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COST OF UNIVERSITY TEACHING, EFFICIENCY AND ECONOMIES OF SCALE

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ABSTRACT

The objective of the study is to empirically verify whether economies of scale exist in teaching management in the Chilean university system. To this end, a sample of 46 universities with different administrative regimes and heterogeneous qualities and sizes was selected for the purposes of the study. Furthermore, an analysis of the costs per enrolled student was conducted, and a Stochastic Frontier (SF) model was employed to assess the degree of management inefficiency. The same data were used to analyze the presence of economies of scale in the joint production of professional teaching and academic quality. The findings indicate the presence of economies of scale in joint production of teaching and quality, thereby refuting the hypothesis of management inefficiency. This analysis facilitates the identification of options for the formulation of academic and financial policies for the university system.

KEYWORDS: Industrial Organization, University Efficiency, University Quality Costs, Economies Of Scale In Universities, Stochastic Frontier, University Funding, University Student Funding.

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INTRODUCTION

Chile's higher education financing policy has been problematic for decades (Meller P. 2014; Cabrales F. 2015). In recent years, attempts have been made to contain costs by fixing fees and the number of enrollment vacancies offered to students. Simultaneously, progressively demanding quality controls have been imposed through a National Quality Assurance System composed of the Education Quality Agency, the Superintendence of Education, and the National Education Council under the Ministry of Education.

Since 2005, authorities have set reference fees to define the value of financial support (loans of different denominations, scholarships, and other aid or demand subsidies) received by students. This system produced several difficulties that led to a political crisis around 2011, particularly due to the high cost of personal indebtedness.

This prompted the debate and, finally, a change in the higher education student financing system. This change is expressed by Law No. 21.091 of 2018. Reference fees became mandatory for universities that received students with financial support for free tuition.

In the present, in practice, all universities that are part of the free-of-charge education system must charge fees calculated by the administrative authority, and their growth is limited by the same. Fees must consider the cost of material and human resources, according to the technical bases, of study programs from groups of related programs. In addition, the fee considers the direct and indirect annual costs and the annualized cost of investments in necessary infrastructure, such as laboratories, services, and buildings. The reference fee also considers the quality of the higher education institution (degree of complexity) via weightings that increase the value of the fee as the value of a group of quality indices increases.

In general, the setting of the fee takes historical information from the universities and adjusts the parameters so that the financial contribution to the students can be financed within the available budget. The available budget arises from a separate independent process: the Public Sector Budget Law. In this sense, a financing system is a cost-containment system.

However, another group of institutions, those that are not affiliated with the free-of-charge policy, can freely define their fees, as well as their vacancies, or annual offers for their undergraduate studies. This is a greater asymmetry if one considers that the annual cost paid by the state as a guarantee for student loans in this sector is approximately 1 billion USD per year. The coexistence of free-of-charge options and state-guaranteed loans generates strong tensions in the system regarding the probabilities of growth and consolidation of the university system

The system designed in this way does not allow the establishment of long-term management criteria, nor does it make it possible to verify whether universities are making efficient use of available resources. Indeed, the system does not provide incentives to take advantage of economies of scale (if any), to efficiently manage the resources allocated to each university (given their specific circumstances), or to define whether different types of universities have an advantage over others.

It is worth noting that the profound transformation brought about by the military dictatorship at the beginning of the 1980s led to a significant increase in the number of universities in Chile, and at least three types of university institutions were created:

- The state universities, many of which were created at that time from regional branches of the state universities of the time: the University of Chile (UCH) and the Universidad Técnica del Estado [State Technical University] (UTE). These universities receive basal contributions regulated by law; these contributions are minimal; they are competed by productivity on an annual basis and, therefore, the largest amount of funding for state universities is provided by the market logic. They belong to the Council of Rectors of Chilean Universities.
- Non-state universities created for public purposes, which existed before the reforms and were also restructured, gave rise to other private or state institutions. These are treated in a mixed manner as they receive basal fiscal contributions but are not subject to the rules of state institutions. In any case, the greatest amount of resources is achieved according to the market logic and demand subsidies. On average, they are the highest-quality group of institutions, according to the criteria of the National Accreditation Commission. They belong to the Council of Rectors of Chilean Universities.
- Private institutions were created as a result of the reforms of the early 1980s, which basically took advantage of the relaxation of regulations to create this type of institution. These institutions operate according to market logic but receive significant resources from the state for free-of-charge education, and the state guarantees the

student loans granted by the system to its students. Only three of these universities belong to the Council of Rectors of the Chilean Universities.

