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THE HETEROGENEITY OF COST DRIVERS IN GRADUATE PROGRAMS AT BRAZILIAN FEDERAL UNIVERSITIES

SHAIANE PISA KISTNER[1]
Federal University of Santa Catarina, Department of Accounting, Florianópolis, SC, Brazil
https://orcid.org/0000-0002-4501-513X
shaiane_pk@hotmail.com

ALTAIR BORGERT
Federal University of Santa Catarina, Department of Accounting, Florianópolis, SC, Brazil
https://orcid.org/0000-0002-0116-8089
altair@borgert.com.br

ABSTRACT

The objective of this study was to analyze the main cost drivers of graduate education at Brazilian federal universities and their influence on the average cost per student. To this end, the statistically significant drivers associated with the average cost per student between 2000 and 2019 were identified, and their impact coefficients and relative importance were estimated using a sample of 57 Brazilian federal universities. To minimize potential bias, the universities were grouped using cluster analysis, and a longitudinal panel data regression model was employed. The results indicate that the most influential cost drivers of graduate education, with respect to their effect on university costs, are, in descending order of relevance: active faculty members per graduate student; graduate students per active faculty member; graduate programs per graduate student; scientific publications per graduate student; extension activities per graduate student; and research groups per graduate student. Furthermore, the results varied across clusters, as no common pattern was observed in either the order of statistical significance or the magnitude of the estimated impact coefficients. As its principal contribution, the study demonstrates the heterogeneity of costs across Brazilian federal universities, highlighting the absence of a single set of cost drivers capable of measuring the average cost per student consistently across all institutions.

Keywords: brazilian federal universities, cost drivers, graduate education.

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[1] **Correspondence address:** R. Eng. Agronômico Andrei Cristian Ferreira, s/n | Trindade | 88040-900 | Florianópolis/SC | Brasil.

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1 INTRODUCTION

In countries where higher education is provided predominantly by public universities, as is the case in Brazil, education plays a central role in promoting the nation's socioeconomic development (Pinto-Ortiz et al., 2024). Within this context, Brazilian federal universities are the country's leading higher education institutions in terms of scientific research, accounting for approximately 95% of national scientific output (Moura, 2019).

Despite their importance, funding allocated to Brazilian federal universities has fluctuated over the years as a result of economic, political, and social changes, as well as successive budget cuts (Corbucci, 2000; Nez & Silva, 2017). Funding declined by 20% between 2016 and 2017 (National Association of Directors of Federal Higher Education Institutions [ANDIFES], 2016). During the first half of 2019, the federal government froze BRL 1.7 billion in university funding, representing approximately 25% of discretionary expenditures (Tenente & Figueiredo, 2019). In addition to these recurring budget freezes, public spending on education declined by 56%, from BRL 11.3 billion to BRL 4.9 billion, between 2014 and 2018 (Mazieiro, 2019). More strikingly, funding transfers to federal universities decreased by 96% between 2015 and 2021 (ASPUV, 2022).

At the same time, society increasingly demands that public resources be allocated and managed efficiently (Ferreira, 2019). Consequently, cost management has become indispensable in the public sector, both to ensure accountability and to demonstrate the effective use of public resources (Almeida et al., 2019). However, because universities perform a wide range of activities, implementing an appropriate costing system is a complex task that must be designed and interpreted according to each institution's objectives (Martins & Peixinho, 2017).

Institutions dedicated exclusively to teaching do not face the same funding requirements as universities that simultaneously engage in teaching, research, and extension activities. The former generally incur lower expenditures because they employ fewer research-active faculty members, resulting in lower personnel costs, which constitute the largest component of university expenditures (Schwartzman, 2022). Koshal and Koshal (1999) and Kistner et al. (2022) identify research as a major contributor to university expenditures, with graduate education exerting a particularly strong influence on institutional costs.

These considerations suggest that each university's mission and institutional characteristics shape its cost structure in distinct ways (Corbucci, 2000; Amaral, 2004). Accordingly, identifying the variables associated with institutional expenditures, commonly referred to as cost drivers, becomes particularly relevant (Kistner et al., 2022). The literature consistently identifies graduate education as a major source of university costs because of the resources required for its operation, including highly qualified faculty, smaller class sizes, expanded research groups, and other research-intensive activities.

Accordingly, investigating the cost drivers associated with graduate education deserves particular attention, as identifying and understanding these determinants can support managerial decision making, budget planning, and performance evaluation in the public sector (Bjørnenak, 2000; Carneiro, 2015), while also addressing society's growing demands for accountability (Almeida et al., 2019; Ferreira, 2019).

This line of research also has important practical implications because it focuses on variables that, unlike expenditures related to retired personnel, can be effectively managed by university administrators, such as the number of graduate programs and student places offered (Kistner et al., 2022). Furthermore, research and extension activities, which are concentrated within graduate education, contribute to the more complex and resource-intensive cost structure of public universities (Kistner et al., 2022). These activities are also influenced by regulatory requirements that demand continuous faculty qualification and the ongoing expansion of graduate education (Goularte & Borgert, 2023; Ministry of Education [MEC], 2022b).

Moreover, considering the findings of Blecich (2020), Duarte et al. (2020), Richartz et al. (2023), Trento et al. (2021), Houghton et al. (2021), Bielschowsky and Amaral (2022), and Goularte and Borgert (2023), all of whom argue that graduate education substantially influences educational costs, the present study focuses specifically on graduate education-related cost drivers in Brazilian federal universities.

Against this background, the objective of this study is to analyze the principal cost drivers associated with graduate education in Brazilian federal universities and to examine their influence on institutional costs. These costs are represented by the average cost per student, considering both *lato sensu* and *stricto sensu* graduate programs. More specifically, the study aims to: (i) identify the most statistically significant graduate education cost drivers associated with the average cost per student in Brazilian federal universities between 2000 and 2019; (ii) determine the relative importance of these cost drivers according to their statistical significance; and (iii) estimate the impact coefficients of the most significant cost drivers on the average cost per student.

From a societal perspective, this study provides evidence that helps clarify the relationship between graduate education and university costs. Because Brazilian federal universities are funded primarily through public tax revenues, understanding the dynamics of university costs is essential for ensuring the long-term sustainability of institutions that generate substantial value for society (Sobral & Cabral, 2025). Graduate education contributes to improving teaching quality, advancing research of public interest, and supporting extension initiatives that directly benefit local communities and help reduce regional inequalities.

Accordingly, this study seeks to demonstrate empirically that the financial sustainability of the teaching, research, and extension mission cannot be managed using generalized funding formulas that disregard the specific characteristics of individual institutions (Kistner et al., 2023). As Brazilian federal universities continue to expand and restructure their campuses to broaden access to higher education through initiatives such as the REUNI Program (MEC, 2022a), increasing social demands for student access, retention, and academic excellence must be balanced against increasingly complex cost structures. By identifying the behavior of key cost drivers, this study provides evidence that may assist society, university administrators, and public policymakers in advocating funding policies that recognize institutional heterogeneity. Furthermore, the findings move beyond descriptive analyses and address a critical gap in the literature concerning the limited availability of empirical research on this topic.

Finally, this study contributes to the academic literature by advancing knowledge on cost drivers in Brazilian federal universities, a subject that remains underexplored despite its importance for improving the quality and efficiency of public spending (Santos et al., 2020; Goularte & Borgert, 2023). Moreover, research on university management is essential for enhancing institutional quality and performance (Souza, 2009). For the purposes of this study, the terms costs, expenses, and expenditures are used interchangeably, although they have distinct conceptual meanings within the Brazilian accounting framework.

2 COSTS DRIVERS

Cost information is essential for supporting managerial decision making by both internal and external stakeholders, while also informing competitive strategies. A cost perspective enables organizations to assess and understand their performance, making cost analysis a fundamental component of organizational management (Carneiro, 2015). Accordingly, understanding and managing the factors that influence costs, commonly referred to as cost drivers, is of paramount importance, as identifying the impact of specific variables on expenditures supports decision making in the public sector, budget planning and forecasting, and performance evaluation (Bjørnenak, 2000; Carneiro, 2015). Consequently, managers must have a thorough understanding of the relationship between these factors and organizational costs (Carneiro, 2015).

In the context of Brazilian federal universities, cost drivers correspond to the variables associated with institutional expenditures. These expenditures must be properly understood, and the effects resulting from changes in their cost drivers should be estimated. The fact that public universities are primarily funded through government appropriations further underscores the importance of understanding how different variables affect institutional costs, thereby encouraging research in this area (Bjørnenak, 2000).

In the public sector, where resources are often limited, cost drivers have been employed as a strategic tool for allocating expenditures according to operational requirements, as demonstrated by Borgert and Gasparetto (2019) and Kistner et al. (2022). However, public organizations are characterized by relatively slow organizational dynamics, marked by rigidity, bureaucracy, formalism, and excessive legalism in their day-to-day operations (Branco, 2013; Marin, 2012), as well as inefficiencies arising from underutilized personnel, political pressures, and budgetary constraints (Shleifer & Vishny, 1994). Therefore, understanding costs, their behavior, underlying causal relationships, and influencing variables is essential for evaluating public-sector performance, as political and institutional changes, among other factors, may either increase or reduce expenditures (Bjørnenak, 2000).

