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ECONOMIES OF SCALE IN BRAZILIAN SUPPLEMENTARY HEALTH: AN ALTERNATIVE PATH TO EXPAND PROFITABILITY

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ABSTRACT

Low profitability has been responsible for the insolvency of a large number of health plan operators (HPO) in recent years, which increasingly requires these entities to assess which services can be optimized without compromising their final activities. An answer to this problem may lie in the adequate dimensioning of support activities. Therefore, the aim of this study is to investigate the economies of scale in the support activities of Brazilian HPO. In the presence of such economies, it can be considered that operators have room to dilute their administrative expenses, suggesting that profitability can be increased without the need for large price increases, which can guarantee the survival of companies in the sector without penalizing their customers. For this purpose, panel data regressions with Random Effects (RE), Fixed Effects (FE) and pooled were estimated, considering 5,185 observations for the period 2011 – 2018. The results found by estimating the total cost function were favorable to the hypothesis of economies of scale in the supplementary health sector. Finally, it was also possible to verify that the type of operator and the geographic location of the administrative headquarters of these entities contribute to the scale effect to a greater or lesser extent. These results show that the economies of scale existing in the sector can significantly contribute to the operational and financial maintenance of various HPO, providing an alternative to mitigate the low profitability of these companies.

Keywords: Administrative Expenses. Economies of Scale. Profitability. HPO.

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1 INTRODUCTION

The Brazilian supplementary health sector brings together the health plan operators (HPO), which provide care to their beneficiary clients through accredited providers of medical, hospital, outpatient, laboratory and related services, as individuals or legal entities (Sancovschi, Macedo & Silva, 2014).

According to data from the National Agency for Supplementary Health (ANS), the aforesaid industry had 47.6 million users at the end of 2020, served by 702 operators, distributed among all Brazilian regions, which were responsible for a total consolidated revenue of around R$ 238.3 billion and a net profit of almost R$ 17.6 billion (ANS, 2021a). Such data show the importance of supplementary health for the economy and the well-being of a large part of the Brazilian population, reflecting the potential of the damage that can be caused as a result of any problems with the HPO.

In an interview with Gazeta Mercantil published on January 21, 2005, the then Chairman of ANS said that about 300 health plan operators were facing significant financial difficulties at the time (Guimarães & Alves, 2009, p. 460). Data from the ANS website show that by August 2021, 222 HPO had already declared bankruptcy or insolvency, and 21 operators were in extrajudicial liquidation (ANS, 2021b).

These numbers are largely explained by the increasing costs to which the HPO are subjected, pressured by the so-called "medical inflation". Since 1999, the National Federation of Supplementary Health (Fenasaúde) has claimed that the operators' expenses have grown too much, requiring major readjustments in the prices of health plans to mitigate the risks of insolvency in the medium and long term (Sindicato das Empresas de Seguros e Resseguros [SINDSEGSP], 2013). Such claims have grounds, as Araújo and Silva (2018) found a decrease in the profit margin of HPO for the period 2003-2014.

But the question that arises is: "Could the scale effect not contribute, at least in part, as a solution to the problem of rising costs and low profitability of the HPO?" An answer to this question can be found in the administrative expenses of these organizations, which are subject to greater predictability and control (Silva, Saraiva, Ferreira, Peixoto & Ferreira, 2020).

As the administrative expenses are related to the support activities, it is easier for organizational restructuring to occur at the administrative level, due to the possibilities of economies of scale resulting from the rationalization of processes, than in the final activities, which are more sensitive and subject to random events (Caetano, Boueri & Sacshida, 2015; Teixeira & Rodrigues, 2021).

The purpose of this study is to analyze the economies of scale in the support activities of Brazilian health insurance operators. To this end, three blocks of variables will be used: a) the first composed of the client base; b) the second portraying the effects of the modality or type of operator; and c) the last being responsible for capturing the influence of geographic location on the administrative costs of these organizations.

This research is relevant because, as the supplementary health sector is characterized by low profitability (Araújo & Silva, 2018), organizational restructuring of the HPO support activities can help them improve their results, mitigating insolvency situations and the risks related to the operational continuity of the business, which ultimately benefits employees, clients, suppliers and a whole range of service providers.

In this sense, it is important to note that investigations on economies of scale in private health operators have already been carried out in other markets, mainly the American and British ones, as in Bernet and Singh (2015), Born, Hughen and Sirmans (2020) and Freeman, Savva and Scholes (2020). However, very little is known about the subject in Brazil, which makes the topic relevant to be researched.

Thus, if the administrative expenses of HPO grow less than proportionally to their number of clients (size) and depend on the type or modality of operator and the geographical location of

their administrative headquarters (economic agglomerations), it is possible to argue that the Brazilian supplementary health sector presents evidence of economies of scale in its administrative activities, indicating that the rational use of idleness in the support activities can benefit the operators and their clients, improving the profitability of the former and mitigating or even eliminating the need for price adjustments above inflation for the latter.

