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Sticky costs and regulation in private healthcare providers

Custos assimétricos e regulação em operadoras de planos de saúde

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Keywords
Sticky cost.
National Supplementary Health Agency regulation.
Private healthcare providers.

Abstract

This study aims to analyze the effects of the Brazilian National Supplementary Health Agency's (NSHA) regulation on sticky costs of private healthcare providers (PHP). The research used financial and operational data from the NSHA analyzed through panel data regression and focused on PHP classified as medical cooperatives and group medicine between 2010 and 2018. The models developed employed different cost proxies (dependent variable) and explanatory variables. We verified that two cost proxies presented significant relations in all models: selling, general, and administrative expenses, and total cost. Concerning regulation variables, one was significant in the two studied modalities: PHP dependency ratio. This paper presents many contributions to different PHP' stakeholders, such as NSHA, their managers, and Brazilian society. Among the main findings are (a) the importance of analyzing the organizations' legal nature when examining sticky costs; (b) the proposal of different regulation variables to understand this phenomenon while displaying its importance in regulated industries; and (c) the relevance of employing different proxies when measuring sticky cost.

Palavras-chave
Custos assimétricos.
Regulação da Agência Nacional de Saúde Suplementar.
Operadoras de planos de saúde.

Resumo

Este artigo apresenta os resultados de uma pesquisa que visou analisar efeitos da regulação da Agência Nacional de Saúde Suplementar (ANS) sobre o comportamento assimétrico dos custos em operadoras de planos de saúde (OPS) brasileiras. Especificamente, enfocaram-se as operadoras classificadas como cooperativas médicas e medicina de grupo entre os anos de 2010 e 2018. Os dados financeiros e operacionais empregados para o seu desenvolvimento foram secundários e coletados junto à ANS. A análise dos dados foi realizada por meio de regressão com dados em painel. Os modelos estimados consideraram diferentes proxies de custos (variável dependente) e variáveis explicativas. Verificou-se que duas proxies de custos tiveram relações significantes em todos os modelos estimados: despesas com vendas, gerais e administrativas, e custo total. No que se refere às variáveis de regulação, observou-se que uma delas foi considerada significante em ambas as modalidades: a razão de dependência das OPS. Esta pesquisa apresenta diversas contribuições aos diferentes stakeholders das OPS, tais como: a ANS, seus gestores e a sociedade. Podem ser citadas como inovações da pesquisa desenvolvida em relação aos estudos predecessores: (a) verificou-se a importância de se considerar a natureza jurídica das organizações, mesmo que pertencentes a um mesmo setor (proxy de estrutura de custos), para se analisar o fenômeno da assimetria de custos; (b) foram propostas diferentes variáveis regulatórias para compreender esse fenômeno, demonstrando sua relevância em setores bastante regulados; e (c) destacou-se a importância do uso de distintas proxies para se mensurar a assimetria de custos.

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Practical Implications

The findings enable regulators to better understand the effects of rules on sticky costs of Brazilian private healthcare providers (PHP). PHP managers can implement more effective actions to continue essential services based on information about the variables related to sticky costs.

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1 INTRODUCTION

Porporato and Werbin (2012) emphasize that traditional cost accounting is based on the assumption that costs vary proportionally according to the level of activities. Recent empirical research has shown that cost variation depends on the magnitude of changes in the level of activities and the direction of these changes (ascending or descending) (Porporato & Werbin, 2012; Shust & Weiss, 2014). These costs behavior contradicts the traditional model, and they are called sticky costs.

The seminal article by Anderson, Banker, and Janakiraman (2003) established the empirical foundation for analyzing sticky costs. However, the authors focused only on selling, general, and administrative (SG&A) expenses as cost proxies. Subsequent studies have observed sticky costs based on other proxies (Pamplona, Fiirst, Silva, & Zonatto, 2016; Grejo, Abbas, Camacho, & Junqueira, 2019). Also, Anderson, Banker, and Janakiraman (2003) limited their research to industrial companies, whereas subsequent literature expanded cost behavior analyses, examining other sectors (Subramaniam & Weidenmier, 2003; Holzhacker, Krishnan, & Mahlendorf, 2015). Notwithstanding, an aspect that remains little addressed in the literature is the role of sectoral regulation on sticky costs, even though regulation significantly influences this phenomenon, as highlighted by Cook, Kieschnick, and Moussawi (2019).