The evolving relationship between universities and government has further intensified the challenges associated with cost management. Higher education has become increasingly expensive relative to productivity gains achieved in other sectors because the amount of instructional time required from faculty has remained virtually unchanged for decades (Berman & Paradeise, 2016). This phenomenon is compounded by the high costs of research involving sophisticated technologies, administrative expansion, reduced teaching loads for faculty members, and growing student expectations regarding the quality of university facilities (Berman & Paradeise, 2016). Moreover, higher education systems are increasingly viewed as robust indicators of a country's capacity to remain among the world's advanced economies, further elevating the importance of this issue in recent years (Duarte et al., 2020).

Managing higher education institutions is inherently complex due to the continuous need to expand and update research activities, improve quality standards, increase student enrollment capacity, address regional disparities, and manage rising operational costs (Silva, 2001). This complexity requires university administrators to develop a comprehensive understanding of the structure, composition, and trends of the variables that drive institutional expenditures (Trento et al., 2021).

Institution-specific characteristics may substantially influence cost behavior. Understanding these characteristics, together with expenditure patterns and trends, is essential for establishing meaningful comparisons across institutions (Magheed, 2016). Such comparisons require standardized measures and comparable variables (Mota et al., 2022). Research by Kistner et al. (2022) highlights the need to better understand and manage graduate education-related variables that exhibit statistically significant relationships with the costs of Brazilian federal universities, thereby reinforcing the importance of further research in this area.

Research on cost management has become increasingly relevant because higher education institutions contribute significantly to national development while generating cultural, social, educational, technological, and economic benefits, largely financed through public resources (Heusi et al., 2015). Consequently, studies that enhance understanding of resource allocation and utilization are fundamental to strengthening the higher education, science, and technology sectors (Schwartzman, 2022).

Within this context, Houghton et al. (2021) focused on graduate education to estimate the educational costs associated with research in Australian public university business schools. Their findings revealed substantial differences between undergraduate and graduate education costs, with graduate education further differentiated between master's and doctoral programs. They concluded that the average cost of master's education is approximately three times higher than that of undergraduate education and that educational expenditures are strongly influenced by research

intensity, which, at the graduate level, results in higher-quality and more costly scientific publications.

Similarly, Trento et al. (2021) examined the evolution of costs across 68 Brazilian federal universities between 2000 and 2019. Their findings showed that the diversity of teaching, research, and extension activities is reflected in institutional expenditures, which exhibited an upward trend throughout the study period and were positively and significantly associated with educational variables. These costs were represented by total executed budgets, personnel expenditures, social security contributions, employee benefits, capital investments, and other current expenditures (Trento et al., 2021).

Examining 31 economics-oriented higher education institutions in Slovenia, Croatia, and Bosnia and Herzegovina, Blecich (2020) investigated the factors influencing institutional efficiency. The study found that institutions were more likely to belong to the most efficient cluster when they exhibited higher student-to-faculty ratios, greater scientific publication output, a larger number of visiting researchers, and higher expenditures per faculty member.

In a different context, Abelino et al. (2020) investigated the effects of public funding on educational performance indicators at Brazilian federal universities using the *Folha University Ranking* (RUF). They concluded that because several dimensions of university performance are not fully explained by financial investments, and because increases in funding may, in some cases, even reduce certain performance indicators, higher expenditures alone do not guarantee improvements across the diverse activities performed by universities.

To investigate the cost structure of a medical university in Iran between 2015 and 2016, Namazi and Zare (2021) applied Activity-Based Costing (ABC) to higher education. Their findings showed that *stricto sensu* graduate programs, particularly doctoral and postdoctoral programs, generated the highest cost per student compared with master's programs. The authors concluded that cost rationalization and control efforts should concentrate primarily on training and educational activities while also considering structural characteristics such as student distribution across academic disciplines, degree levels, and campuses.

Graduate education was also the focus of Hernández (2020), who conducted a case study at a Mexican university to examine the scope and limitations of a research-oriented graduate program based on its funding structure and budget allocation. The study concluded that universities should periodically develop strategies to improve the performance indicators used by the national agency responsible for evaluating graduate education through coordinated efforts between administrative and academic managers of graduate programs. Accordingly, allocating financial resources to graduate education and research enables institutions to improve their performance in national evaluation systems (Hernández, 2020).

Additional studies have also examined university costs, including those by Chiau and Panucci (2014), Widiyono et al. (2020), Santos et al. (2021), and Kistner et al. (2023). However, previous research has generally relied on traditional methodological approaches that assume homogeneous cost behavior across universities, overlooking the unique characteristics of individual institutions. Consequently, there remains a significant gap in the literature regarding empirical evidence on the behavior of graduate education-related cost drivers in Brazilian federal universities.

The literature on strategic cost management in the public sector demonstrates that identifying cost drivers is essential for understanding institutional costs, evaluating the effects of budget constraints, and optimizing resource allocation. Nevertheless, empirical studies examining graduate education-related cost drivers in Brazilian federal universities remain scarce (Kistner et al., 2022).

This lack of empirical evidence poses a challenge for public governance because, without accounting for institutional heterogeneity, regulatory agencies are more likely to adopt standardized formulas for estimating the average cost per student. Such approaches may overlook the fact that graduate education constitutes the cornerstone of the university's teaching, research,

and extension mission, generating societal returns through the development of highly qualified human capital, regional technological advancement, and extension initiatives that directly benefit local communities. Based on the existing literature on university costs, the variables included in this study are presented in Table 1.

Table 1

Data used in previous studies, required for estimating the variables of this study

Data	Theoretical Background of the Data
Average cost per student	Tribunal de Contas da União (TCU, 2002); Boaventura et al. (2019); Santos e Pereira (2019); Kistner et al. (2022); Kistner et al. (2023).
Number of students or enrollments	TCU (2002); Magalhães et al. (2010); Flégl e Vitavská (2013); Dombroski et al. (2019); Santos e Pereira (2019); Boaventura et al. (2019); Blecich (2020); Duarte et al. (2020); Trento et al. (2021); Kistner et al. (2022), Kistner et al. (2023).
Number of faculty members	Magalhães et al. (2010); Toompuu e Põlajcva (2014); Boaventura et al. (2019); Blecich (2020); Duarte et al. (2020); Trento et al. (2021); Kistner et al. (2022); Kistner et al. (2023); Pinto-Ortiz et al. (2024).
Number of extension activities	Koshal e Koshal (1999); Amaral (2004); Palotti et al. (2024); Richartz et al. (2020); Trento et al. (2021); Houghton et al. (2021).
Number of graduate programs	Koshal e Koshal (1999); Trento et al. (2021); Kistner et al. (2022); Kistner et al. (2023).
Number of research groups	Koshal e Koshal (1999); Amaral (2004); Richartz et al. (2020); Trento et al. (2021); Houghton et al. (2021); Kistner et al. (2022); Kistner et al. (2023).
Number of academic supervisions	Trento et al. (2021); Kistner et al. (2022); Kistner et al. (2023).
Number of scientific publications	Amaral (2004); Flégl e Vitavská (2013); Richartz et al. (2020); Trento et al. (2021); Kistner et al. (2022); Kistner et al. (2023).

Source: Adapted from Trento et al. (2021).

The variables examined in this study were defined based on the data presented in Table 1 and on the methodologies adopted by previous studies that employed these variables either directly or as the basis for constructing analytical metrics. It should be noted, however, that studies specifically addressing graduate education cost drivers remain scarce, representing a gap in the literature that this research seeks to address. Furthermore, for the purposes of this study, cost drivers are understood as mechanisms for assigning costs to graduate education operational activities (Alonso, 2022), rather than as variables that directly and independently increase or decrease institutional costs.

3 METHODOLOGICAL PROCEDURES

3.1 Characterization of Graduate Education

Graduate education in Brazil emerged as a direct response to growing social, economic, and political demands for development, becoming a major area of activity within Brazilian federal universities. Its primary purpose was to establish the conditions necessary for conducting comprehensive and rigorous scientific research (Corbucci, 2000; Fehlauer et al., 2019). Graduate programs expanded rapidly as a result of supportive legislation, increased financial investment, and the establishment of research funding agencies. These initiatives contributed to the international recognition of Brazilian graduate education, which is regarded as one of the country's most successful educational achievements because of the quality of its programs and as the largest graduate education and research system in Latin America (Moritz et al., 2013; Schwartzman, 2022). These advances have reinforced the sustained presence of research and extension activities within universities, thereby influencing their cost structures (Houghton et al., 2021).

Despite the inherent complexity of university cost management and persistent budgetary constraints, demand for graduate programs has continued to grow. According to the Brazilian Coordination for the Improvement of Higher Education Personnel (CAPES, 2021), *stricto sensu*

graduate education expanded by 48.6% over the past decade. Consequently, both the number of graduate programs and student enrollments increased substantially, placing additional demands on university resource management, as these factors further complicate institutional administration (Silva, 2001; Schwartzman, 2015).

Furthermore, graduate education accounts for a substantial share of the training of university faculty and researchers and represents the segment of Brazilian higher education that has experienced the greatest expansion since the 1990s, achieving remarkable results and gaining increasing visibility in global rankings (Moritz et al., 2013). This performance is closely associated with the international recognition of Brazilian graduate education, which stems both from research funding initiatives promoted by the Brazilian National Council for Scientific and Technological Development (CNPq) and from the evaluation processes coordinated by CAPES (Moritz et al., 2013).