2 THEORETICAL BACKGROUND

2.1 Economies of Scale

One of the ways to determine the operational efficiency of a company lies in an analysis regarding possible economies of scale (or increasing returns of scale) in its production processes and/or its administrative activities (Varian, 2015). The origin of these economies is closely linked to the expansion of production in the presence of idle capacity, which would be responsible for reducing unit costs, thus increasing the profitability of firms (Besanko, Dranove, Shanley & Schaefer, 2009).

The explanation for this phenomenon can be found in the total cost (*TC*) or mixed cost (*MC*) formula, which is broken down into a portion represented by fixed costs (*FC*) and another made up of variable costs (*VC*). In other words, the total cost in firms can be expressed as follows: $TC = FC + VC$.

As the name implies, the fixed cost is a cost that remains constant, regardless of changes in the company's activity level. Examples of fixed costs are rents, depreciation, property taxes, and administrative salaries. Variable costs, on the other hand, change in direct proportion to the level of activity. Examples of variable costs are cost of sold goods, direct labor, direct materials, electricity, and selling and administrative expenses (Garrison, Noreen & Brewer, 2013).

When the two sides of the total cost equation are divided by the quantity produced (*Q*), the formula for average total cost (*ATCo*) arises, which is broken down into the elements average fixed cost (*AFCo*) and average variable cost (*AVCo*), i.e., $ATCo = AFCo + AVCo$.

This equation shows that as long as the firm's idle capacity persists (short-term analysis), the average variable cost will remain constant per unit produced. In turn, as the level of activity increases, average fixed costs decrease, with the opposite occurring for a downturn in the level of production (Pindyck & Rubinfeld, 2013).

For example, if the unit cost of a chest X-ray is R$ 25 for a hospital, this is its average variable cost. By multiplying the *AVCo* by the number of clients (*Q*) submitted to such an exam in a given day, the *VC* is obtained. In the case of a hospital bed that has a fixed cost, i.e., a daily cost of R$ 5,000.00, its *AFCo* will be a function of the number of people sharing this space. Thus, if only one person uses the bed, its average fixed cost will be R$ 5,000.00; with two people, the average fixed cost price will fall to R$ 2,500.00, and so on, successively, until the limit of the place is reached.

Economies of scale can explain why some firms are more lucrative or profitable than others. Through these economies, it is possible to maximize profit as the produced quantity increases, because some processes become more productive only on a large scale, as they provide reductions in average production costs as a result of fixed costs being apportioned among the units produced and variable costs growing steadily with the volume produced. This can be observed when all inputs are duplicated and the cost increases in a smaller proportion than the inputs (Vendruscolo & Alves, 2009).

Thus, so that there is evidence of economies of scale in an industry, its production costs or its expenses with the provision of services must undergo less than proportional increments to an increase in production, indicating that the generation of one more unit of product or service has the ability to reduce its marginal cost (Caetano et al., 2015; Cunha, 2018). According to Besanko

et al. (2009) there are three basic behaviors for unit cost curves that are able to portray the occurrence of economies of scale in firms, as shown in Figure 1.

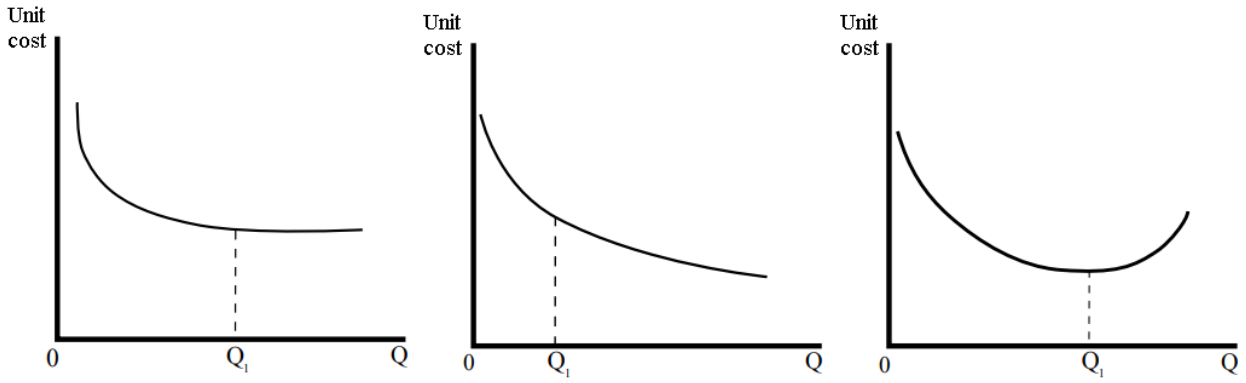

Figure 1. Possible Behaviors of Cost Curves in Economies of Scale
Source: Teixeira, R. F. A. P., & Rodrigues, A. (2021).