Among the studies that examined this cost behavior from a regulation viewpoint are Porporato and Werbin (2012) and Holzhacker et al. (2015). For these authors, organizations subject to price regulation by external agencies tend to reduce sticky costs to mitigate operational risks. In Brazil, this is the case of private healthcare providers (PHP), which are closely regulated by the National Supplementary Health Agency (NSHA) (Varella & Ceschin, 2014). Among the NSHA classification of PHP, those classified as medical cooperatives and group medicine stand out. NSHA data (ANS, 2020) indicate that these two classes of PHP, together, are responsible for serving more than 35.6 million beneficiaries and sum 542 organizations operating in the country. A preliminary study by Avelar, Jordão, Boina, Santos, and Ferreira (2019a) suggested relationships between PHP sticky costs and the NSHA. However, the authors focused exclusively on one class of providers, failing to highlight the role of regulated prices – which seems relevant in this context. Thus, there is a theoretical gap on the effects of price regulation on the Brazilian PHP sticky cost, a relevant object of research given the essential role of these organizations in the national health system.

This study sought to answer the following research question: how does the National Supplementary Health Agency's price regulation affect the private healthcare providers' sticky costs? Therefore, we analyzed the effects of price regulation on the costs' asymmetric behavior in Brazilian PHP (medical cooperatives and group medicine) between 2010 and 2018. The research adopted the following specific objectives, (a) to identify sticky costs in the two classes of PHP, (b) to observe accounting variables that influence such costs, and (c) to verify the effect of the NSHA's regulation variables on the cost behavior of the PHP analyzed.

Studies that focus on Brazilian PHP sticky costs are relevant for many reasons. First, it is important to study this cost behavior in emerging economies, which present quite different characteristics compared to developed countries (where the phenomenon was initially reported) (Zonatto, Magro, Sant'Anna, & Padilha, 2018; Stimolo & Porporato, 2019). Second, PHP have a crucial role in the Brazilian national health system. The country's supplementary health system has more than 73 million beneficiaries and almost 1,200 operating PHP, the main ones classified as medical cooperatives or group medicine (ANS, 2020). Third, the providers classified in these two categories have several characteristics in common. However, at the same time, these characteristics distinguish them from other PHP registered in the NSHA, which hinders comparability among all the PHP operating in the country (Resolução de Diretoria Colegiada n. 39, 2000; Guimarães & Nossa, 2010; Avelar, Souza, Amaral, & Reyes, 2019b). Fourth, studies focusing on the role of price regulation in the organizations' sticky costs are important, particularly those in the health area (Holzhacker et al., 2019). Finally, this study expands the analysis developed by Avelar et al. (2019a) when considering the most relevant modalities of PHP in the country, focusing on the role of price regulation as a determinant of sticky costs, and gathering data from a period where the country faced different macroeconomic realities (growth, recession, and low growth) – which is a relevant variable for the analysis of sticky costs (Reis & Borgert, 2019).

The research counted on financial and operating data of PHP, obtained from the NSHA. Data were treated and analyzed using panel data regression. Costs of services were considered inadequate as a proxy for analyzing sticky costs in the proposed models. However, SG&A expenses, as well as total costs, were proxies that had significant relationships in all estimated models. Among the regulation variables, the PHP dependency ratio was considered significant for both classes of PHP.

Models involving providers classified as medical cooperatives presented more significant variables for sticky costs than group medicine. Findings contributing to enrich the literature are (i) the importance of analyzing the organizations' legal nature when examining sticky costs; (ii) different regulation variables have been proposed to understand this phenomenon, demonstrating its relevance in highly regulated sectors; and (iii) the relevance of employing different proxies when measuring sticky costs, which is a procedure often ignored in the literature.

2 LITERATURE REVIEW

2.1 Sticky costs

Porporato and Werbin (2012) emphasize that knowledge about cost behavior is relevant to organizations' management. The authors point out that the traditional approach to cost behavior assumes symmetric variation of costs in the face of changes in the organization's level of activity. Thus, costs would change proportionally according to activity variation, regardless of direction (ascending or descending). In contrast to this symmetric behavior of costs, recent literature on the topic has focused on costs with asymmetric behavior or sticky costs.