3.2 Research design, population, sample, study period, and variables

Unlike purely descriptive approaches that are limited to reporting budgetary data, this study is inferential, exploratory, analytical, and descriptive in nature. Methodologically, it adopts a predominantly quantitative approach while also incorporating qualitative elements during the inference stage.

The study population comprises the 68 Brazilian federal universities operating in 2023. The period of analysis spans from 2000 to 2019. To construct the sample, only institutions with available data for at least 10 of the 20 years analyzed were included. This criterion was established to balance two objectives: avoiding potential bias arising from excessively short time series that could produce unrealistic trends, while minimizing the exclusion of institutions from the sample. Applying this criterion resulted in a final sample of 57 Brazilian federal universities operating during the 2000–2019 period. The initial year of analysis (2000) was selected because it coincides with the enactment of the Fiscal Responsibility Law (Supplementary Law No. 101, 2000), which established transparency requirements for public accounts. The final year (2019) was chosen to avoid potential bias associated with the COVID-19 pandemic, which began affecting university operations in 2020.

The study variables are presented in Table 2, together with the corresponding data sources and the metrics used to represent each cost driver. It is important to note that the denominator "graduate students" (GS) was employed as a scaling factor. Because the variable measuring the number of graduate students would become meaningless if normalized by the same denominator (GS), the number of active faculty members (AF) was used instead for this specific variable. This procedure was adopted to mitigate scale bias and prevent differences in university size from distorting the statistical estimates. Consequently, the model enables the estimation of the actual influence of the cost drivers, allowing meaningful comparisons among institutions with different structural and financial characteristics.

Table 2

Variables of the study, required data, and metrics used for estimation

Variables	Concept	Data	Metric used
ACS	Captures the executed budget, excluding expenditures on retired personnel, divided by the number of enrolled students.	Total executed budget; Total number of students	Division of total executed expenditures on active personnel by the total number of students
GS/AF	Captures the number of students enrolled in graduate education.	Number of graduate students; Number of active faculty members	Division of the number of graduate students by the number of active faculty members

AF/GS	Captures the number of active faculty members.	Number of graduate students; Number of active faculty members	Division of the number of active faculty members by the number of graduate students
GP/GS	Captures the number of graduate programs offered	Number of graduate programs; Number of graduate students	Division of the number of graduate programs by the number of graduate students
EA/GS	Captures the number of extension activities carried out.	Number of extension activities; Number of graduate students	Division of the total number of extension activities by the number of graduate students
AS/GS	Captures the number of completed graduate academic supervisions (as evidenced by the completion and publication of master's dissertations and doctoral theses).	Number of academic supervisions; Number of graduate students	Division of the total number of academic supervisions by the number of graduate students
RG/GS	Captures the number of existing research groups.	Number of research groups; Number of graduate students	Division of the total number of research groups by the number of graduate students
RP/GS	Captures the number of scientific publications produced	Number of scientific publications; Number of graduate students	Division of the total number of scientific publications by the number of graduate students

Notes. Abbreviations: ACS = Average Cost per Student; GS = Graduate Students; AF = Active Faculty Members; GP = Graduate Programs; EA = Extension Activities; AS = Academic Supervisions; RG = Research Groups; SP = Scientific Publications. Source**:** Adapted from Trento et al. (2021), Goularte and Borgert (2023), and Kistner et al. (2022).

The dependent variable is the average cost per student, while all remaining variables are treated as independent variables. It is important to note that although the variables related to research, extension activities, and scientific publications also encompass undergraduate education, their primary emphasis is on graduate education.

3.3 Procedures for data collection and analysis

Data were collected through documentary research using the following sources: Management Reports, Activity Reports, and Statistical Yearbooks published by the universities; the database of the National Institute for Educational Studies and Research Anísio Teixeira (INEP); and the Federal Budget Panel (SIOP), consistent with the procedures adopted in previous studies, such as Kistner et al. (2022).

The financial data corresponding to the executed budget were adjusted from December 31 of each reference year to April 2023 using the Broad National Consumer Price Index (IPCA), published by the Brazilian Institute of Geography and Statistics (IBGE). This index has been employed in previous studies on the costs of Brazilian federal universities, such as Trento et al. (2021), and is necessary to remove the effects of inflation, thereby allowing meaningful comparisons of monetary values over time.

The educational variables were selected based on data availability across Brazilian federal universities and their relationship with institutional costs and graduate education. Initially, a cluster analysis was conducted to identify universities with similar behavioral patterns. Cluster analysis served as a technical criterion for partitioning the sample into groups of institutions with comparable data characteristics. This procedure was adopted to avoid estimating the impact of the cost drivers on the average cost per student by pooling all universities into a single analysis, which would overlook institutional heterogeneity. Instead, relatively homogeneous groups were created, allowing the estimation of relationships that better reflected the characteristics of each cluster.

The objective was to allocate observations into clusters representing similar joint patterns across the study variables, with high internal homogeneity and substantial heterogeneity between groups (Fávero & Belfiore, 2020). This study employed a hierarchical agglomerative clustering

method. Data from 2019 were used because the objective was not to examine the temporal variability of the variables within individual institutions.

Because the dependent variable is expressed in monetary units (Brazilian reais), whereas the independent variables are measured in quantitative units, all data were standardized using the Z-score method (Fávero & Belfiore, 2020). This procedure resulted in clusters of universities characterized by high internal homogeneity and substantial heterogeneity across groups. The number of clusters was determined based on the distance measures among universities, grouping the most similar institutions at each stage while avoiding clusters composed of a single institution. From this point onward, all subsequent analyses were conducted separately for each cluster.

Next, descriptive statistics were computed. The between variation was calculated to assess differences among Brazilian federal universities over time, whereas the within variation was used to evaluate the variation within each university throughout the study period (Fávero & Belfiore, 2020). Subsequently, the most significant graduate education cost drivers associated with the average cost per student were identified using a longitudinal panel data regression model. Specifically, the cost drivers exhibiting the greatest statistical significance, as measured by the *p*-value, were identified and ranked according to their relative impact. When two or more variables exhibited identical *p*-values, their ranking was determined according to the magnitude of their estimated coefficients, from the largest to the smallest in absolute value, regardless of whether the coefficient was positive or negative.

In addition, statistical tests were performed to determine whether the regression models should be estimated using fixed-effects or random-effects specifications. This decision was based on the Hausman test. After selecting the appropriate specification, the model parameters were estimated according to the following general equation (Fávero & Belfiore, 2020):

$$Y_{it} = a_i + b_1.X_{1it} + b_2.X_{2it} + \ldots + b_k.X_{kit} + \varepsilon_{it}$$

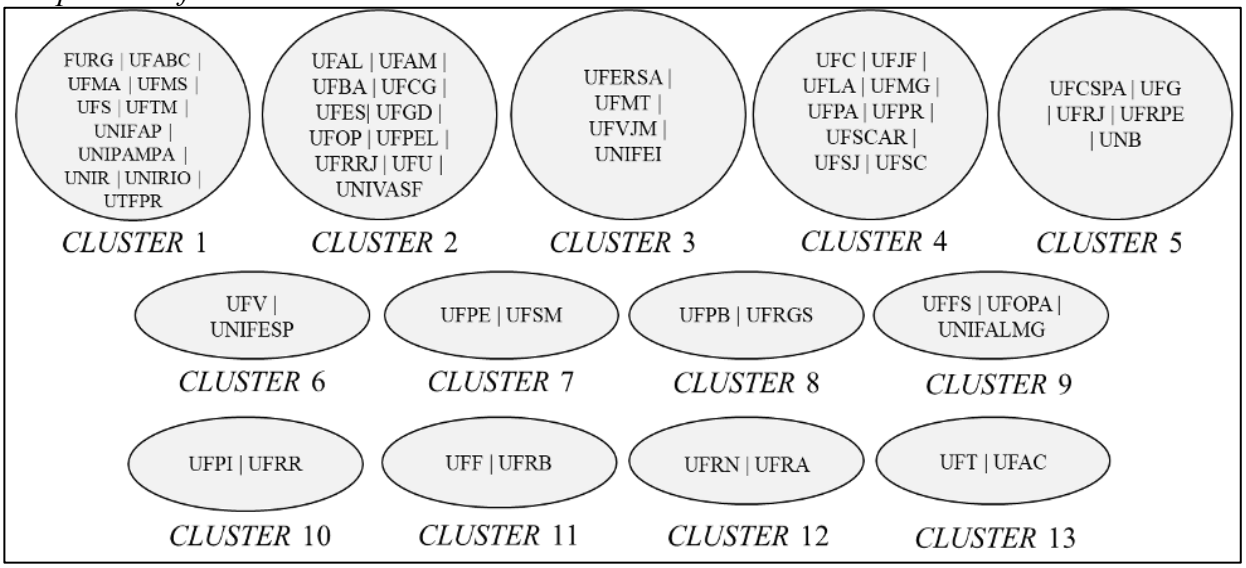
The model expresses the average cost per student at Brazilian federal universities as a function of the principal graduate education cost drivers. The model specification follows Fávero and Belfiore (2020, p. 794), in which: Y represents the phenomenon under investigation (average cost per student); α denotes the individual intercept for each university; β represents the coefficients associated with each explanatory variable; X denotes the explanatory variables, which vary across universities and over time; i identifies each university in the sample; t represents each time period (year); k indicates the total number of coefficients and explanatory variables included in the model; and **ε** corresponds to the idiosyncratic error term.