The first curve in Figure 1, from left to right, is the "L" curve, which corresponds to the decrease of the unit or average cost due to production increments until the quantity Q_1, where, after that, the company would always operate at its minimum cost.

In mass production or service delivery companies, such as healthcare operators, unit costs become relatively low only with a large quantity produced (Varian, 2015). Thus, firms that can increase their production volume without increasing their fixed costs will obtain economies of scale (Hogendorn, 1975). The opposite occurs with diseconomies of scale or decreasing returns to scale, in which the average total cost expands more than proportionally as output increases (Besanko et al., 2009).

For Wessels (2002), one reason for the existence of increasing returns to scale is that many production processes require a large scale to function effectively. The division of labor, that is, the specialization of employees in performing one or a few tasks (Mas-colell, Whinston & Green 1995), the particular characteristics of some firms (Varian, 2015) and the geographical location of the companies (Fujita, Krugman & Venables, 1999) are also cited as inducing economies of scale.

On the other hand, one of the main reasons for diseconomies of scale is that as firms persistently grow, they become more difficult to manage (Wessels, 2002). The scarcity of qualified personnel, luxury in corporate buildings, and high executive salaries can also generate additional costs for large firms (Griffin & Tversky, 1992).

In other words, when there is idle capacity of the fixed factors of production, the growth of activities allows the economies of scale to occur. In turn, when this idle capacity reaches its limit, the fixed factors of production begin to represent productive bottlenecks, generating diseconomies of scale (Varian, 2015).

Considering some studies that have addressed the issue of economies of scale, Oliveira, Amaral and Silva (2003) presented an empirical study on economies of scale in Brazilian banks between 1997 and 2001. The study used financial data from the financial statements of 85 commercial and multiple banks. The models used in the study were: cost function and profit function, both estimated by multiple regression and tabular analysis. As a result, the presence of economies of scale was detected. Furthermore, in the stratified analysis for small banks, evidence of increasing returns to scale was found.

Vendruscolo and Alves (2009) verified whether Brazilian mobile phone carriers were enjoying economies of scale through the analysis of polynomial cost function and cost curves, with a panel data model for the period 1998-2005. The estimated cost function results revealed that production based on the number of clients showed increasing returns to scale in the industry.

Bernet and Singh (2015) evaluated the presence of economies of scale in the operation of local public health units in the state of Florida (United States), during the period 2008 – 2010, considering five basic public health activities: communicable disease surveillance and investigation; chronic disease prevention; food hygiene services; on-site sewage treatment and disposal services; and vital records services. In general, the results confirmed that local public health facilities in Florida have economies of scale, indicating that serving a larger number of people can reduce the unit costs of the services provided. Lima and Silveira Neto (2017) analyzed the effects of the administrative decentralization process, which culminated in the creation of 1,016 new municipalities in Brazil in the 1990s. The authors used data from the period 1991 - 2000, based on the difference-in-differences estimator methodology. The results showed that the municipalities that underwent the secession process increased their *per capita* capital expenditures by 14.7%, evidencing that the increase in municipal expenditures can be explained by the reduction of economies of scale.

The work of Cunha (2018) based on data from the period 2010-2014 estimated some models to try to explain the administrative expenses of Brazilian Closed Complementary Welfare Entities (EFPC) or pension funds. In all modeling, the findings confirmed that the main explanatory variables, i.e., total financial assets (*proxy* for financial management), total participants (proxy for pension management) and geographic location (regional effect) resulted in economies of scale.

Bernardelli, Kortt, and Dollery (2019), meanwhile, investigated whether a reduction in the number of municipalities in the state of Parana (Brazil) would provide economies of scale for the aforementioned state government. Based on a panel dataset covering the period 2002-2017, the authors found that municipal expenditures are characterized by substantial economies of scale, confirming that municipal consolidations can lead to lower *per capita* expenditures.

Another interesting study is that of Born et al. (2020), who examined whether the three largest private health insurers in the United States differed from other insurers in the same business for the *per capita* premium variables, claims, and operating expenses, using data from the period 2010-2018. The findings revealed no statistically significant differences for *per capita* premium and claims incurred. However, it was possible to verify economies of scale in the operating expenses of the three largest insurance companies in relation to the others, which brings evidence that the former are already performing close to the limit of efficiency.

Finally, Freeman et al. (2020) sought to verify the existence of economies of scale and overflow between the number of voluntary and emergency admissions in English hospitals during the period 2007-2016. Evidence was found that increments in emergency admissions for one type of care reduce costs in the other emergency admission modalities. On the other hand, the opposite was found for increases in voluntary admissions relative to emergency admissions (diseconomies of scale).