Discussions about sticky costs emerged in response to criticism of traditional cost behavior (Malik, 2012). Grejo et al. (2019) clarify that, although the literature has already identified the emergence of sticky costs, the methodology proposed by Anderson et al. (2003) was the first offering evidence of asymmetric behavior of costs. The authors proposed a model in which the SG&A expenses were used as a proxy for costs (dependent variable), while the level of revenue as a proxy for the level of activity (independent variable). They found that when there was a drop in revenue, the cost was reduced to a lesser extent than increased, considering a proportional growth in revenue (Anderson et al., 2003). The authors referred to costs presenting this asymmetric behavior as sticky costs.

The discussion on sticky costs led to an expansion in the literature, allowing a global understanding of this type of cost behavior. Some studies observed the phenomenon in developed economies, especially that of the United States and European nations, such as Calleja et al. (2006), Shust and Weiss (2014), Venieris, Naoum, and Vlismas (2015), Cook et al. (2019), Zhang, Yin, Han, and Aroskar (2019), and Hartlieb, Loy, and Eierle (2020). These authors analyzed companies and identified sticky costs, some focusing on specific sectors, while others including different determining variables. However, the level of asymmetry identified usually varied according to the country and the sector analyzed in each research.

As for companies located in emerging economies, studies are, in general, regionalized. Studies worth highlighting are Richartz, Borgert, and Lunkes (2014), Pamplona et al. (2016), Ferreira, Costa, and Ávila (2016), Zonatto et al. (2018), Stimolo and Porporato (2019), and Li, Ying, Chen, and Zhang (2020). In these studies, sticky costs were found at different levels and in different contexts, and the research focused on specific nations. The work by Pamplona et al. (2016) demonstrated that Brazilian companies presented less sticky costs than those in Chile and Mexico. Zonatto et al. (2018) studied the BRICS, finding variations in asymmetry levels when considering periods of economic growth or recession. Stimolo and Porporato (2019) examined Argentina, highlighting the importance of sticky costs in emerging economies. The authors pointed out that these countries have particular characteristics – which are different from those analyzed during the first models' construction – and require studies prepared to consider such idiosyncrasies.

Several of the studies mentioned above have demonstrated asymmetric behavior in different cost proxies (not only in SG&A expenses), highlighting other explanatory variables of this phenomenon (Reis & Borgert, 2019; Grejo et al., 2019; Stimolo & Porporato, 2019; Hartlieb et al., 2020). However, variables linked to regulation are still little explored in the literature concerning sticky costs. Porporato and Werbin (2012) emphasize that market regulation is relevant to explain sticky costs. In addition, Holzhacker et al. (2015) explain that price regulation tends to include greater complexity in companies' cost structure decisions, influencing sticky costs. That said, the private healthcare providers' business is subject to intensively price regulation in Brazil, which means a fertile field of study to understand the relationship between sticky costs and regulation.

2.2 Private healthcare providers (PHP) and the regulation of the National Supplementary Health Agency (NSHA)

A PHP is a legal entity, formed as a civil or commercial society, cooperative, or self-managed entity, which operates a product, service, or private health care plan contract (Law 9656/1998). Brazilian Law 9961 of 2000 has played a crucial role in the PHP business by creating the National Supplementary Health Agency (NSHA) (in Portuguese, Agência Nacional de Saúde Suplementar – ANS). The agency resolution 39/2000 (Resolução de Diretoria Colegiada n. 39, 2000) classifies the PHP as administrator, self-management, medical cooperative, dental cooperative, philanthropic, group medicine, and group dentistry. Table 1 shows the number of beneficiaries and active providers by classification. PHP classified as administrators are not listed since, according to the NSHA resolution, they differ substantially from the others. These organizations are companies that administer healthcare plans without taking the risk related to these plans' operations.

Table 1. Number of PHP beneficiaries and active organizations in 2020

NSHA Classification of PHP	Number of beneficiaries	Number of active PHP
Self-management	4,319,557	160
Medical cooperative	17,282,146	283
Dental cooperative	3,373,873	103
Philanthropic	904,891	36
Group Medicine	18,346,069	259
Group Dentistry	12,951,918	181

Source: Adapted from the National Supplementary Health Agency (ANS, 2020)

Among the providers offering medical and hospital services, the PHP classified as medical cooperatives and group medicine prevail, both in the number of beneficiaries and active organizations. Also, these providers have accentuated differences from other classes. For example, self-management providers present particularities and work in specific niches (Avelar et al., 2019b), and philanthropic PHP are certified non-profit entities and enjoy tax exemptions (Resolução de Diretoria Colegiada n. 29, 2000). Finally, PHP offering dental healthcare are significantly distinct from the medical ones, a condition that undermines the joint analysis (Guimarães & Nossa, 2010). Therefore, this study focused only on the providers classified as medical cooperatives and group medicine, considering their relevance and ensuring the results' comparability.

