hong and Zimmer (2016) highlight that an increase in the level of expenses has the potential to improve student performance, although this effect would not be observed in the short term. The authors suggest that the benefits of these expenses are perceived only after four years.

Regarding control variables, considering a level of significance at 5%, the variables age, female, marital status single, Caucasian, and income from 1.5 to 3 times the minimum wage were significant to explain performance. Age presented a positive coefficient of 1.33, showing that older students tend to perform better in the Enade, confirming the relationship expected in this study. Santos (2012) also found a positive result between age and performance in the Enade. A potential explanation for this result is that older individuals usually have accumulated previous knowledge or even experience and are more committed to examinations.

Regarding the students' sex, the literature shows that women perform better than men on average (Rangel & Miranda, 2016; Pike & Robins, 2019). This study is in line with the literature, showing that the higher the number of women taking the test, the higher the university's mean score; if 100% of the women were women, the mean score would increase by 23 points. This finding corroborates the study by Pike and Robbins (2019), in which a positive relationship was found between the percentage of female students and their performance in undergraduate programs. However, it differs from the study reported by Ferreira (2015), in which men performed better in the Enade, though she only addressed Accounting programs.

Regarding the students' marital status, the results indicate a positive and significant relationship with student performance, i.e., if 100% of the students were single, the mean score would increase by 39.10 points. This finding diverges from the results reported by Santos (2012) and Ferreira (2015), in which the performance of married students was superior to that of single students. However, Andrade and Corrar (2008) found results similar to those found in this study. The fact that married students perform poorer than single students may be related to a married individual's responsibilities, whether father or mother, which can interfere in their time available for studies and, consequently, their academic performance.

Regarding the students' race, the results showed that if 100% of the students were Caucasian, the universities' mean score would increase by 6.95. However, the results did not indicate a significant relationship for Afro-Brazilian students. These results diverge from those reported by Rutherford and Rabovsky (2014), in which a negative relationship was found between being an Afro-American and Hispanic student and performance. The result is also opposed to Pike and Robins (2019) study, which indicates a negative relationship between the percentage of Afro-descendant and performance in undergraduate student performance. This study, however, is in agreement with Ferreira (2015), who states that Caucasian students tend to perform better than mixed-race and indigenous students. She also found that Afro-Brazilian students tend to present inferior performance than Caucasian students, which is opposed to this study's results.

The educational level of the students' mothers was also statistically significant. The mothers who had completed high school or had a college degree were significantly related to performance. Hence, if 100% of the mothers of the students who took the Enade had completed high school, the mean score would increase by 16.89 points, and if 100% of the mothers had a college degree, the mean score would increase by 30.28 points. This study's findings confirmed what was expected, that the higher the educational level of the students' mothers or guardians, the better the student performance. However, Ferreira (2015) found a different result, in which the students whose mothers had attended higher education or graduate studies performed worse than those whose mothers had a lower level of education. A potential explanation is that mothers with higher educational levels influence their children to dedicate themselves to studies, encouraging them to perform better.

Finally, regarding the students' income, the results revealed a positive and statistically significant relationship between students with a family income from 1.5 and 3 times the minimum wage and performance. The remaining income ranges were not significant. Even though it was expected that students at higher levels of family income would present superior performance, the model's results do not indicate this relationship. This finding is opposed to the study by Ferreira (2015), in which students with higher family incomes tend to perform better than those with lower family incomes. However, Moreira (2010) reports that student performance among students with higher family income is inferior to the performance of students from lower family income levels. A potential explanation for students with lower income performing better than those at higher income levels may be motivation. Students with lower incomes may consider the university to be an opportunity to grow personally and professionally, consequently, dedicate themselves more intensively to academic activities. In this sense, Diaz (2007) notes that there is a limited effect of income on student performance; that is, there is a point in which this effect starts decreasing.