2.2 Supplementary Health Statistics and Research Hypotheses

In summary, the HPO that work with private health plans are divided into five categories: self-management, medical cooperatives, philanthropy, specialized health insurers, and group medicine (ANS Collegiate Directory Resolution No. 39, 2000). Self-managed HPO offer health care services to employees and their dependents, ex-employees, retirees and pensioners of companies or group of companies, and to participants and dependents of foundations, unions and class entities (ANS Normative Resolution No. 137, 2006). Medical cooperatives and philanthropies are non-profit HPO, with the difference that the latter must be certified as philanthropic entities with the National Council of Social Assistance (CNAS) and declared as of public utility with the Ministry of Justice (MJ) or with state and municipal government agencies (ANS Collegiate Board Resolution No. 39, 2000). Specialized health insurers can only operate in

the health segment, and their by-laws must forbid operations in any other line of business or modality (Law 10185, 2001). The other types of HPO are classified as group medicine (ANS Collegiate Directory Resolution #39, 2000).

So that the size of the Brazilian supplementary health market can be better understood, some statistics have been calculated. The data refer to the year 2018 and the statistics are presented in Table 1.

Table 1
Statistics of the HPO in 2018

Description	Type of Operator				
	Self-Management	**Medical Cooperative**	**Philanthropy**	**Specialized Health Insurer**	**Group Medicine**
Total Revenue (R$ billion)	26.43	71.56	5.89	46.02	63.27
Total Expenses (R$ billion)	25.35	68.14	5.68	42.52	60.03
Total Profit (R$ billion)	1.08	3.42	0.21	3.50	3.24
Administrative Expenses (R$ billion)	2.13	6.75	0.99	2.17	6.58
Number of Clients (millions)	3.55	17.15	0.87	6.01	17.78
Revenue *per capita* (R$ thousand)	7.45	4.17	6.74	7.66	3.56
Expenses *per capita* (R$ thousand)	7.15	3.97	6.50	7.08	3.38
Profit *per capita* (R$ thousand)	0.30	0.20	0.24	0.58	0.18
Administrative Expenses *per capita* (R$ thousand)	0.60	0.39	1.13	0.36	0.37
Administrative Expenses/Total Expenses	8.40%	9.91%	17.43%	5.10%	10.96%
Total Number of HPO	118	275	37	9	224
Administrative Expenses/No. HPO (R$ million)	18.05	24.55	26.76	241.11	29.38
HPO based in the Center-West Region	17	24	0	0	13
HPO based in the Northeast Region	19	30	0	0	22
HPO based in the Northern Region	3	11	1	0	4
HPO based in the Southeast Region	59	150	29	9	150
HPS based in the Southern Region	20	60	7	0	35

Source: Prepared by the authors based on ANS (2019).

It is possible to verify in Table 1 that the Brazilian supplementary health, despite having earned in 2018 a total gross revenue of R$ 213.17 billion, managed to convert only R$ 11.45 billion into profit, which represented an average of R$ 17.3 million per HPO.

This number becomes more modest when the average annual profit per client or *per capita* of the HPO is ascertained, which was approximately R$300.00 in 2018, with such value ranging from R$180.00 for HPO in group medicine to R$580.00 for health insurers, which really characterizes the sector as one of low profitability.

The low profitability of the HPO draws even more attention when compared with the average of their administrative expenses *per capita*, which was around R$ 620.00, with the insurers having the lowest administrative costs (R$ 360.00) and the philanthropic entities having the highest (R$ 1,130.00). In other words, these numbers show that the average administrative structure of the HPO is very expensive, especially considering the fact that it is linked to a means activity and not to an end activity.

Thus, one possibility to mitigate the administrative expenses of the HPO lies in economies of scale by increasing the client base of these entities, which translates into reduced *per capita*

expenses. These economies have already been verified in Brazil for the banking (Oliveira et al., 2003), mobile telephony (Vendruscolo & Alves, 2009), and closed complementary pension plan (Cunha, 2018; Teixeira & Rodrigues, 2021) sectors, but there is still a lack of research in supplementary health. Thus, the research hypothesis (*H1*) was developed.

H1: There are economies of scale in Brazilian HPO if their administrative expenses grow less than proportionally to their number of clients.

In the validity of this hypothesis, the HPO would have the opportunity to rationalize their support activities, obtaining gains that could be converted into: a) greater profitability without the need to increase prices, benefiting their clients; b) better safety margin against insolvency; c) redirection of resources to the final activities, when necessary; and d) constitution of funds against high severity events, as provided in Chapter IV of the Annex to ANS Normative Resolution n. No. 435, of November 23, 2018, especially if considered an adverse pandemic scenario or health crisis.