2.3 Development of the hypotheses

As highlighted by Avelar et al. (2019a), Porporato and Werbin (2012), and Holzhacker et al. (2015), regulatory matters such as price regulation can interfere with the organizations' cost behavior. For instance, Brazilian private healthcare providers (PHP) are strictly regulated by the NSHA, who control the prices charged and consequently influence sticky costs. Thus, based on the authors above, hypotheses regarding these norms were developed to guide this study.

Holzhacker et al. (2015) found changes in sticky costs in healthcare organizations after regulatory changes. This suggests that the same dynamic could apply to PHP, which has undergone several regulatory processes since the creation of NSHA. However, a legal measure (Direct Action of Unconstitutionality 1931/03) established that PHP contracted before the agency's regulation (called in this study old plans) would not be subject to the rules, and the contract signed between the parties (providers and beneficiaries) prevail. Thus, as the PHP could adjust these plans' prices following their business goals and market conditions – which reduce the effects of sticky costs measured based on the models that employ revenues as a proxy for the level of activities – Hypothesis 1 is:

H_1: The greater proportion of old plans in the PHP portfolios tends to reduce the organizations' sticky costs.

Also, the adjustment of prices for individual healthcare plans is different from collective plans (contracted by companies and other organizations). According to Varella and Ceschin (2014), while individual plans can only be adjusted with the authorization of the NSHA, the collective can be adjusted based on the negotiation among the parties. Thus, it is expected that the PHP will have preferences for collective plans and, based on them, will be able to reflect the variations in their expenses in their prices, according to their interests. Again, there is a possibility of influencing revenues according to the organization's needs. Therefore, based on Avelar et al. (2019a), Hypothesis 2 is:

H_2: The greater proportion of collective plans in the PHP portfolios reduces the organizations' sticky costs.

Finally, the dependency ratio, i.e., "percentage ratio between the sum of the number of children under 15 and those over 60, and beneficiaries between 15 and 59 years old" (ANS, 2016, p. 4), stands out. For the elderly, Kudlawicz, Steiner, and Frega (2015, p. 61) point out that normative resolution n. 63/03 (Resolução Normativa n. 63, 2003) caused the readjustment of health plans for the group over 60 to be restricted to a fixed amount in relation to the first age group. This implied a reduction in PHP revenues due to the prohibition on increasing monthly fees and leveraging costs for the last age group (which tends to use more services). Considering that, contrary to the previous hypotheses, there is a reduced legal margin to influence revenues for the benefit of providers, Hypothesis 3 was developed based on Avelar et al. (2019a):

H_3: Highest dependency ratio in the PHP portfolios leads to an increase in the organizations' sticky costs.

3 METHODOLOGY

The first step in developing this study consisted of a search for articles on sticky costs in the databases of the Brazilian Coordination for the Improvement of Higher Education Personnel (Capes) – Science Direct and Scopus. We selected articles according to relevance following the databases criteria and identified those offering empirical, theoretical, and methodological contributions to the topic. In addition, databases gathering articles produced in Latin America were consulted to consolidate a regional character. We selected articles from Scielo, Redalyc, and Google Scholar, observing the studies' relevance and contribution. Thus, articles that contributed to the development of the theme of sticky cost were selected in both developed and emerging economies, with a focus on Latin America and Brazil.

The population examined was Brazilian private healthcare providers (PHP), and the sample comprised the PHP classified by the National Supplementary Health Agency (NSHA) as medical cooperatives and group medicine. The study used secondary data collected from the NSHA website, referring to 2010-2018 (ANS, 2006). The year 2010 was chosen because it was the year Brazil adhered to the international accounting standards (Gelbcke, Santos, Iudícibus, & Martins, 2018). The option to limit the sample to PHP classified as medical cooperatives and group medicine was due to their characteristics, as explained in subsection 2.2. Table 2 shows the number of PHP in the sample (per class and year).