4 RESULTS AND DISCUSSIONS

4.1 Cluster analysis and descriptive statistics

The clusters of Brazilian federal universities were formed based on the similarity of their data patterns. According to Fávero and Belfiore (2020), determining the number of clusters is a methodological decision made by the researcher. Accordingly, 13 clusters were established (Figure 1), as the distance between groups increases substantially beyond this point. This choice was intended to avoid large increases in intergroup distance that would lead to the inclusion of observations with less homogeneous characteristics within the same cluster (Fávero e Belfiore, 2020, p. 330).

Figure 1
Composition of the clusters



Source: Authors' own elaboration.

The formation of the clusters reflects the overall similarity of the data rather than being driven by a single key factor. Instead, cluster membership depends on the complete set of observations associated with each university, as well as their similarities and differences relative to the remaining institutions. The analysis validates the resulting clusters by confirming that between variation is significantly greater than within variation at the 5% significance level, thereby demonstrating high internal homogeneity and substantial heterogeneity across clusters. For the statistical analysis, the average cost per student was transformed using the natural logarithm (ln) to reduce data dispersion.

For illustrative purposes, Cluster 6 was selected because it exhibited the highest coefficient of determination (R^2) among the estimated regression models. This cluster comprises the Federal University of Viçosa (UFV) and the Federal University of São Paulo (UNIFESP).

Based on these data, descriptive statistical analyses of the between and within variation of the independent variables were performed. The results indicate that the variables exhibiting the greatest within variation are: (1) GS/AF; (2) AF/GS; (3) EA/GS; (4) RG/GS; and (5) SP/GS. In contrast, the remaining variables exhibit greater between variation across Brazilian federal universities over time than variation within the same institution. The remaining descriptive statistical results are presented in Table 3.

Table 3
Descriptive statistics: mean, median, and standard deviation – Cluster 6

Statistics	ACS (ln)	GS/AF	AF/GS	GP/GS	EA/GS	AS/GS	RG/GS	SP/GS
Mean	11,16	3,51	0,30	0,05	0,39	0,23	0,07	2,25
Median	10,88	3,36	0,30	0,04	0,20	0,22	0,08	2,23
Standard deviation	0,46	0,72	0,06	0,02	0,39	0,13	0,02	0,95

Source: Authors' own elaboration.

The dependent variable, ACS (ln), has a mean of 11.16 and a median of 10.88, with a standard deviation of 0.46. The close proximity between the mean and the median, together with the relatively low standard deviation, indicates that the universities within this cluster exhibit a reasonably homogeneous and internally balanced average cost per student.

Regarding the number of graduate students (GS/AF), the variable showed a mean of 3.51 and a median of 3.36 among the cost drivers, with a moderate standard deviation (0.72). This

pattern suggests moderate and well-controlled internal variability across the institutions in the cluster. A similar pattern was observed for the number of active faculty members (AF/GS), the number of graduate programs offered (GP/GS), the number of research groups (RG/GS), and the number of scientific publications (SP/GS).

The number of academic supervisions (AS/GS) presented a mean of 0.23 and a median of 0.22, with a standard deviation of 0.13. Although this level of dispersion indicates some variability, the close correspondence between the mean and the median suggests an approximately symmetric distribution. This finding indicates that academic supervision activities are characterized by relatively uniform variation around the mean, reflecting the continuous and regular flow of master's and doctoral completions typical of the universities within this cluster.

In contrast, extension activities (EA/GS) exhibited a standard deviation equal to their mean (0.39). This pattern suggests a right-skewed distribution, indicating that extension activities do not follow a consistent linear pattern over time but instead alternate between periods of intense activity and years of lower engagement. Nevertheless, the absence of heteroscedasticity in the residuals indicates that the relationship between the independent variables and the average cost per student is appropriately captured by the specified model.

4.2 Panel data regression

In the panel data regression stage, the stepwise method was employed as a model refinement strategy. This procedure consists of the sequential elimination of variables based on their statistical significance, thereby maximizing the predictive performance of the model (Fávero & Belfiore, 2020). A minimum confidence level of 95%, corresponding to a 5% significance level, was adopted. The diagnostic tests indicated the absence of multicollinearity and heteroscedasticity.

The estimation of separate regression models for each cluster, rather than a single regression for the entire sample, is justified by the premise that cost drivers are associated with the average cost per student (ACS) in different directions and magnitudes depending on the institutional profile and characteristics of each group. Accordingly, the creation of specific clusters is based on rejecting standardized coefficients that could obscure institutional heterogeneity. Furthermore, due to space limitations, this article presents the estimated regression models only for Cluster 6. Nevertheless, Table 5 and Figure 2 summarize the estimated models for all clusters.

Accordingly, Table 4 presents the three panel data regression models estimated to identify the specification in which all cost drivers are statistically significant. The diagnostic tests indicated that the random-effects model provides the most appropriate specification, as the individual effects of the Brazilian federal universities were found not to be correlated with the independent variables.

Table 4

Estimated model: Random effects – Cluster 6

Explanatory variables	Model 1		Model 2		Model 3	
	Coef.	*p. value*	Coef.	*p. value*	Coef.	*p. value*
Constant	7.25	0.000 ***	7.21	0.000 ***	7.06	0.000 ***
GS/AF	0.53	0.000 ***	0.53	0.000 ***	0.55	0.000 ***
AF/GS	3.70	0.000 ***	3.72	0.000 ***	3.79	0.000 ***
GP/GS	10.43	0.000 ***	10.12	0.000 ***	10.42	0.000 ***
EA/GS	0.19	0.015 **	0.20	0.006 ***	0.23	0.000 ***
AS/GS	-0.04	0.803	-	-	-	-
RG/GS	-0.09	0.580	-0.97	0.556	-	-
SP/GS	0.22	0.000 ***	0.23	0.000 ***	0.22	0.000 ***
R^2	0.9573		0.9572		0.9567	

Notes. *** p < 0.01; ** p < 0.05; and * p < 0.10. Abbreviation: Coef. = coefficient.
Source: Authors' own elaboration.

In Model 1, all explanatory variables available in the dataset were included. The results indicate that only two cost drivers failed to reach statistical significance at the 5% level: (1) AS/GS and (2) RG/GS. In Model 2, the least significant variable (AS/GS) was removed. The results show

that RG/GS remained statistically non-significant. Model 3 was then estimated after excluding RG/GS, resulting in a specification in which all remaining cost drivers were statistically significant at the 1% level: (1) GS/AF; (2) AF/GS; (3) GP/GS; (4) EA/GS; and (5) SP/GS.

It is important to note that, in some models estimated for the other clusters, variables that did not meet the minimum threshold for statistical significance were retained because their exclusion reduced the overall significance of the model, suggesting that they may function as control variables within those specific clusters. Accordingly, Model 3 was selected as the most appropriate specification for Cluster 6. Based on the *p*-values and the magnitude of the estimated coefficients, the cost drivers were ranked in the following order of importance: (1) GP/GS; (2) AF/GS; (3) GS/AF; (4) EA/GS; and (5) SP/GS. The following model specification was therefore established for this cluster.

$$lnACS_{it} = 7.06 + 10.42\,.\,GP/GS_{it} + 3.79\,.\,AF/GS_{it} + 0.55\,.\,GS/AF_{it} + 0.23\,.\,EA/GS_{it} + 0.22\,.\,SP/GS_{it} + \varepsilon_{it}$$

The obtained R^2 indicates that 95.7% of the variation in the natural logarithm of the average cost per student (lnACS) is explained by changes in the graduate education cost drivers included in Model 3. The remaining variation is attributable to random factors not captured by the variables considered in this study. It is worth emphasizing that, for the purposes of this research, cost drivers are conceptualized as mechanisms for allocating institutional expenditures rather than as direct generators of costs.

Accordingly, the results indicate that a one-unit increase in GP/GS is associated with an expected increase of 10.42 units in lnACS. In other words, given the available resources, allocating an additional unit of resources to the provision of graduate programs has an estimated impact of 10.42 on the natural logarithm of the average cost per student. The model therefore reflects the consequences of allocating resources to this specific activity. The expansion of graduate programs may increase the demand for additional faculty members to support new courses. Considering that personnel expenditures constitute the largest component of university budgets, this relationship is expected. Moreover, offering graduate programs often requires a complex institutional infrastructure, including laboratories, specialized equipment, administrative staff, academic buildings, and classrooms, which helps explain why this variable exhibits the largest impact on the average cost per student.

A one-unit increase in AF/GS, which measures the number of active faculty members relative to graduate students, is associated with an expected increase of 3.79 units in lnACS. Thus, allocating resources to the recruitment and retention of active faculty members has an estimated effect of 3.79 on lnACS, indicating that faculty payroll represents the second most influential cost driver within this cluster. This relationship is consistent with the additional expenditures incurred through the hiring of new faculty, including salaries and employment-related benefits. It should also be noted that faculty teaching graduate courses generally possess higher academic qualifications, which are typically associated with higher levels of remuneration.