Various types of institutions are at the center of a lively debate about the efficiency, relevance, purpose, and amount of fiscal contributions to various types of universities. Therefore, verifying the existence of management inefficiencies and economies of scale is of great importance to contribute to the design of public policies in a country whose higher education budget has doubled in the last 15 years.

1. LITERATURE REVIEW

University activities are usually divided simplistically into three main categories: Teaching, Research, and Extension (in Chile, the term "linkage with the environment" is used). Therefore, in simplified terms, the products, in the same order, would be graduates, publications, and a series of heterogeneous products that are grouped under "linkage with the environment."

The boundaries between products are blurred (for example, professional development (master's degrees, diplomas, and others) have been considered teaching, and in other cases, linkage; the research process is valued differently depending on the source of funding, etc.). To finance the free education policy, Chilean law considers only those costs that are reasonable for teaching, although in practice it is difficult to distinguish what proportion of academic hours, staff, equipment, and infrastructure correspond to teaching, research, and outreach.

Two aspects of the Chilean fee system should be noted:

- Fees are differentiated by program, that is, according to the degree to which a study program leads.
- Fees are independent of the number of courses or credits taken by students. In other words, there are no fees for transferable credits, hours of dedication, materials, use of infrastructure, or the number of subjects taken.

Thus, for example, a year of study in a pedagogy program is less expensive than a year in law, even though pedagogy students may have more hours of classes or use additional resources (laboratories, externships, etc.). This is because of the prevailing market logic in the country. The pricing system produces several management problems and distorting incentives that are not discussed here. However, the pricing process underway should reduce these situations.

University products are differentiated by their quality, and this is a variable that is not directly observable, but of great relevance. In fact, all analyses referring to university management, higher education, and related areas use some measure of relative quality (rankings, ad hoc scores, student preferences, etc.).

Various quality rankings have emerged at the international level. Each of them has an instrumental definition of quality that does not always deliver consistent results among them. The debate on the consistency, usefulness, and relevance of university rankings[1] is broad and impossible to summarize here.

To measure the quality of Chilean universities, we chose to consider the indexes prepared by the two most important press media in the country, the 2017 indexes of El Mercurio (EM) and La Tercera (LT). These indices have similar characteristics to the most internationally known indices, as shown by Ganga, Saez et al. (2020). al. (2020). These are the weighted averages of a group of objective indicators and a group of surveys of students, academics, and specialists. They have the advantage of coverage for the Chilean case (international indices do not consider most Chilean universities); they can be considered more by Chilean students[2] when making their higher education decisions, and only these have the same coverage as the economic and financial information provided by the Ministry of Education.

Thus, in both indices, there is a sub-index that refers to student preferences, this should be significant for this work for two reasons:

1- It may be associated with a revealed market preference.
2- In fact, students' preferences have been used as an indicator of university quality in Chile, based on the preferences of the top scorers in admission tests. In fact, this preference is the basis for some items of state financing, the so-called Indirect Tax Contribution (Aporte Fiscal Indirecto - AFI).

To obtain an idea of the divergences that may exist

[1] A comprehensive review on rankings is provided in Hazelkorn E. and Mihut G. (2021; Eds.). Unesco (2013) also carries out an extensive and important review.

[2] The relationship between student preferences, learning experience, as well as other values of higher education and the ranking of universities or programs occupies Chapter IV of Hazelkorn E. and Mihut G. (2021; Eds.). (2021; Eds.). The evidence reported by the authors of this chapter indicates that there is little relationship between rankings and student preferences, good educational experiences and the application of relevant university values.

between the LT and EM rankings, a simple correlation and Spearman analysis were performed for the rankings. Table 1 shows the results, and it can be seen that there is a high correlation between the two and that they are not independent.