With regard to the percentage of administrative expenses over total expenses, it is possible to observe a great asymmetry between the different types of operators. Specialized health insurers, which are the largest entities in the sector in terms of size, spent an average of 5.10% of their expenses on maintaining their administrative structures in 2018, while all the others showed percentages higher than this. This means that the former already operate close to their production possibilities boundary, which suggests that all the other modalities of HPO would still have economies of scale to be exploited, as identified analogously by Oliveira et al. (2003) for small-sized firms in the Brazilian banking sector and Born et al. (2020) for the set of the smallest American private health insurers. As such, the hypothesis (*H2*) was developed:

H2: Self-managed HPO, medical cooperatives, philanthropic entities and group medicine have greater untapped economies of scale when compared to specialized health insurers.

Another interesting finding refers to the spatial distribution of the HPO, which was carried out according to the geographical location of the administrative headquarters of these entities. The intention of this method is to verify the prospects of economies of scale, based on the effects of economic agglomerations on administrative activities (Fujita et al., 1999). According to Table 1, while almost 60% of the operators have their administrative headquarters located in the Southeast region, on the other extreme, only 3% of the HPO are based in the Northern region. Thus, it is expected that the Southeast region, as it has the largest Gross Domestic Product (GDP), for having large economies of agglomeration due to the abundance of productive factors (Azzoni, 2013; Lima & Lima, 2016) and for having health operators that tend to distribute a greater share of their results (Avelar, Souza, Ferreira, Silva & Souza, 2020), has the HPO with the largest economies of scale, which is given by hypothesis (*H3*):

H3: HPO with administrative headquarters in the Southeast region present greater economies of scale than HPO with headquarters in the other regions of Brazil.

It is important to emphasize that all hypotheses were constructed to capture the potential for economies of scale in three different business dimensions of the HPO, namely: number of clients, type of operator and geographic location of the administrative headquarters. While the increase in the number of clients generates economies of scale because firms have several activities that operate in a relatively fixed manner, such as internal auditing, accounting, IT and compliance systems, etc. (Caetano et al., 2015), the type of operator captures economies of scale due to the differences between the entities (Silva & Loebel, 2016), and the location of the headquarters of

the HPO measures the economies of scale related to the degree of development of different Brazilian geographic regions (Azzoni, 2013; Lima & Lima, 2016).

3 METHODOLOGICAL PROCEDURES

Annual data on the administrative expenses of health operators, found in their financial statements, in addition to information on their number of clients, the type of operator, and the location of their administrative headquarters for the period 2011-2018 were used in the study. All data were collected from the ANS website and are available for consultation by the general public. Since not all HPO provided complete information to ANS in the years analyzed, the final sample included 5,185 remarks. Table 2 summarizes the final sample.

Table 2
Calculation of the Final Sample

Description	Quantity
Total of remarks for health insurance operators in the period 2011-2018	9,726
(-) Remarks of HPO with exclusively dental services in 2011-2018	(3,550)
(-) Remarks of HPO with missing data in the period 2011-2018	(986)
(-) Excluded remarks that could not be logarithmized	(5)
(=) Final Sample of HPO Remarks in the period 2011-2018	**5,185**

Source: Prepared by the authors.

The 5,185 remarks in the final sample were composed this way: 616 HPO for the year 2011; 631 HPO for the year 2012; 635 HPO for the year 2013; 650 HPO for the year 2014; 659 HPO for the year 2015; 665 HPO for the year 2016; 666 HPO for the year 2017; and 663 HPO for the year 2018.

As the collected data combines cross-sectional and time-series remarks, the methodology of panel data econometrics was chosen, which explicitly considers the issue of heterogeneity, with individual differences between the studied units being formally captured (Gujarati & Porter, 2011).

The quantitative variables considered in the study revealed a log-normal distribution, which invalidates the normality assumption. Thus, to mitigate such problem, these variables were logarithmized (ln). In this regard, Gujarati and Porter (2011) recall that one of the advantages of estimating a log-log type regression is that the coefficients of the explanatory variables have the property of measuring the elasticity, or the percentage change of one unit, in the dependent variable.

The proposed empirical model is exploratory in nature and its formulation was developed as a cost function, with administrative expenses as the product and the inputs being given by the number of clients of the HPO, the type of operator and its geographic location, as shown in equation (1) below:

$$lnDespAdm_{it} = \beta_0 + \beta_1 lnCli_{it} + \beta_n X_{it} + \varepsilon_{it} \quad (1)$$

where *i* refers to the HPO and *t* to time. The dependent variable *lnDespAdm* refers to the natural logarithm of administrative expenses, representing the total cost; the coefficient β_0 captures the fixed cost portion; and the main explanatory variable, which is the natural logarithm of the number of clients *lnCli*, expresses the variable cost.