Table 2. Number of PHP in the sample, per year, per classification

Classes of PHP	2010	2011	2012	2013	2014	2015	2016	2017	2018
Group medicine	333	307	241	221	212	213	209	204	203
Medical cooperatives	327	320	309	301	294	288	294	288	271
Total	660	627	550	522	506	501	503	492	474

Source: Elaborated by the authors

Financial data was obtained from the providers' annual financial statements, and operational data was gathered from the NSHA's website by request supported on the Brazilian freedom of information law (Law 12527/2011).

The data were analyzed using panel data regression, widely used in studies on sticky costs since the seminal study by Anderson et al. (2003). Three models were estimated for each class of PHP, and three different cost proxies were used, following the works by Pamplona et al. (2016), Zonatto et al. (2018), Avelar et al. (2019a), Reis and Borgert (2019): costs of rendered services, selling, general, and administrative (SG&A) expenses, and total cost.

The first estimated model was based on the original study by Anderson et al. (2003), aiming to identify the providers' sticky costs (Equation 1). For all models presented below, (a) *cost* means the different proxies of costs mentioned above, (b) *REV* is the providers' net sales revenue, and (c) *Red* is the multiplier reduction, which is a dummy variable (1 is applied when there is a decrease in revenues between the periods, and 0 otherwise). Also, α, β, *i*, *t*, and μ represent, respectively, the intercept, the coefficients, the organization, the period, and the error.

$$log\left(\frac{Cost_{i,t}}{Cost_{i,t-1}}\right) = \alpha + \beta_1 \times log\left(\frac{REV_{i,t}}{REV_{i,t-1}}\right) + \beta_2 \times \text{Red} \times log\left(\frac{REV_{i,t}}{REV_{i,t-1}}\right) + \mu \quad (1)$$

The models were estimated to verify the influence of accounting variables on the sticky costs, based on the studies by Richartz and Borgert (2016) and Reis and Borgert (2019). Not all variables cited by those authors were used, either because they are variables exogenous to the providers or because they demand information from the capital market (unavailable to the vast majority of PHP). Equation 2 presents the model.

$$log\left(\frac{Cost_{i,t}}{Cost_{i,t-1}}\right) = \alpha + \beta_1 \times log\left(\frac{REV_{i,t}}{REV_{i,t-1}}\right) + \beta_2 \times Red \times log\left(\frac{REV_{i,t}}{REV_{i,t-1}}\right) + \beta_3 \times \text{Red} \times log\left(\frac{AVAI_{i,t}}{TAS_{i,t}}\right) + \beta_4 \times \text{Red} \times log\left(\frac{FIX_{i,t}}{TAS_{i,t}}\right) + \beta_5 \times \text{Red} \times log\left(\frac{TPC_{i,t}}{TAS_{i,t}}\right) + \beta_6 \times \text{Red} \times log(TAS_{i,t}) + \mu \quad (2)$$

Where:

AVAI is the available asset;

FIX is the fixed asset (property and equipment);

TPC is the third party capital used; and

TAS is the total asset.

Finally, models related to NSHA regulation on the PHP's sticky costs were estimated. Based on legislation on healthcare providers and the study by Avelar et al. (2019a), three variables with the potential to influence costs with asymmetric behavior were selected: the proportion of old plans in the providers' portfolios, proportion of collective plans in their portfolios, and the providers' dependency ratio. The possibility of a PHP owning a hospital was also considered. Chart 1 shows the operationalization of the variables related to regulation. Equation 3 presents the model.

Hypothesis	Variable	Acronym in the model	Calculation	Reference
H_1	Proportion of old plans in the providers' portfolios	OLD	Number of old plan beneficiaries ÷ Total number of beneficiaries	NSHA (ANS, 2018a)
H_2	Proportion of collective plans in the providers' portfolios	COL	Number of beneficiaries of collective plans ÷ Total number of beneficiaries	NSHA (ANS, 2016)
H_3	Providers dependency ratio	DEP	Number of beneficiaries under 15 over 60 ÷ Number of beneficiaries over 15 and under 60	NSHA (ANS, 2016)

Chart 1. Operationalization of variables related to regulation
Source: Elaborated by the authors

$$log\left(\frac{Cost_{i,t}}{Cost_{i,t-1}}\right) = \alpha + \beta_1 log\left(\frac{REV_{i,t}}{REV_{i,t-1}}\right) + \beta_2 \times Red \times log\left(\frac{REV_{i,t}}{REV_{i,t-1}}\right) + \beta_3 \times Red \times log(COL_{i,t}) + \beta_4 \times Red \times log(OLD_{i,t}) + \beta_5 \times Red \times log(DEP_{i,t}) + \beta_6 \times Red \times log(HOSP_{i,t}) + \mu \quad (3)$$