Table 3

**Results from the regression model with panel data**

Variables	Coefficient	P-value
Current cost without UH (COSTS)	-0.00007	0.18
Age (AGE)	1.33	0.00
Female sex (SEXFEM)	23.38	0.00
Marital status (SINGLE)	39.10	0.00
Race (CAUCASIAN)	6.95	0.03
Race (AFRO)	9.06	0.12
Mother's education (HIGHSCHOOL)	16.89	0.00
Mother's education (COLLEGE)	30.28	0.00
Income (INCOMEUP1.5)	-3.37	0.25
Income (INCOME1.5TO3)	14.51	0.00
Income (INCOME3TO4.5)	-4.56	0.38
Income (INCOME4.5TO6)	8.29	0.20
Constant	-48.40	0.00
Chow test		0.00
Breusch and Pagan test		0.00
Hausman test		0.00
Wooldridge test for autocorrelation		0.00
Wald test for heteroscedasticity		0.00
VIF for multicollinearity		2.83
Ramsey test to specify the model		0.00
Doornik-Hansen		0.01

Source: study's data

Despite the importance of identifying the relationship between expenditure with education and student performance, no evidence was found regarding how resources can promote universities' results. Results concerning the students' sociodemographic variables and the universities' current cost per student indicate that in this sample, the sociodemographic factors were more important for student performance than the resources applied by HEIs. Ferreira (2015) believes that students from public universities have a differentiated profile, as they tend to be more engaged with studies. On the other hand, Pike *et al.* (2011) state that the university's resources are indirectly related to the students' expected results because these resources have the potential to improve the qualification of professors, which in turn benefit student performance.

## 5. Final Considerations

It is relevant to investigate the impact of HEIs expenditure on student performance considering a context in which resources available to federal universities are scarce. The main effects include a potential decrease in student performance. Therefore, this study's objective was to identify the relationship between current cost per student among federal universities and undergraduate student performance. Thus, a total of 62 Brazilian federal universities were analyzed from 2010 to 2019.

The results did not show a relationship between student performance and the HEIs expenditures. Therefore, hypothesis H1: Federal universities with higher current cost per student tend to perform better in the Enade, was rejected. The sociodemographic factors, on the other hand, such as age, race, sex, marital status, maternal education, and income, present a relevant influence on performance in the Enade. Hence, the conclusion is that factors inherent to the students' context have a more significant impact on performance than the resources invested in universities, which corroborates Ferreira's findings (2015).

A possible explanation for cost per student being irrelevant for student performance may be that for it to have any impact would require other than only the amount of resources, i.e., good resources management (Rocha & Funchal, 2019). Additionally, Pike *et al.* (2011) indicate that the HEIs' levels of costs would be related to student performance in the first years of a program. Hence, considering that Enade was adopted as a proxy for performance in this study, the students' background and their cumulative knowledge in the program, additional evidence may be obtained if other measures are adopted to verify student performance in the programs' first years. Other peculiarities of the institutions analyzed here may also affect the level of costs, considering that the relationship between costs and student performance remains unclear. Dahlvig *et al.* (2020) believe that the relationship between resources and student performance is not direct or linear; that is, after a certain point, increments in the level of resources would not affect student performance. Additionally, other variables may be relevant for this analysis because they tend to affect costs or even student performance, such as: when the institution was founded, its location, the programs offered, and the faculty members' degree, among others.

This study's limitations include a lack of data that would enable assigning current costs per student into subgroups. Being able to classify costs into categories would enable a clearer perspective of how the universities' expenditures are allocated, such as cleaning, energy, personnel, and others, which may have an isolated impact on student performance. Another limitation is that even though data from the Enade were analyzed from 2010 to 2019, distinct fields of knowledge are evaluated in each Enade. For this reason, the mean scores may have been affected given the different fields of knowledge that were evaluated in the study period, as well as due to the different programs provided by each of the HEI in the sample.

From the higher education's perspective, it is crucial for the institutions to identify the expenditures more likely to improve student performance (Pike & Robbins, 2019). Therefore, future studies are needed to assess the level of costs and specific performance in the different fields of knowledge such as exact, human, social sciences, etc. Additionally, other proxies should be adopted for universities' expenditures that enable specific analyses of groups of expenditures to contribute to relevant discussions. Therefore, a potential topic for future studies would be to analyze the performance of programs in the health field, considering, among the determinants of current cost per student, the costs with UH, as this field also include hospital infrastructure. Future studies are suggested to use other estimation models, considering lags in the relationship between the HEIs' level of costs and scores the students obtain the Enade. Finally, data concerning the different levels of the universities' infrastructure and development could be considered, such as how old a university is, the types of programs it offers (undergraduate, Master's, and doctoral programs), and proxies for the institutions' infrastructure.

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