Table 3
Variables Used

Variable	Description	Expected Sign	Theoretical Framework
lnCli	Natural logarithm of the number of clients	+	Oliveira et al. (2003); Vendruscolo e Alves (2009); Cunha (2018); and Teixeira e Rodrigues (2021).
AutoG	Dummy for self-managed HPO	-	Oliveira et al. (2003); Born et al. (2020).
CoopMed	Dummy for HPO in medical cooperative mode	-	Oliveira et al. (2003); Born et al. (2020).
Filant	Dummy for HPO in philanthropic mode	-	Oliveira et al. (2003); Born et al. (2020).
MedGrup	Dummy for HPO in group health mode	-	Oliveira et al. (2003); Born et al. (2020).
NO	Dummy for HPO headquartered in the Northern region	+	Azzoni (2013); Lima and Lima (2016); and Avelar et al. (2020)
NE	Dummy for HPO headquartered in the Northeast region	+	Azzoni (2013); Lima and Lima (2016); and Avelar et al. (2020)
SU	Dummy for HPO headquartered in the Southern region	+	Azzoni (2013); Lima and Lima (2016); and Avelar et al. (2020)
CO	Dummy for HPO headquartered in the Midwest region	+	Azzoni (2013); Lima and Lima (2016); and Avelar et al. (2020)

Source: Prepared by the authors.

If the coefficient of the natural logarithm of the number of clients is less than the unity, that is, $\beta_1 < 1$, it can be stated that there are increasing economies of scale in Brazilian HPO, indicating that administrative expenses grow less than proportionally to the number of clients.Figure 2 demonstrates how the variation in the number of clients of the HPO influences their administrative expenses *per capita*, according to the data collected.

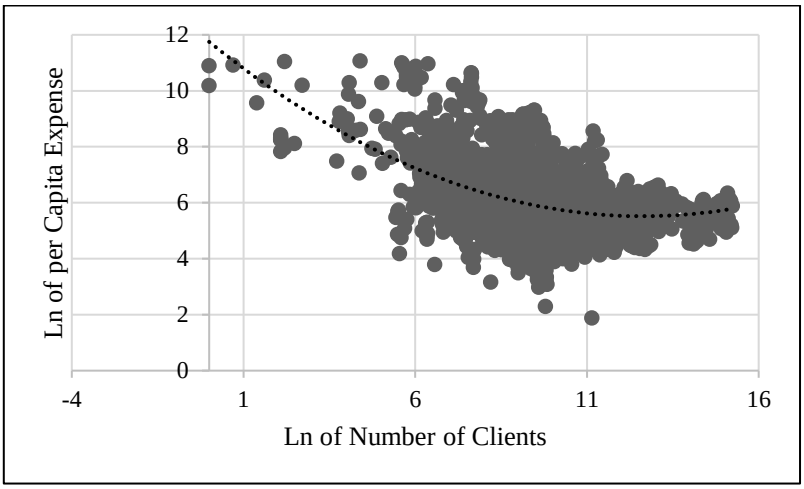

Figure 2. Initial Evidence of Economies of Scale in HPO
Source: Prepared by the authors.

Figure 2 indicates that the data from the HPO behave as expected by theory for a U-shaped cost curve, i.e., apparently, the increase in the number of clients leads to reductions in administrative expenses up to a certain point (economies of scale), where, after this point, increases in these expenses would occur (diseconomies of scale). However, since the purpose of this research is to analyze the economies of scale in the support activities of Brazilian health insurance operators, only the descending part of the curve will be investigated.

With respect to the dummies for the type of HPO, we chose to adopt the specialized health insurers as the base category, since these are the ones that have the lowest administrative expenses

in percentage terms, operating closer to the efficiency limit. Thus, it is expected that the other modalities of HPO, that is, self-management, medical cooperative, philanthropic and group medicine have greater possibilities to reduce their administrative expenses (negative sign), if compared to the base category.

Finally, for the geographic dummies, the Southeast region was defined as the base category, since this is the location subject to the greatest scale gains through economies of agglomeration, according to Azzoni (2013) and Lima and Lima (2016). In addition, this is the region where the HPO that tend to distribute a larger share of their results are located (Avelar et al. 2020). Thus, it is expected that HPO with administrative headquarters outside this region will exhibit lower economies of scale in their administrative expenses (positive sign).

4 RESULTS

First, descriptive statistics were calculated for the dependent variable *lnDespAdm* and for the only quantitative independent variable *lnCli*, since the other explanatory variables tested in the model are qualitative (dummies). Table 4 summarizes the results.

Table 4
Descriptive Statistics

Variables	Notes	Mean	Standard Deviation	Minimum	Maximum
lnDespAdm	5,185	15.67	1.49	4.02	21.44
lnCli	5,185	9.69	1.72	0.00	15.24

Note: lnDespAdm = natural logarithm of administrative expenses and lnCli = natural logarithm of the number of clients.
Source: Prepared by the authors.