Tests were used to select the best-estimated model: (a) Chow test, to choose between the fixed effects model or pooled ordinary least squares; (b) Breusch-Pagan Lagrange multiplier test, to choose between the random effects model or pooled ordinary least squares; and (c) Hausman test to choose between the random effects or fixed effects model (Gujarati & Porter, 2011; Fávero, 2015). Other tests were applied after estimating the models to assess the compliance with assumptions and adequacy criteria: F/Wald test, variance inflation factor, Wooldridge test, and modified Wald test (Gujarati & Porter, 2011; Fávero, 2015). Figure 1 summarizes the methodological procedures.

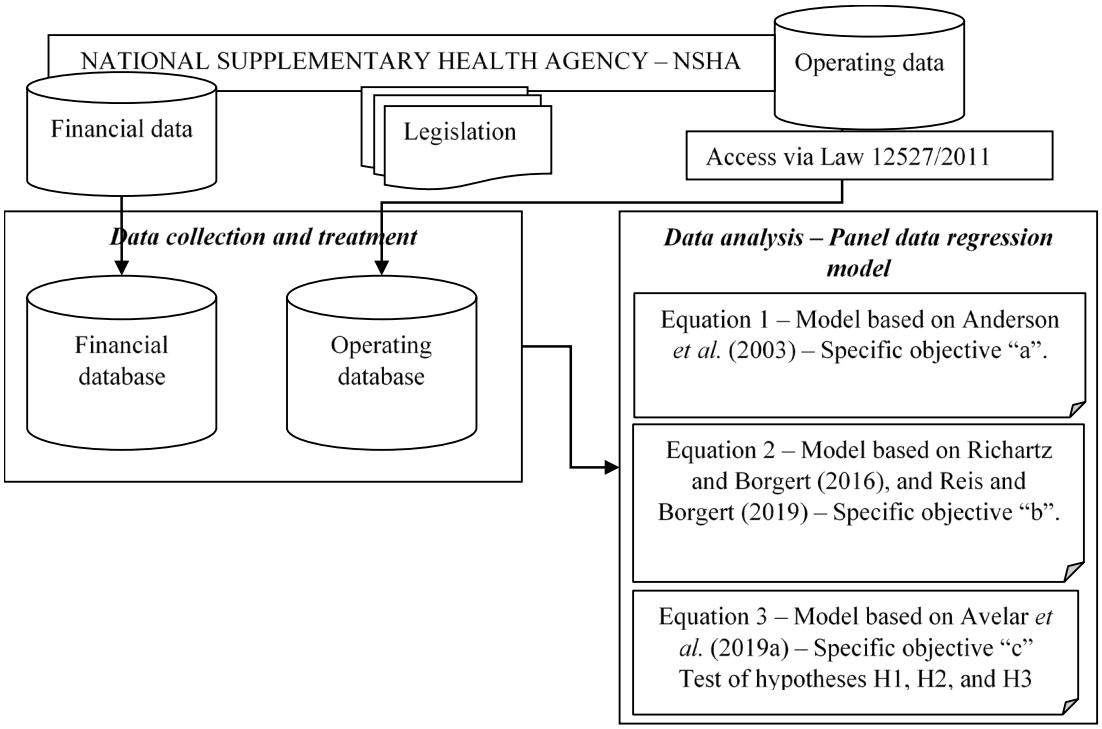

Figure 1. Synthesis of the methodological procedures
Source: Elaborated by the authors

4 RESULTS

The results obtained when applying the original model by Anderson et al. (2003) (Equation 1) are described in Table 3. There was no significance observed for any variable in any of the providers' classes when adopting the dependent variable cost of rendered services. On the other hand, the variables related to revenue were significant for the models of SG&A expenses and total costs in both classes of PHP. Table 3 also shows that sticky costs only occur when the variable SG&A expenses were used as a cost proxy in the case of medical cooperatives. Sticky costs were not evident for group medicine providers.

Table 4 shows the results obtained for each PHP classes based on the model with accounting variables (Equation 2). Again, no significant relationship of their independent variables was found when the proxy was the costs of rendered services. On the other hand, two variables revealed sticky costs – earnings available and fixed assets – since they presented significant relationships in both remaining models estimated for the medical cooperatives. The asymmetric behavior of costs, when observing the total costs variable, can be considered sticky. In contrast, anti-sticky behavior was observed for the dependent variable SG&A expenses. PHP classified as group medicine did not show sticky behavior in this model.