Similarly, a one-unit increase in GS/AF, which measures the number of enrolled graduate students relative to active faculty members, is associated with an expected increase of 0.55 units in lnACS. Therefore, allocating resources to increasing graduate enrollment has an estimated effect of 0.55 on the average cost per student. This relationship can be explained by the need to establish additional class sections as enrollment expands. The creation of new classes requires additional classrooms, teaching materials, equipment, and faculty members, thereby increasing institutional costs.

A one-unit increase in EA/GS is associated with an expected increase of 0.23 units in lnACS. Compared with the other variables, allocating resources to extension activities has a relatively modest budgetary impact. This finding may be explained by the fact that many extension activities receive financial support from philanthropic organizations or institutional partners,

thereby reducing the direct financial burden on universities and, in some cases, generating additional revenue for Brazilian federal universities.

Finally, a one-unit increase in SP/GS is associated with an expected increase of 0.22 units in lnACS. Direct investment in scientific production proved to be the least costly allocation alternative within this cluster, exhibiting the smallest estimated impact among the analyzed cost drivers. This positive association may reflect the faculty time devoted to research activities, as well as the financial investments required in certain fields of knowledge. Furthermore, increased research output is generally accompanied by a higher volume of journal publications and conference participation. In the latter case, graduate students frequently request institutional financial support to cover travel, accommodation, and registration expenses, thereby generating additional costs for the university.

It is important to emphasize that these findings do not imply that expanding graduate education necessarily increases institutional costs or the overall university budget. Rather, they indicate that, given a fixed pool of available resources, allocating those resources to the creation or maintenance of graduate programs is associated with a larger estimated effect on lnACS (10.42) than allocating the same resources to active faculty members (3.79), graduate student enrollment (0.55), extension activities (0.23), or scientific production (0.22).

4.3 Discussion of the results

Table 5 summarizes the results of the longitudinal panel data regression models and highlights the variables that achieved statistical significance at a confidence level of 95% or higher, ranked according to their relative importance based on the smallest *p*-value.

According to Table 5, the graduate education cost driver AF/GS emerged as the most recurrent statistically significant variable, being identified in 9 of the 13 clusters analyzed. This finding is particularly noteworthy because personnel expenditures constitute the largest share of university budgets (Kistner et al., 2022). The result is consistent with the findings reported by Duarte et al. (2020), Pinto-Ortiz et al. (2024), and Schwartzman (2022).

It is also important to note that the estimated coefficients for AF/GS, which measures the number of active faculty members relative to graduate students, exhibited both negative and positive signs across the different clusters. Negative coefficients indicate lower average costs associated with an increase in the faculty workforce, whereas positive coefficients indicate higher costs resulting from faculty expansion. This pattern underscores the heterogeneous nature of graduate education cost drivers. The positive relationship may be explained by the need to recruit additional faculty members. Since graduate faculty generally possess higher academic qualifications, they also tend to receive higher salaries, which may simultaneously contribute to improvements in the quality of higher education (Pinto-Ortiz et al., 2024). Conversely, the negative relationship may reflect the participation of volunteer faculty members, whose activities do not generate salary-related expenditures.

Another graduate education cost driver that appeared frequently across the estimated models was GS/AF, which measures the number of enrolled graduate students relative to active faculty members. This variable was also statistically significant in 9 of the 13 clusters. This finding highlights the central role of graduate education in the cost structure of universities, corroborating the conclusions of Koshal and Koshal (1999), Kistner et al. (2022), and Schwartzman (2022). Moreover, GS/AF ranked among the two most statistically significant variables with the largest estimated impacts in 5 of the 9 clusters in which it appeared, consistent with the findings of Blecich (2020) and Duarte et al. (2020). Similar to AF/GS, this cost driver exhibited both positive and negative relationships with institutional costs.

Table 5

Regression model outputs by cluster

Clusters		Explanatory variables							
		Constant	GS/AF	AF/GS	GP/GS	EA/GS	AS/GS	RG/GS	SP/GS
1	*p*-value	0.000	0.052	-	-	0.008	-	0.086	0.000
	Level of influence	10.34	-0.07	-	-	-0.20	-	0.64	0.04
	Rank	-	Contr.	-	-	2	-	Contr.	1
2	*p*-value	0.000	0.000	-	-	-	0.025	-	0.000
	Level of influence	10.54	-0.09	-	-	-	-0.01	-	0.03
	Rank	-	1	-	-	-	3	-	2
3	*p*-value	0.000	0.000	0.000	-	-	-	0.009	-
	Level of influence	10.52	-0.12	0.16	-	-	-	0.60	-
	Rank	-	2	1	-	-	-	3	-
4	*p*-value	0.000	0.000	0.008	0.000	-	-	-	-
	Level of influence	10.60	-0.04	0.41	-7.77	-	-	-	-
	Rank	-	2	3	1	-	-	-	-
5	*p*-value	0.000	0.000	-	0.000	0.001	-	-	-
	Level of influence	10.95	-0.07	-	1.04	-0.61	-	-	-
	Rank	-	2	-	1	3	-	-	-
6	*p*-value	0.000	0.000	0.000	0.000	0.000	-	-	0.000
	Level of influence	7.06	0.55	3.79	10.42	0.23	-	-	0.22
	Rank	-	3	2	1	4	-	-	5
7	*p*-value	0.000	-	0.000	0.000	-	0.000	0.007	0.000
	Level of influence	10.47	-	1.04	-22.66	-	0.13	-1.28	0.08
	Rank	-	-	2	1	-	3	5	4
8	*p*-value	0.000	0.007	0.000	0.004	-	0.000	0.000	-
	Level of influence	9.43	0.04	1.18	10.74	-	-0.98	8.33	-
	Rank	-	5	2	4	-	3	1	-
9	*p*-value	0.000	0.000	-	-	0.004	0.029	0.001	-
	Level of influence	10.84	-0.20	-	-	0.41	-0.07	-1.90	-
	Rank	-	1	-	-	3	4	2	-
10	*p*-value	0.000	0.110	0.001	-	0.110	-	0.000	-
	Level of influence	8.81	0.57	1.35	-	-0.92	-	-0.30	-
	Rank	-	Contr.	2	-	Contr.	-	1	-
11	*p*-value	0.000	-	0.000	-	-	-	0.000	0.001
	Level of influence	10.59	-	0.31	-	-	-	-2.49	0.07
	Rank	-	-	2	-	-	-	1	3
12	*p*-value	0.000	0.029	0.000	0.043	0.003	-	0.026	-
	Level of influence	11.16	-0.19	-1.07	6.38	0.54	-	3.96	-
	Rank	-	4	1	5	2	-	3	-
13	*p*-value	0.000	-	0.012	0.015	-	-	-	0.023
	Level of influence	10.25	-	-0.09	-1.71	-	-	-	0.33
	Rank	-	-	1	2	-	-	-	3

Notes. the remaining variables were excluded from the model because they did not achieve statistical significance at the 5% level or better. "Ctrl." indicates a variable retained in the model as a control variable. Source: Authors' own elaboration.

The positive association may be attributed to the need to establish additional class sections as graduate enrollment increases, thereby requiring additional physical facilities, teaching materials, equipment, and faculty members. In contrast, the negative relationship may be explained by the limited enrollment capacity of graduate courses, which allows fixed costs to be spread across a larger number of students. Consequently, as graduate enrollment increases, the average cost per student tends to decline because additional students can often be accommodated within existing classes without changes in faculty staffing, enabling the same costs to be shared among a larger student population.

The subsequent graduate education cost drivers found to be significant in the estimated models were GP/GS and RG/GS, both of which appeared in 7 of the 13 clusters. The GP/GS variable indicates that offering a larger number of graduate programs has a significant effect on university costs, corroborating the findings of Trento et al. (2021) and Kistner et al. (2022).

GP/GS exhibited both positive and negative relationships with institutional costs. The negative relationship may be explained by the fact that new programs can rely on faculty members already employed by the institution, thereby avoiding additional hiring. Conversely, the positive relationship may arise from the need to expand the faculty workforce to meet the demand generated by new graduate programs, in addition to the use of institutional facilities and material resources.

Regarding RG/GS, the results demonstrate that the cost driver associated with research groups, whose members are predominantly graduate students, affects the average cost per student. This finding corroborates the studies by Blecich (2020), Houghton et al. (2021), and Kistner et al. (2022). A dual pattern of effects was also identified. The positive relationship may be explained by the consumption of university resources by students engaged in research and extension activities. In contrast, the negative relationship may be attributed to external incentives and funding that support the activities of research groups, thereby generating additional revenue for the institutions.

SP/GS was present in 6 of the 13 clusters. This result indicates that scientific output, which involves substantial participation by graduate students, affects the average cost per student, consistent with the conclusions of Blecich (2020), Houghton et al. (2021), and Kistner et al. (2022). Once again, both positive and negative relationships were observed. The negative relationship follows a rationale similar to that applied to extension activities and research groups, as these three cost drivers are interconnected. In other words, extension activities frequently carried out by students participating in research groups often result in scientific publications. Consequently, funds transferred by partner institutions temporarily increase university revenues, thereby reducing university costs. The positive relationship was discussed in the analysis of Cluster 6.