Table 1. Correlations between Rankings La Tercera/El Mercurio.

N° Observations: 40	
Spearman Rho	0.8293
Spearman Test H0: rankings are independent	Prob > |t| = 0.0000
Simple Score Correlation	0.8346

The component scores of the rankings were as follows:

- The student preference scores from both rankings had an even higher correlation of 94.92%. This indicates that both measure student preferences identically.
- The largest discrepancies (< 80%) were found between the sub-index of LT students and the total EM score (76.2%), which was replicated analogously between the latter and the sub-index of EM students (79.6%).

The following figure shows the relationship between the La Tercera ranking (vertical axis) and El Mercurio ranking (horizontal axis). Universities above the 45° line have lower rankings in La Tercera than in El Mercurio, and those below the 45° line have the opposite.

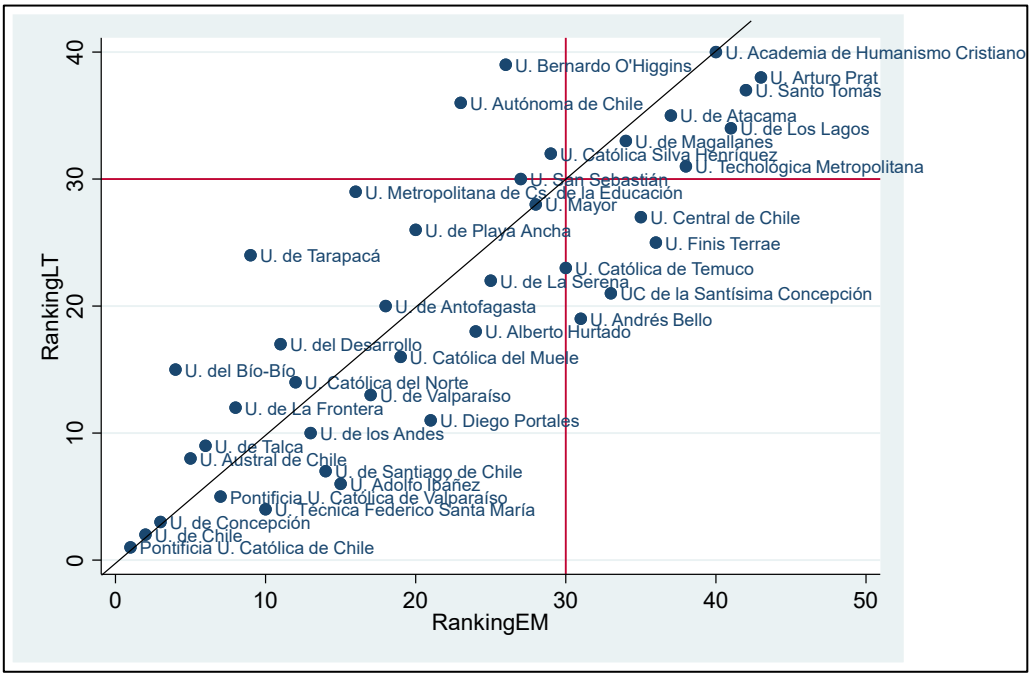


Figure 1. Comparative ranking.

It was considered necessary to incorporate some structural aspects of universities into the analysis. Specifically, there are differences among the three types of universities: state universities, private universities, and private universities with state contributions. A second differentiation is made based on institutional seniority, distinguishing between universities that are more than 40 years old (prior to the reform and the early 1980s) and those that are less than 40 years old. A regional/metropolitan dummy variable was also considered (in fact this difference is made within the Council of Rectors as it seems to influence the costs of the Universities.) Finally, the existence of medical schools, which, in previous literature, is usually considered due to the high costs of training these professionals.

1.1. Theoretical basis for SF analysis

Productive efficiency relates actual production to the maximum possible production and is defined as the ratio of actual output to maximum potential output. In general terms, the Stochastic Frontier (SF) method can be applied to any problem in which the observed outcome deviates from the potential outcome in some direction, that is, the observed outcome is less than or greater than the potential outcome.