By applying the antilogarithm to the dependent variable, it is possible to verify that the average administrative expenses of HPO in the period 2011-2018 was around R$6.43 million, with this amount ranging from a minimum of R$55.60 to a maximum of R$2.05 billion. In turn, for the quantitative independent variable, when performing the same procedure, it was possible to verify that the average number of clients of health insurance companies was 16,155 in the analyzed period, and this amount was in the range of 1 to 4,148,552.

When estimating a first model for the cost function of administrative expenses of HPO, by Ordinary Least Squares (OLS), 225 atypical or influential points (outliers) that needed to be removed (because they were biasing the estimated coefficients) were identified through analysis of the normal kernel density function.

After removing these outliers, the Skewness/Kurtosis normality test showed $\chi^2 = 6.89$ with a p-value = 0.0320, which does not allow the rejection of the null hypothesis of normality at 1% significance. Next, the Breush-Pagan heteroscedasticity test was applied, which resulted in $\chi^2 = 352.33$, with p-value = 0.0000, which led to the rejection of the null hypothesis of homoscedasticity at 1% significance level. In a complementary manner, the Wooldridge autocorrelation test was also performed, which revealed F-value = 416.39, with p-value = 0.0000, indicating first-order autocorrelation at 1%. However, to solve the heteroscedasticity and autocorrelation problems, the correction based on standard-robust errors proposed by White (1980) and following the work of Huber (1967), also known as the Huber-White procedure, was adopted. With the corrections performed, the estimation of equation (1) was performed for the pooled, fixed effects (FE) and random effects (RE) models.

When comparing the pooled and FE models, Chow's test presented a p-value of 0.0000, which is a favorable argument for the second model. The comparison between the pooled and RE models, on the other hand, was by the Breush-Pagan Lagrande Multiplier (BP) test, which resulted in a p-value close to 0.0000. In this situation, the RE model is superior to the pooled model.

As both models, FE and RE, proved to be more adequate than the pooled model, the Schaffer and Stillman test was performed, which is equivalent to the Hausman test for estimates with robust standard errors. This test revealed a p-value of 0.0000, showing that the FE model is more adequate for the database in question. Anyway, considering that this is an exploratory study, we chose to present the results of the three models, i.e., pooled, RE and FE, as a way to verify the robustness of the results, as well as to help build an empirical literature on the subject. Table 5 summarizes the models.

All three developed models revealed quite high values for the degree of fit of the regression line, with the model by FE presenting an overall $R^2 = 0.7648$, the one by RE an overall $R^2 = 0.8083$ and the pooled one an $R^2 = 0.8121$, with the F-statistic for all of them indicating that the variables together are significant for modeling.

Table 5
Regression Results

Dependent Variable = lnDespAdm			
Independent Variables	**Pooled Model**	**RE Model**	**FE Model**
Constant	8.6609***	10.0473***	10.1005***
lnCli	0.7769***	0.6609***	0.5705***
AutoG	-0.4173***	-0.7622***	-
CoopMed	-0.5504***	-0.7424***	-
Filant	0.4143***	0.0674	-
MedGrup	-0.8927***	-1.1743***	-
NO	0.3703***	0.3382***	-
NE	0.1609***	0.1326**	-
SU	-0.0928***	-0.1296**	-
CO	0.0116	0.0418	-
No. of remarks	4.960	4.960	4.960
Nr. of groups	-	675	675
F-statistic	1,363.52	1,410.81[b]	266.58
R^2	0.8121	0.8083[a]	0.7648[a]

***Significant at 1%, **significant at 5%, and *significant at 10%.
[a]R^2 overall; [b] χ^2 statistic.
Note: Heteroscedasticity and autocorrelation corrected by the Huber-White standard-robust errors method. lnCli = natural logarithm of the number of clients; AutoG = self-management; CoopMed = medical cooperative; Filant = philanthropy; MedGrup = group medicine; NO = HPO based in the Northern region; NE = HPO based in the Northeast region; SU = HPO based in the Southern region; and CO = HPO based in the Midwest region.
Source: Prepared by the authors.

With respect to the explanatory variables, it was found that the coefficient β_1, referring to the variable *lnCli*, was less than unity and presented the expected positive sign, being statistically significant in the developed models.

In a more detailed analysis, it is possible to see that the administrative expenses of Brazilian HPO by the FE model increase by a little more than 0.57% for each 1% increment in the number of clients, evidencing the possibility of economies of scale in the supplementary health sector of around 43% (1 – 0.57%), with this coefficient being 0.66% for the RE model (economies of scale of 37%) and almost 0.78% for the pooled model (economies of scale of 22%). All these findings support *H1*.

In turn, as the fixed effects model captures all the heterogeneity existing in the intercepts of each analyzed unit, it does not allow the use of dummies variables (Gujarati & Porter, 2011).

Thus, the analysis of such variables in this study was performed for the other models (RE and pooled), which enables the verification of *H2* and *H3*.