EA/GS was present in 5 of the 13 clusters. The results demonstrate the influence of extension activities on university costs, as observed by Amaral (2004), Palotti et al. (2024), Richartz et al. (2023), Trento et al. (2021), and Houghton et al. (2021). Both positive and negative effects were also identified. The positive relationship may be explained by funding provided by philanthropic organizations or institutional partners, which assume the costs of these activities and increase the temporary revenues of Brazilian federal universities. The negative relationship, in turn, arises from the external financing of extension activities, whereby expenses associated with the time and resources of students and faculty members are covered by partner institutions through financial incentives for extension initiatives and projects.

Finally, AS/GS was statistically significant in only 4 clusters. Despite its lower recurrence, the variable proved relevant, as documented by Trento et al. (2021) and Kistner et al. (2022), and also exhibited dual effects. The positive relationship may stem from the additional faculty effort required for student supervision, which entails greater investment in research, materials, facilities, and time, since each new supervision involves a student who uses institutional infrastructure. Under conditions of high demand, the need to hire additional faculty members may affect costs because graduate students begin their programs under the supervision of a faculty advisor. The negative relationship, in contrast, may be associated with scholarships granted to students for

supervised scientific production, whose funds are recorded as university revenues and reduce the average cost per student.

Figure 2 summarizes the specifications of the proposed panel data regression models, together with their respective R^2 values. In 8 of the 13 model specifications, R^2 exceeded 50%, indicating that the graduate education-related explanatory variables accounted for more than half of the variation in the average cost per student in 61.5% of the clusters (8/13). This result reinforces the importance and relevance of graduate education in determining university costs.

For illustrative purposes, however, it is important to note that Clusters 1 and 2 are the most similar to each other when both the number of universities and the observed means are considered. Nevertheless, their explanatory variables and impact coefficients are not identical, further demonstrating the existence of institutional particularities even among universities with apparently similar cost profiles.

Accordingly, the findings indicate that the average cost per student is an unsuitable indicator for assessing performance and establishing comparisons among higher education institutions. This issue had previously been raised by Corbucci (2000) and Schwartzman (2022) and is corroborated by the results of the present study.

Figure 2

Regression model specifications by cluster

Clusters	Expressões dos modelos		
1	R^2 33%	$lnCMA_{it} = 10{,}34 + 0{,}04 \cdot \frac{PC}{APG_{it}} - 0{,}20 \cdot \frac{AE}{APG_{it}} - 0{,}07 \cdot \frac{APG}{DA_{it}} + 0{,}64 \cdot \frac{GP}{APG_{it}} + \varepsilon_{it}$	
2	R^2 26%	$lnCMA_{it} = 10{,}54 - 0{,}09 \cdot \frac{APG}{DA_{it}} + 0{,}03 \cdot \frac{PC}{APG_{it}} - 0{,}01 \cdot \frac{O}{APG_{it}} + \varepsilon_{it}$	
3	R^2 67%	$lnCMA_{it} = 10{,}52 + 0{,}16 \cdot \frac{DA}{APG_{it}} - 0{,}12 \cdot \frac{APG}{DA_{it}} + 0{,}60 \cdot \frac{GP}{APG_{it}} + \varepsilon_{it}$	
4	R^2 25%	$lnCMA_{it} = 10{,}60 - 7{,}77 \cdot \frac{CPG}{APG_{it}} - 0{,}04 \cdot \frac{APG}{DA_{it}} + 0{,}41 \cdot \frac{DA}{APG_{it}} + \varepsilon_{it}$	
5	R^2 29%	$lnCMA_{it} = 10{,}95 + 1{,}04 \cdot \frac{CPG}{APG_{it}} - 0{,}07 \cdot \frac{APG}{DA_{it}} - 0{,}61 \cdot \frac{AE}{APG_{it}} + \varepsilon_{it}$	
6	R^2 96%	$lnCMA_{it} = 7{,}06 + 10{,}42 \cdot \frac{CPG}{APG_{it}} + 3{,}79 \cdot \frac{DA}{APG_{it}} + 0{,}55 \cdot \frac{APG}{DA_{it}} + 0{,}23 \cdot \frac{AE}{APG_{it}} + 0{,}22 \cdot \frac{PC}{APG_{it}} + \varepsilon_{it}$	
7	R^2 80%	$lnCMA_{it} = 10{,}47 - 22{,}66 \cdot \frac{CPG}{APG_{it}} + 1{,}04 \cdot \frac{DA}{APG_{it}} + 0{,}13 \cdot \frac{O}{APG_{it}} + 0{,}08 \cdot \frac{PC}{APG_{it}} - 1{,}28 \cdot \frac{GP}{APG_{it}} + \varepsilon_{it}$	
8	R^2 91%	$lnCMA_{it} = 9{,}43 + 8{,}33 \cdot \frac{GP}{APG_{it}} + 1{,}18 \cdot \frac{DA}{APG_{it}} - 0{,}98 \cdot \frac{O}{APG_{it}} + 10{,}74 \cdot \frac{CPG}{APG_{it}} + 0{,}04 \cdot \frac{APG}{DA_{it}} + \varepsilon_{it}$	
9	R^2 44%	$lnCMA_{it} = 10{,}84 - 0{,}20 \cdot \frac{APG}{DA_{it}} - 1{,}90 \cdot \frac{GP}{APG_{it}} + 0{,}41 \cdot \frac{AE}{APG_{it}} - 0{,}07 \cdot \frac{O}{APG_{it}} + \varepsilon_{it}$	
10	R^2 68%	$lnCMA_{it} = 8{,}81 - 0{,}30 \cdot \frac{GP}{APG_{it}} + 1{,}35 \cdot \frac{DA}{APG_{it}} - 0{,}92 \cdot \frac{AE}{APG_{it}} + 0{,}57 \cdot \frac{APG}{DA_{it}} + \varepsilon_{it}$	
11	R^2 52%	$lnCMA_{it} = 10{,}59 - 2{,}49 \cdot \frac{GP}{APG_{it}} + 0{,}31 \cdot \frac{DA}{APG_{it}} + 0{,}07 \cdot \frac{PC}{APG_{it}} + \varepsilon_{it}$	
12	R^2 60%	$lnCMA_{it} = 11{,}16 - 1{,}07 \cdot \frac{DA}{APG_{it}} + 0{,}54 \cdot \frac{AE}{APG_{it}} + 3{,}96 \cdot \frac{GP}{APG_{it}} - 0{,}19 \cdot \frac{APG}{DA_{it}} + 6{,}38 \cdot \frac{CPG}{APG_{it}} + \varepsilon_{it}$	
13	R^2 55%	$lnCMA_{it} = 10{,}25 - 0{,}09 \cdot \frac{DA}{APG_{it}} - 1{,}71 \cdot \frac{CPG}{APG_{it}} + 0{,}33 \cdot \frac{PC}{APG_{it}} + \varepsilon_{it}$	

Notes. the remaining variables were excluded from the model because they did not achieve statistical significance at the 5% level or better. R^2: coefficient of determination. Source: Authors' own elaboration.

This conclusion is supported by the analysis of Table 5 and Figure 2, together with the individual examination of the clusters, which reveals the absence of a single common pattern in the equations determining university costs. The variables comprising the statistically significant cost drivers vary across clusters, and even when the same variables appear in different clusters, the direction of their effects may alternate between positive and negative. Thus, the same variable may be associated with higher costs in one group of universities and lower costs in another.

It is also noteworthy that the clusters with the highest coefficients of determination (R^2) are those containing the smallest number of universities. This finding suggests that regressions estimated separately for each Brazilian federal university may provide a more appropriate basis for identifying cost drivers, thereby reinforcing the premise that each university has a unique and institution-specific cost structure. Moreover, this evidence supports the argument that the average cost per student is not a comparable metric for assessing institutional performance.

5 CONCLUSION

Based on the evidence obtained in this study, it was found that all Brazilian federal universities currently in operation maintain graduate programs, underscoring the relevance of the present investigation. Accordingly, this study aimed to analyze the main graduate education cost drivers in Brazilian federal universities and to identify the extent to which the most statistically significant cost drivers influence institutional costs.

To minimize bias in the results, the universities were analyzed using homogeneous groupings obtained through cluster analysis, resulting in 13 distinct clusters. This approach is justified by the institutional particularities inherent to each university. Furthermore, all cost drivers considered in the study were found to be statistically significant in at least one of the 13 clusters. However, five of the seven indicators were statistically significant in more than half of the clusters, indicating a consistent pattern.

These cost drivers comprised: active faculty members (9 occurrences), enrolled graduate students (8 occurrences), graduate programs offered (7 occurrences), research groups (7 occurrences), and scientific publications (6 occurrences). It can therefore be inferred that these graduate education-related cost drivers play a relevant role in determining the average cost per student among the explanatory variables analyzed. The findings also indicate that no hierarchical pattern of significance exists across the clusters, such that a cost driver that is highly significant in one cluster may be less relevant or even statistically insignificant in another.