In the context of productive efficiency, potential production, given inputs and technology, is the maximum possible production that defines the frontier. The actual output falls below the efficiency frontier because of random factors or technical inefficiency. On the cost side, the frontier is defined

by the minimum potential cost, and the actual cost is higher than the minimum frontier due to random reasons or management inefficiency.

Similarly, the profit frontier is defined in terms of the maximum possible profit. Profit efficiency is defined as the ratio of the actual profit to the maximum possible profit (assuming that both are positive or negative).

This is important to understand the limitations of the analysis and select appropriate tools for analysis. However, the work is oriented toward clearly explaining the work done with data from Chilean universities in a particular year. Thus, we restrict the presentation of this theoretical basis to the essential elements of the study being developed. However, we will discuss those aspects that could be useful in similar studies and/or with alternative approaches.

Among the many possible analysis objectives, the question at hand is that, compared to best practices in the Chilean university industry, how much more could be "produced" with the current level of resources? The question can also be seen as: How much is the cost of producing a certain level of university "product?"

Furthermore, from the point of view of the allocation of financing (direct through direct contributions or indirect through the setting of fees), at a given cost per student, universities that are inefficient in the use of resources should have different incentives and treatment from those whose cost is explained by the quality or quantity of their activities on their own scale of production.

Aspects more specific to the university case are detailed below. For now, we adopt a level of generality in which the "product" is observable and homogeneous, and the companies participating in the market are only interested in maximizing profits (or minimizing losses).

Thus, the central concepts to be specified refer to: (i) economies of scale, (ii) substitutability and complementarity of inputs for production, (iii) separability of inputs (or productive factors), (iv) technical change, and (v) technical efficiency.

The original SF analysis is due to Aigner, Lovell, and Schmidt (1977) and Meeusen and van den Broeck (1977). In a world without errors or inefficiency, a company's product will be

$$q_i = f(z_i, \beta)$$

In the SF approach, we assume that it is possible to find companies producing less than the maximum potential, that is, with some degree of inefficiency, and that this can be specified as

$$q_i = f(z_i, \beta)\varepsilon_i \, .$$

Where ε_i is the efficiency level of the company *i*. This will be in an interval (0,1], so that ifε_i =1, the company will be fully efficient. If ε_i< 1, the company will not be making the best possible use of the resources used, given the technology available. The level of output is strictly positive; therefore, the degree of efficiency will also be positive (ε_i.>0). In addition, production is also subject to random circumstances that affect its performance:

$$q_i = f(z_i, \beta)\varepsilon_i * e^{v_i}$$

Applying natural logarithms to both sides of the expression, we obtain:

$$Ln(q_i) = Ln\big(f(z_i, \beta)\big) + Ln(\varepsilon_i) + v_i$$

Assuming that there are k factors, that the production function is linear in logarithms, and defining $u_i = -Ln(\epsilon_i)$ we get:

$$Ln(q_i) = \beta_0 + \sum_{j=1}^{k} \beta_j Ln\big(z_{ji}\big) + v_i - u_i$$

This result is consistent with the initial assumptions.

Considering the indirect cost function derived over the dual of the production function, we specify the problem as follows:

$$Ln(c_i) = \beta_0 + \beta_q Ln(q_i) + \sum_{j=1}^{k} \beta_j Ln\big(p_{ji}\big) + v_i + u_i$$

where q_i is the output, z_{ji} are input quantities, *and* c_i a re costs y p_{ji} are input prices. This specification shows that inefficiency can be viewed as an output below potential or as a cost above potential.

From a statistical perspective, it should be noted that from the above specification, an estimate is obtained as follows:

$$Ln(y_i) = \beta_0 + \beta_q Ln(x_i) + \sum_{j=1}^{k} \beta_j Ln\big(p_{ji}\big) + v_i + su_i$$

where *s* = 1 if it is a production function and s= -1 if it is a cost function.