The coefficient of the dummy variable for self-managed HPO was negative and significant in the RE and pooled models, suggesting that, on average, this type of operator has greater possibilities to reduce its administrative expenses when compared to the base category of specialized health insurers, which already operate closer to the efficiency limit. When calculating the median administrative expenses for self-managed HPO, according to Gujarati and Porter (2011), we find a 53.34% greater potential for reducing administrative expenses according to the RE model, with this percentage being 34.12% for the pooled model.

The same occurs with the dummies for medical cooperatives and HPO that operate in the group medicine modality, and both presented negative and significant coefficients. While the former revealed 52.40% (RE) and 42.33% (pooled) higher possibilities of reducing their administrative expenses if compared to the base category, the latter showed 69.10% (RE) and 59.05% (pooled) higher chances of reducing the same expenses.

On the other hand, opposite results were obtained by philanthropic entities. The pooled model showed that these HPO are 51.33% less likely to reduce their administrative expenses compared to the base category, with these chances being 6.97% lower for the RE model. However, for the latter model, the result was not statistically significant. Thus, *H2* is confirmed for self-managed HPO, medical cooperatives and entities that operate with group medicine.

On the other hand, it is possible to verify that most of the types of operators that are smaller in size than the insurers enjoy idleness in their support activities, which configures potential economies of scale in the administrative expenses of these entities. It is worth noting that similarly, Oliveira et al. (2003) had already found untapped economies of scale in small banks *vis-à-vis* large ones, while this same effect was verified in the United States by Born et al. (2020) for smaller health insurers relative to larger ones.

The dummies for HPO with headquarters in the Northern and Northeast regions confirmed the expectations, being characterized by a positive sign and statistical significance. According to the model by RE, health insurers that are located in these two regions tend to have, respectively, around 40.24% and 14.18% less possibilities of reducing their administrative expenses than those in the Southeast region, with these percentages being 44.82% and 17.46% when considering the pooled model.

The opposite result to the expected one was obtained by the HPO headquartered in the Southern region. In both models – RE and pooled – the coefficients for this variable were negative and significant, indicating that the HPO headquartered in this region have greater economies of scale than the HPO headquartered in the Southeast region. This greater potential reduction in administrative expenses is 12.16% for the RE model and 8.86% for the pooled model, suggesting that other regional factors may be influencing more intensely on the administrative expenses of HPO in the Southern region than the effects arising from economic agglomerations (Azzoni, 2013), GDP (Lima & Lima, 2016) and distributed outcomes of HPO (Avelar et al., 2020).

Finally, the coefficients for the dummies for operators headquartered in the Midwest region were positive in the RE and pooled models. However, they were insignificant from a statistical point of view, which ratifies *H3* only for the HPO of the Northern and Northeast regions.

5 CONCLUSIONS

The purpose of this study was to analyze the economies of scale in the support activities of Brazilian health insurance providers. In the presence of such economies, one can consider that the operators have room to dilute their administrative expenses, showing that profitability can be increased without the need for large increases in prices, which can ensure the survival of companies in the sector without penalizing their clients.

As it was possible to verify by estimating the econometric models, the HPO showed viability of reducing their administrative expenses between 22% and 43% for each 100% increase in the number of clients (cost dilution). Furthermore, it was possible to infer that the type of operator and the geographical location of the administrative headquarters have a statistically significant influence on administrative expenses. The results showed that self-managed HPO, medical cooperatives and group medicine have greater perspectives of reduction in their administrative expenses, if compared to specialized health insurers that already operate close to their efficiency limit. On the other hand, it was verified that the HPO headquartered in the Northern and Northeast regions have a lower capacity to reduce these same expenses when compared to HPO headquartered in the Southeast region, with this movement being in the opposite direction for operators headquartered in the Southern region.

These results show that the economies of scale existing in the supplementary health sector can make a relevant contribution to maintaining the operational and financial continuity of several HPO, bringing an alternative to mitigate the sector's low profitability, customer dissatisfaction, insolvency, and even assist in the constitution of funds against high severity events, as provided in chapter IV of the Annex to ANS Normative Resolution No. 435, of November 23, 2018.

An important limitation of the study lies in the fact that it only carried out one evaluation regarding economies of scale. As verified in the methodology, the data from the health operators seem to behave in a "U" shape, suggesting that after a certain number of clients, their administrative expenses would start to increase again, leading to diseconomies of scale.

In this sense, we recommend that future studies try to estimate other functional forms for the administrative expenses of HPO, such as a second-degree polynomial equation using the number of clients and its quadratic version as the main explanatory variables. With this type of modeling, it will be possible to find the ideal number of clients that minimizes the administrative expenses of these operators, which results in maximizing the profit or the surplus of resources to be applied in the final activities, allowing the financial and operational sustainability of these entities in adverse scenarios, such as those resulting from economic or public health crises.

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