Consequently, the results should be interpreted individually for each cluster, considering the different effects of the cost drivers within each institutional context. Accordingly, institution-specific analyses should consider the university of interest according to the cluster to which it belongs, and the corresponding model estimated for that cluster. The study therefore makes an empirical contribution by demonstrating that the unique characteristics of the Brazilian federal universities examined must be considered, requiring a careful and context-specific interpretation of the findings.

Another important contribution of this study lies in challenging the assumption that the average cost per student can be used as a standardized benchmark for comparison across Brazilian federal universities. By demonstrating that each cluster is characterized by a distinct regression equation and a different set of cost drivers, the study provides empirical support for the arguments advanced by Corbucci (2000) and Schwartzman (2022), who contend that the average cost per student is not an appropriate metric for comparing Brazilian federal universities. The findings indicate that the average cost per student reflects managerial resource allocation decisions and the relative intensity of effort devoted to different institutional activities. Therefore, the notion that universities share a homogeneous cost structure is not supported, highlighting the need for analytical models that account for the distinctive characteristics and strategic priorities of each institution.

As demonstrated, particularly in Table 5 and Figure 2, each group of universities with similar characteristics exhibited different cost drivers and impact coefficients when compared with the remaining clusters. This variation reflects differences in institutional objectives, which give rise to distinct explanatory variables and impact coefficients in the estimation of university costs (Koshal & Koshal, 1999).

The conclusions of this study are limited to Brazilian federal universities and should not be generalized to private or state higher education institutions. Likewise, the findings cannot be extrapolated to periods prior to 2000 and may differ substantially after 2019, given the effects of the COVID-19 pandemic. Nevertheless, this study provides a methodological basis for future research involving private and state universities, alternative cost drivers, or Brazilian federal universities during subsequent periods.

An additional limitation is that the analysis did not distinguish alternative and internally generated funding sources obtained by universities through lato sensu graduate programs. It is

acknowledged that specialization programs may be financed and managed through supporting foundations and institutional revenues, whereas academic master's and doctoral programs depend primarily on federal government funding and research agencies such as CAPES. Because the scope of this study focused on cost drivers affecting the federal budget, future research should incorporate external and private funding managed by these partner foundations.

Finally, future studies should estimate impact coefficients separately for each Brazilian federal university in order to validate the regression specifications proposed in this study. Institution-specific analyses are also recommended to investigate whether consistent patterns exist in the statistical significance ranking of cost drivers and whether these patterns are associated with the geographical regions in which the universities are located. In addition, future research may extend the analysis to include data collected during and after the COVID-19 pandemic to assess its potential effects on the estimated relationships and resulting inferences.

REFERENCES

Abelino, J., Borgert, A., & Engelage, E. (2020, July 29–31). Efeitos da aplicação de recursos públicos nos indicadores de educação em universidades federais brasileiras. *Anais do XX USP International Conference in Accounting*.

Almeida, J. H. M., Aquino, C. V. M. G., & Silva, C. R. M. (2019). Quanto custa um aluno do ensino superior? Um estudo na Universidade Estadual Vale do Acaraú (UVA). *Educação Online, 14*(30), 93–111. https://doi.org/10.36556/eol.v14i30.505

Alonso, M. (2022). Custos no serviço público. *Revista do Serviço Público – RSP, 73*(85), 127–152. https://revista.enap.gov.br/index.php/RSP/article/view/8726

Amaral, N. C. (2004). Evolução do custo do aluno das IFES: eficiência? *Avaliação: Revista da Avaliação da Educação Superior, Campinas, 9*(2), 115–125. https://periodicos.uniso.br/avaliacao/article/view/1272

Associação Nacional dos Dirigentes das Instituições de Ensino Superior. (2016, 09 ago). *MEC anuncia corte de 20% no orçamento 2017 das Universidades Federais*. Andifes. https://www.andifes.org.br/?p=49895

ASPUV. (2022, 18 jul). *Investimentos nas universidades federais caíram 96% desde 2015*. Aspuv. https://aspuv.org.br/investimentos-nas-universidades-federais-cairam-96-desde-2015/

Berman, E. P., & Paradeise, C. (2016). Introduction: the university under pressure. *Research in the Sociology of Organizations, 46*, 1–22. https://epberman.net/wp-content/uploads/2018/09/berman-paradeise-introduction.pdf

Bielschowsky, C. E., & Amaral, N. C. (2022). O custo do aluno das 2.537 instituições de educação superior brasileiras: cai um mito? *Educação & Sociedade, 43*, 1–21. https://doi.org/10.1590/ES.243866

Bjørnenak, T. (2000). Understanding cost differences in the public sector: a costs drivers approach. *Management Accounting Research, 11*(2), 193–211. https://doi.org/10.1006/mare.2000.0128

Blecich, A. A. (2020). Factors affecting relative efficiency of higher education institutions of economic orientation. *Management: Journal of Contemporary Management Issues, 25*(1), 45–67. https://hrcak.srce.hr/file/347103

Boaventura, F. A. A., Moreira, N. P., & Gonçalves, A. R. A. (2019, november 11–13). Análise dos fatores associados ao custo por aluno das universidades federais brasileiras que aderiram ao REUNI. *Anais do XXVI Congresso Brasileiro de Custos*.

Borgert, E. A., & Gasparetto, V. (2019). Fatores que influenciam os custos, na abordagem da gestão estratégica de custos: análise empírica em centros de saúde municipais. *Cuadernos de Contabilidad, 20*(49). https://doi.org/10.11144/Javeriana.cc20-49.fica

Branco, L. S. C. (2013). O planejamento estratégico no setor público brasileiro. *GєCont – Revista de Gestão e Contabilidade da UFPI, 1*(1), 173–182. https://revistas.ufpi.br/index.php/gecont/article/view/1556

Carneiro, D. M. (2015). *Determinantes de custos: Uma proposta de sistematização* [Dissertação de mestrado, Universidade de São Paulo].

Chiau, A. V., & Panucci-Filho, L. (2014). Custos nas instituições federais de ensino superior: Análise comparativa entre duas Universidades Federais do Sul do Brasil. *REICE - Revista Iberoamericana sobre Calidad, Eficacia y Cambio en Educación, 12*(1), 55–71. https://revistas.uam.es/reice/article/view/2864

Coordenação de Aperfeiçoamento de Pessoal de Nível Superior. (2021, February 10). *Pós-graduação brasileira cresce 48% na última década*. CAPES. https://www.gov.br/capes/pt-br/assuntos/noticias/pos-graduacao-brasileira-cresce-48-na-ultima-decada

Corbucci, P. R. (2000). *As universidades federais: Gastos, desempenho, eficiência e produtividade* (Texto para Discussão No. 752). Instituto de Pesquisa Econômica Aplicada. https://repositorio.ipea.gov.br/bitstream/11058/2309/1/TD_752.pdf

Duarte, M. G. P., Gonçalves, E., Chein, F., & Taveira, J. G. (2020). Drivers of scientific-technological production in brazilian higher education and research institutions. *Revista de Economia Contemporânea, 24*(3), 1–41. https://doi.org/10.1590/198055272432

Fávero, L. P., & Belfiore, P. (2020). *Manual de análise de dados: Estatística e modelagem multivariada com Excel®, SPSS® e Stata®*. GEN.

Fehlauer, D. K., Vieira, A. M., & Claro, J. A. C. S. (2019). Pesquisa em administração e sua relação com o Plano Nacional de Pós-Graduação. *Gestão e Desenvolvimento, 16*(3), 83–105. https://www.redalyc.org/journal/5142/514262384005/movil/

Ferreira, E. C. C. (2019). *A importância das instituições de ensino superior no desenvolvimento regional em Portugal* [Tese de doutorado, Universidade de Évora]. http://hdl.handle.net/10174/25457

Flégl, M., & Vitavská, K. (2013). Efficiency at faculties of economics in the Czech Public higher education institutions: Two different approaches. *International Education Studies, 6*(10), 1-12. https://doi.org/10.5539/ies.v6n10p1

Goularte, M. de M., & Borgert, A. (2023). Determinantes de custos em universidades federais brasileiras. *Revista ABCustos, 18*(1), 75–97. https://revista.abcustos.org.br/abcustos/article/view/665

Hernández, F. S. (2020). Alcances y límites de la asignación de presupuesto y financiamiento en posgrados del PNPC-CONACYT. *Revista Perspectiva Empresarial, 7*(2), 65–73. https://doi.org/10.16967/23898186.656

Heusi, A. C. da S., Moraes, M. C. B., Raupp, F. M., & Beuren, I. M. (2015). Determinação do cálculo do custo por vaga e matrícula efetiva em universidade pública. *Revista Gestão Universitária na América Latina - GUAL, 8*(3), 70–92. https://doi.org/10.5007/1983-4535.2015v8n3p70

Houghton, K. A., Bagranoff, N., & Jubb, C. (2021). The funding of higher education: an empirical examination of the cost of education in business schools. *A Journal of Accounting, Finance and Business Studies, 57*(4), 780–809. https://doi.org/10.1111/abac.12230

Kistner, S. P., Gasparetto, V., & Borgert, A. (2022). *Costs drivers* estruturais e os custos em uma universidade federal brasileira. *Revista de Contabilidade e Controladoria, 14*(3), 103–121. https://revistas.ufpr.br/rcc/article/view/84372

Kistner, S. P., Gomes, H. M. S, Borgert, A., & Richartz, F. (2023). Cost drivers e os custos de universidades federais brasileiras. *Anais do XXI Colóquio Internacional de Gestão Universitária*.