In addition, it should be noted that the distribution of the inefficiency component (u_i) should be restricted to positive values (it is not easy to interpret efficiency as greater than potential). This leads to a discussion of the error distribution to be observed. The estimation of a basic SF model is distinguished based on the assumptions of error distribution u_i. Three types of models can be distinguished from the literature on the subject.

i- Exponential, in which the u_i errors distribute exponential, independents and constant variance σ_u^2

ii- Semi-normal, in which errors are independent and variance is constant with distribution $N^+(0, \sigma_u^2)$.

iii- Truncated normal, in which the errors are independent, with constant variance and

$N^+(\mu, \sigma_u^2)$ truncated at 0.

In the literature on the choice of distribution assumption for μ there are no specific recommendations. In the case of this paper, a semi-normal distribution will be assumed, because panel data are not used and because this specification of the inefficiency term is more sensitive to the presence of the latter[3].

1.2. Product Quality

In the case of the university market, the quality of the "product" is not constant. Moreover, quality is an important cost factor to consider from a public policy standpoint and from the perspective of student preferences. In fact, in Chile, the public accreditation system is a qualitative hierarchical system that associates financing possibilities with a number of years of accreditation. From the private point of view, in Chile, only some universities are selective because they regularly receive more student applications than there are places available, while others have difficulties filling open enrollments in programs of the same denomination. This shows that there is an order of preference for institutions among young people who apply to these centers.

Quality can be viewed as a product and modeled based on a continuous, non-negative measure. This way of incorporating quality into cost studies has antecedents (Koshal R. and Koshal M.; 1995 and Fu T.T. et al.; 2019).

2. METHODOLOGICAL APPROACH

Administrative data of Chilean universities were obtained from the database of the Higher Education Information Service (SIES) of the Chilean Ministry of Education (MINEDUC). Information from 2017 was used because (a) they are the first to be published completely and homogeneously, and (b) data referring to later years reflect the influence of specific regulations on tuition fees and vacancies. Thus, teaching cost decisions are influenced by exogenous constraints that may have had an unknown influence on university management.

3. CONDUCTING RESEARCH AND RESULTS

El Mercurio's ranking has been chosen because it has greater coverage and better information on its preparation.

A summary of the universities' characteristics is presented in Table 2.

Table 2. Descriptive statistics of the Universities.

	EM Score	2016 enrollment	Total Wealth (M$ of 2017)	Operating income (in M$ of 2017)
Average	60.01	13,302.52	$ 135,655,244	$ 73,357,615
Maximum	87.10	43,403.00	$ 831,600,000	$ 481,000,000
Minimum	32.10	927.00	$ 6,467,561	$ 2,872,693
Standard Deviation Estándar	12.69	9,432.48	$ 159,658,012	$ 92,636,940

Source: Own elaboration

In addition, it should be noted that 16 of them are state universities, nine are private universities with state contributions, and eight are universities that existed before 1980.

It can be seen that there are important differences between universities in all magnitudes summarized here. Similarly, it is important to consider that the differences in enrollment, net worth, and income are greater than those provided by the quality measure that we use.

An SF analysis was conducted on the average production costs of students in Chilean universities. Considering the definitions of costs noted above, the total costs correspond to universities' operating costs, to which their operating results were added. Thus, the LCMEOP variable is the natural logarithm of operating costs +/- profit/loss for the period divided by the total enrollment of each university.

The explanatory variables of the model are the natural logarithm of enrollment LMAT, the measure of the scale of operation; the logarithm of the score obtained in the El Mercurio LQEM ranking, the measure of university quality; and the natural logarithm of the product of total enrollment by the El Mercurio LMATQEM ranking score, which allows capturing the interaction between changes in university quality and enrollment[4]. A variable was added to capture the effect of the value of university

[3] Papadopoulos A, Parmeter C. (2023 and 2021), Ming-Yen C. et al (2022), Wang W.S. et al (2011), among others develop the problem of choosing the technical inefficiency distribution assumption. (2023 y 2021) , Ming-Yen C. et al (2022), Wang W.S. et al (2011), and others develop the problem of choosing the assumption of distribution of technical inefficiency.

[4] The calculation of (dis)economies of scope appears statistically as a change of scale. It is defined as a situation in which a company simultaneously produces two or more goods (say a and b) and the interaction between the production processes makes the joint production cost (higher)lower than producing each one separately. Formally C(qa,qb) (>)< c(qa,0) +c(0,qb). The specification used here is derived from Pulley M and Humphrey D. (1991).

infrastructure on average costs[5]. The variable was constructed as the logarithm of Non-Current Assets/Total Enrollment.

In addition, binary variables were incorporated to capture university specificities. As noted above, there are at least three types of universities in which organizational culture can influence operational costs. For this purpose, the qualitative variables "priest", which denotes those private universities with state support (existing prior to the 1980s), and "state", which denotes those state universities, were added.

A qualitative variable "medicine" was also added to denote those universities that offer medical degrees. The same distinction has been made by other authors (Koshal R. and Koshal M., 1995, and Fu T.T. et al 2019).

A summary of the SF estimates is presented below.

Table 3. Summary statistics SF.

Variable	fr1	fr2	fr3
LCMEOP			
LMAT	-.46770073***	-.46135973***	-.46672909***
LQEM	-3.9664778***	-3.8537341***	-3.8686206***
LMATQEM	.00826699***	.00840292***	.00841498***
LCOPME	.36666226***	.44116239***	.43008625***
priestat		-.27591246*	-.27340789*
estatal		-.24224158**	-.23787643**
medicina		-.02814785	
_cons	20.772631***	19.932501***	20.116085***
lnsig2v			
_cons	-3.4189377***	-2.888507***	-2.8864731***
lnsig2u			
_cons	-2.324485*	-11.638389	-11.180455

legend: * p<0.05; ** p<0.01; *** p<0.001

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The summary results are as follows:

1- The variables associated with university type were significant and negative. The average costs associated with private universities (recently created) are higher than those of older private and state universities.
2- The presence of medical schools is not statistically significant on average costs.
3- There are economies of scale in student enrollment and in the quality of the University. In other words, universities with more students and of better quality have lower average costs.
4- Conversely, larger and more inclusive universities experience rising costs.
5- The efficiency component of the SF, σ_u^2 (lnsig2u) is not significant in any of the expressions. This means that there is no evidence of inefficiency in the management of the Universities. Additionally, this result implies that the cost differences between universities are random, and the model is reduced to an OLS model.

For these reasons, we proceed to estimate the behavior of the OLS costs. The results of the model specifications are shown below.

Table 4. Summary of OLS Results.

Variable	mod¬1	mod¬2	mod¬3
LMAT	-.4613537***	-.4667184***	-.44530321***
LQEM	-3.8536718***	-3.8685133***	-3.8930821***
LMATQEM	.0084028***	.00841478***	.00811822***
LCOPME	.44116403***	.43008928***	.38071195**
priestat	-.27591155*	-.27340634*	
estatal	-.24224245*	-.23787794*	
medicina	-.02814861		
Constant	19.934614***	20.118618***	20.478779***
N	46	46	46
r2	.75649562	.75599152	.70502777
r2_a	.71163955	.71845176	.67625

legend: * p<0.05; ** p<0.01; *** p<0.001

[5] Universities created after the 1980s tended to lease infrastructure (buildings, machinery and other fixed assets), while older universities tended to own the fixed assets.

3.1. Dependent Variable: LCMEOP

Considering the heterogeneity of the universities, dispersion estimators based on robust variance estimations are presented. Furthermore, when considering the amount of data, the result is reasonably good and consistent with the SF calculation.

The coefficient associated with university assets is positive, revealing that fixed investment in universities puts upward pressure on the average costs. This aspect was the subject of debate as it was observed that new universities were opting to lease infrastructure. It was suspected that this was a way of extracting rents, as the leased infrastructure was also owned by companies related to the property. The data show that there could also be an attempt to include the operating costs.