Koshal, R., & Koshal, M. (1999). Economies of scale and scope in higher education. *Economics of Education Review, 18*(2), 269–277. https://doi.org/10.1016/S0272-7757(98)00035-1

Lei Complementar nº 101, de 04 de maior de 2000. (2000). *Estabelece normas de finanças públicas voltadas para a responsabilidade na gestão fiscal e dá outras providências*. https://www.planalto.gov.br/ccivil_03/leis/lcp/lcp101.htm

Magalhães, E. A. de, Silveira, S. de F. R., Abrantes, L. A., Ferreira, M. A. M., & Wakim V. R. (2010). Custo do ensino de graduação em instituições federais de ensino superior: O caso da Universidade Federal de Viçosa. *Revista de Administração Pública, 44*(3), 637-666. https://bibliotecadigital.fgv.br/ojs/index.php/rap/article/view/6940/5507

Magheed, B. A. (2016). The determines of the sticky cost behavior in the Jordanian industrial companies listed in Amman Stock Market. *Journal of Accounting, Business & Management, 23*(1), 64–81. https://journal.stie-mce.ac.id/index.php/jabminternational/article/view/100

Marin, J. C. (2012). The impact of strategic planning and the balanced scorecard methodology on Middle managers' performance in the public sector. *International Journal of Business and Social Science, 3*(1),114–127. https://ijbss.thebrpi.org/journals/Vol_3_No_1_January_2012/12.pdf

Martins, E., & Peixinho, R. M. T. (2017). Desenvolvimento de um sistema de contabilidade de gestão: o caso da Universidade do Algarve. *Dos Algarves: A Multidisciplinary e-Journal*, *29*, 64–82. https://dosalgarves.com/index.php/dosalgarves/article/view/112

Mazieiro, G. (2019, May 2). *Em 4 anos, Brasil reduz investimento em educação em 56%; cortes continuam*. UOL. https://educacao.uol.com.br/noticias/2019/05/02/em-4-anos-brasil-reduz-investimento-em-educacao-em-56.htm

Ministério da Educação e Cultura. (2022a). *Programa de Apoio a Planos de Reestruturação e Expansão das Universidades Federais (Reuni)*. http://portal.mec.gov.br/reuni-sp-93318841

Ministério da Educação e Cultura. (2022b). *Qual é a diferença entre faculdades, centros universitários e universidades?* http://portal.mec.gov.br/pet/127-perguntas-frequentes-911936531/educacao-superior-399764090/116-qual-e-a-diferenca-entre-faculdades-centros-universitarios-e-universidades

Moritz, G. O., Pereira, M. F., Moritz, M. O., & Maccari, E. A. (2013). Brazilian post graduation degree studies: evolution and main challenges in the prospective scenarios environment. *Future Studies Research Journal, 5*(2), 3–34. https://future.emnuvens.com.br/FSRJ/article/view/136

Mota, S. C., Oliveira, A. R. V. de, Nunes, N. T. S., & Figueirêdo, H. S. de, Junior. (2022). Comparative analysis of cost management in higher education Brazilian Federal Institutions. *Revista do Serviço Público (RSP), 73*(1), 112–135. https://doi.org/10.21874/rsp.v73.i1.4934

Moura, M. (2019, 11 abr). Universidades públicas respondem por mais de 95% da produção científica do Brasil. *Ciência na Rua*. https://ciencianarua.net/universidades-publicas-respondem-por-mais-de-95-da-producao-cientifica-do-brasil/

Namazi, M., & Zare, S. (2021). Calculation of the cost of student education: A case study of Shiraz Medical School. *Journal of Advances in Medical Education & Professionalism, 9*(2), 109–122. https://doi.org/10.30476/JAMP.2020.86837.1271

Nez, E., & Silva, R. T. P. (2017). Uma discussão sobre o ensino na universidade para a "além" da sociedade do conhecimento. *Revista Panorâmica online, 22*, 65–79. https://periodicoscientificos.ufmt.br

Palotti, P. L. de M., Joppert, M. P., & Machado, J. A. (2024). A influência de aspectos organizacionais das instituições de ensino e pesquisa sobre os custos de transação na formação de parcerias com governos locais. *Revista de Administração Pública, 58*(3), 1–22. https://doi.org/10.1590/0034-761220230344

Pinto-Ortiz, L., Pias-Machado, D., & Costa-Quintana, A. (2024). Geração de valor público nas universidades federais brasileiras. *Revista Iberoamericana de Educación Superior, 15*(43), 105–122. https://doi.org/10.22201/iisue.20072872e.2024.43.1330

Richartz, L., Borgert, A., & Cavichioli, D. (2023). Análise de possíveis determinantes de custos em universidades pública e privada. *Enfoque – Reflexão Contábil, 42*(1), 33–52. https://periodicos.uem.br/ojs/index.php/Enfoque/article/view/57138

Santos, E. F., Abbas, K., & Catânio, A. R. (2020). Costs drivers: reflexões sobre definições, conceitos e aplicabilidades. *Revista Mineira de Contabilidade, 21*(1), 34–45. https://revista.crcmg.org.br/rmc/article/view/1046

Santos, J. A., & Pereira, V. de C. (2019, november 11–13). A destinação orçamentária da União e sua vinculação ao custo aluno nas Universidades Federais. *Anais do XXVI Congresso Brasileiro de Custos*.

Santos, M. I. C., Santos, R. F., & Callado, A. A. C. (2021). O efeito sunk cost no processo decisório dos discentes de Instituições de Ensino Superior. *RC&C -Revista Contabilidade e Controladoria, 13*(2), 113–129. http://dx.doi.org/10.5380/rcc.v13i2.79197

Schwartzman, S. (2015). Demanda e políticas públicas para o ensino superior nos BRICS. *Caderno CRH, 28*(74), 267–290. https://www.scielo.br/j/ccrh/a/mNwp7dMJt65k5RKf6kSj8qb/?lang=pt

Schwartzman, S. (2022). Pesquisa e pós-graduação no Brasil: duas faces da mesma moeda? *Estudos Avançados, 34*(104), 227–254. https://www.scielo.br/j/ea/a/mM4ZbvgxfKYSjWv6bwL7fMg/abstract/?lang=pt

Shleifer, A., & Vishny, R. W. (1994). Politicians and firms. *The Quarterly Journal of Economics, 109*(4), 995–1025. https://scholar.harvard.edu/files/shleifer/files/politicians_firms.pdf

Silva, A. C. (2001). Alguns problemas do nosso ensino superior. *Estudos Avançados, 15*(42), 269–293. https://www.scielo.br/j/ea/a/K7qGYkTrDXZB5VHJfprtdKF/

Sobral, B., & Cabral, B. (2025). O valor de uma universidade pública: Qual é o retorno da UERJ à sociedade fluminense. *Cadernos do Desenvolvimento Fluminense, 29*, 283–301. https://doi.org/10.12957/cdf.2025.89435

Souza, I. M. (2009). *Gestão das universidades federais brasileiras: Uma abordagem fundamentada na gestão do conhecimento* [Tese de doutorado, Universidade Federal de Santa Catarina]. https://repositorio.ufsc.br/handle/123456789/93410

Tenente, L., & Figueiredo, P. (2019, May 15). *Entenda o corte de verba das universidades federais e saiba como são os orçamentos das 10 maiores*. G1. https://g1.globo.com/educacao/noticia/2019/05/15/entenda-o-corte-de-verba-das-universidades-federais-e-saiba-como-sao-os-orcamentos-das-10-maiores.ghtml

Toompuu, K., & Põlajeva, T. (2014). Theoretical framework and an overview of the cost drivers that are applied in universities for allocating indirect costs. *Procedia - Social and Behavioral Sciences, 110*(2014), 1014-1022.

Tribunal de Contas da União. (2002). *Decisão Plenária nº 408, de 24 de abril de 2002: Relatório consolidado das auditorias operacionais realizadas em universidades federais com o objetivo de se obterem dados regionais como contribuição para a elaboração de um diagnóstico na área do ensino superior em nível nacional. Metodologia de avaliação inicialmente aplicada na Fundação Universidade de Brasília*.

Trento, D., Borgert, A., & Engelage, E. (2021). Comportamento dos custos em universidades federais brasileiras e sua relação com variáveis de educação. *Revista Universo Contábil, 17*(3), 118–141. https://ojsrevista.furb.br/ojs/index.php/universocontabil/article/view/10065

Widiyono, D., Mujiyanto, K., & Surono, E. K. (2020). Analysis of the implementation of the education cost in private Buddhist higher education in Indonesia. *International Journal of Scientific & Technology Research, 9*(1), 142–148. http://www.ijstr.org/final-print/jan2020/Analysis-Of-The-Implementation-Of-The-Education-Cost-In-Private-Buddhist-Higher-Education-In-Indonesia.pdf

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest.

DATA AVAILABILITY

The authors declare that all data underlying the research presented in the manuscript are contained within the manuscript itself.

AUTHOR CONTRIBUTIONS

Roles	1st author	2nd author
Conceptualization	♦	
Data Curation	♦	
Formal Analysis	♦	
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