As noted above, the coefficients of "scale" in enrollment (LMAT) and university quality (LQEM) are negative, but the joint coefficient (LMATQEM) is positive. This reveals that there are economies of scale in enrollment and university quality (the more students there are and the higher the quality, the lower the average cost), but taken together, the average cost is increasing.

This reveals that the average cost will be U-shaped, and that it is possible to determine a minimum average cost university size. In addition, if there is no evidence of inefficiency in Chilean universities, this "minimum average cost" is a useful policy instrument.

The following graphs show these observations: In the case of enrollment, the adjustment obtained is as shown in Graph X.

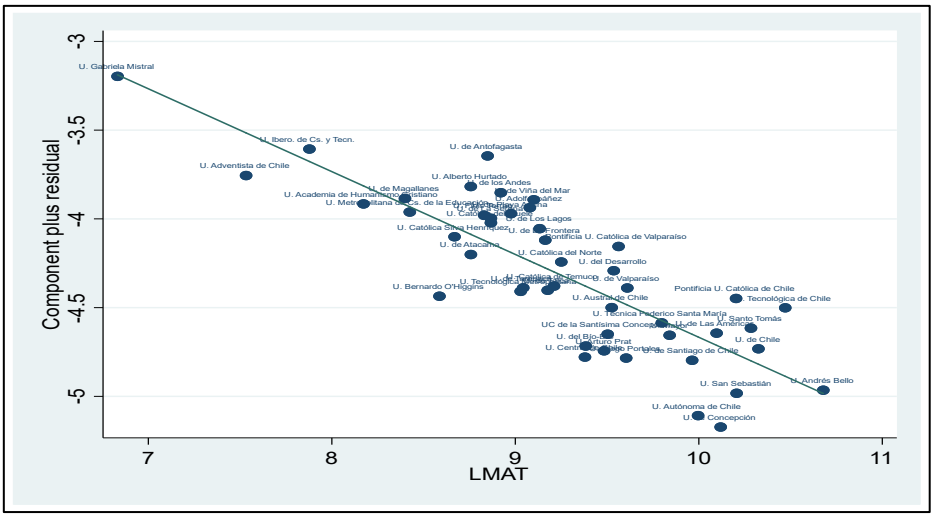


Figure 2. Estimated Values by OLS/ Logarithm of No. of Enrollees.

Something similar occurs with the ranking score (LQEM). However, the following graph shows the average cost estimate obtained from the model in relation to the joint variable (LMATQEM). For clarity, a trend curve was incorporated to smoothen data. The graph shows the U-curve and reveals that there is a combination of quality and minimum average cost tuition.

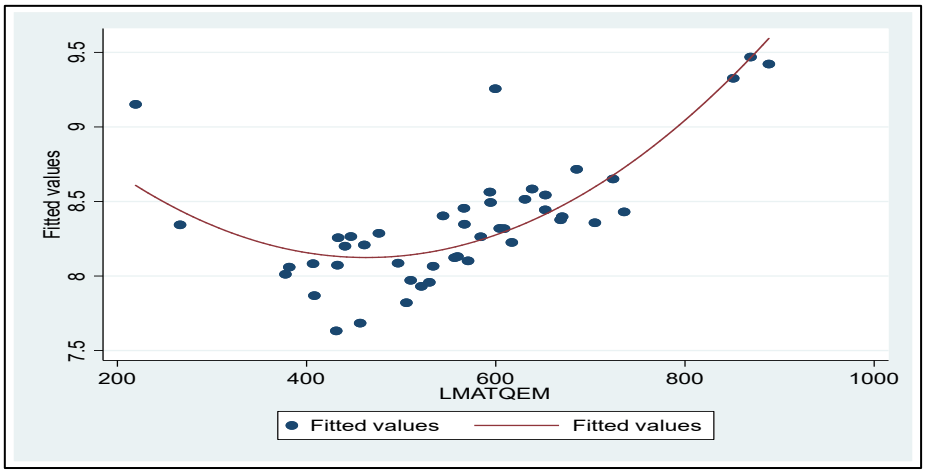


Figure 3. OLS/Logarithm Estimates of Enrollment Quality.*

This result shows that there is room for political decision-making. In effect, the quality-enrollment combination shows that there is a set of options available for whatever purposes are pursued.

Thus, it is possible that for political reasons, it is decided to support a university of high quality and enrollment defined by regional conditions in a specific region. This study allows us to infer the approximate costs of this decision.

Similarly, the analysis shows that there is a trade-off between quality and enrollment; thus, it is possible that by merging two or more universities, an equal cost per student, but of better quality, is obtained.

If, on the other hand, there is interest in minimizing the costs of university education, there is a feasible minimum cost combination that can be implemented.

In this case, Table 5 shows the 10 universities whose estimated average costs are closest to the minimum cost combination.

These universities are mostly private, of below-median quality (all are ranked below 23rd place), and with below-average enrollment. Some are much larger than the average (with enrollment greater than 20,000 students). It is worth noting that those with the highest ranking are also among those with the lowest enrollment (La Serena, Alberto Hurtado, and B. O'Higgins), and reveals a strategy that the higher education market is spontaneously adopting.

Table 5. Least Cost Universities.

UNIVERSITY	EM Ranking	Total Enrollment	Average Cost	Total Cost	Estimated Average Cost	Estimated Total Cost
Other Universities		13.945		$ 81,661,913		$ 48,517,243
Least Cost Universities.						
U. de Atacama	37	6.359	$ 2,862	$ 18,202,362	$ 3,206	$ 20,389,526
U. de La Serena	25	7,090	$ 3,668	$ 26,002,614	$ 3,184	$ 22,572,226
U. Academia de Humanismo Cristiano	40	3,542	$ 2,859	$ 10,125,226	$ 3,164	$ 11,207,507
U. de Las Américas	44	24,264	$ 3,230	$ 78,382,448	$ 3,017	$ 73,195,200
U. Bernardo O'Higgins	26	5,358	$ 1,888	$ 10,113,499	$ 2,897	$ 15,521,471
U. Alberto Hurtado	24	6,356	$ 3,741	$ 23,779,122	$ 2,858	$ 18,165,556
U. Católica de Temuco	30	10,003	$ 2,568	$ 25,691,170	$ 2,782	$ 27,826,502
U. de Los Lagos	41	9,251	$ 3,216	$ 29,752,636	$ 2,614	$ 24,183,722
UC de la Santísima Concepción	33	13,399	$ 2,012	$ 26,952,834	$ 2,492	$ 33,396,578
U. Santo Tomás	42	29,260	$ 2,613	$ 76,459,696	$ 2,174	$ 63,605,248
U. de Viña del Mar	39	8,957	$ 2,942	$ 26,351,678	$ 2,063	$ 18,482,080
Average		11,258		$ 31,983,026		$ 29,867,783

CONCLUSION

The analysis presented here is based on available information. The study universe is statistically small and could explain the absence of inefficiencies that we sought to verify using the SF analysis and, certainly, the R^2 coefficient of the OLS regression.

The data problem could be improved by incorporating a panel analysis for several years. This would allow a temporal analysis to be added to the results. However, there are nontrivial regulatory changes whose effects are not predictable a priori.

The non-existence of inefficiency in the data analyzed, of course, does not prevent it from appearing in other periods. However, they contribute to establishing an efficiency frontier for university system performance.

The analysis shows that there are economies of scale by enrollment and quality in the case of Chilean universities. However, the joint effect raises the average costs of universities. This can be explained by the aggregation of all educational costs. Research and outreach costs, although relevant, have independent justifications. In this sense, it seems reasonable to make an effort to separate the costs of different university functions.

If the setting of fees and the number of vacancies is intended to contain the operational costs of universities (which receive state contributions), then it is relevant to note that the combination of minimum cost between quality and enrollment implies universities of low quality and possibly high enrollment or, alternatively, small but high-quality universities.

There was no evidence of inefficiency in university management. However, private universities have a higher average cost than traditional private and state universities do.

Fixed investment in universities tends to increase the average teaching costs. Thus, in the case of state universities, it is possible to consider an asset management scheme that is independent of university management.

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