Finally, Table 5 presents the results for the models that considered the regulation variables (Equation 3). None of the variables in the models that used the dependent variable cost of rendered services were considered significant. As observed in the previous models, when using the variables SG&A expenses and total costs as proxies, significant results were obtained regarding revenues and, in some cases, there is evidence of sticky costs.

Considering the dependent variable total costs, the estimated model for medical cooperatives revealed sticky cost – with a contribution from the variable dependency ratio. On the other hand, when considering the variable SG&A expenses as proxy costs in the providers classified as group medicine, the variable dependency ratio demonstrated an anti-sticky asymmetric behavior. It should be noted that the other regulation variables were not considered significant in the estimated models. From the results, it was possible to confirm hypothesis 3, that the highest dependency ratio in the providers' portfolios increases the occurrence of sticky costs. However, it was not possible to confirm hypotheses 1 and 2, which assumed the relationship between the sticky costs and the variables proportion of old plans and proportion of collective plans in the providers' portfolio. Chart 2 summarizes the results regarding the hypotheses.

Table 3. Results – Original model

Classification	**Medical cooperatives**			**Group medicine**		
Dependent variable	Cost of rendered services	Selling, general, and administrative expenses	Total costs	Cost of rendered services	Selling, general, and administrative expenses	Total costs
Model	Fixed effects	Random effects	Pooled ordinary least squares	Pooled ordinary least squares	Fixed effects	Fixed effects
Log of revenue variation	258321.50	0.47***	0.31***	2701.28	0.35***	0.46***
Dummy of revenue reduction	-6903.12	-0.03***	-0,00	-374.85	0.02	0.02
Intercept	-248114.90	-0.48***	-0.29***	-2094.19	-0.37***	-0.46***
Chow test	5.43***	0.86	1.07	0.70	2.16***	1.95***
Lagrange multiplier	0.00	8.73***	0.20	0.00	0.32	0.06
Hausman test	0.43	1.70	7.37	1.83	9.14***	10.21***
Wald and F test	0.50	140.84***	29.55***	2.12	9.65***	10.14***
Variance inflation factor	1.78	1.78	1.78	1.67	1.67	1.67
Wooldridge test	29.01***	428.55***	8902.38***	1.415e+07***	147.171***	3397.52***
Modified Wald test	1.5e+40***	3.9e+36***	1.9e+34***	1.7e+41***	1.2e+36***	2.7e+36***

Source: Elaborated by the authors
Note: *Significance of less than 10%; ** significance of less than 5%; *** significance of less than 1%

Table 4. Results – Accounting variables

Classification	**Medical cooperatives**			**Group medicine**		
Dependent variable	Cost of rendered services	Selling, general, and administrative expenses	Total costs	Cost of rendered services	Selling, general, and administrative expenses	Total costs
Model	Fixed effects	Random effects	Pooled ordinary least squares	Pooled ordinary least squares	Fixed effects	Fixed effects
Log of revenue variation	342928.90	0.38***	0.40***	3437.49	0.39***	0.42***
Dummy of revenue reduction	-164846.90	0.17*	-0.25*	-2344.79	-0.08	0.10
Log of earnings available[a]	3862.38	-0.04***	-0.01	-11.05	0.01	-0.01
Log of fixed assets[a]	41253.01	0.03*	0.02	-7.48	-0.06	-0.07
Log of third parties capital[a]	855815.30	0.05	-0.01	-93.72	0.00	-0.13
Log of asset[a]	60287.20	-0.03**	0.03*	269.31	0.01	-0.03
Dummy of owning a hospital	104178.30	0.01	0.04	-66.30	0.02	0.03
Intercept	-340735.50	-0.38***	-0.39***	-2927.62	-0.43***	-0.43
Chow test	5.57***	0.90	1.04	0.71	2.08***	1.89***
Lagrange multiplier	0.00	7.06***	1.24	0.00	1.05	1.37
Hausman test	18.87***	19.70***	17.50**	7.43	32.12***	41.58***
Wald and F test	0.15	157.93***	77.55***	2.67	3.53***	4.06***
Variance inflation factor	23.66	23.66	23.66	14.45	14.45	14.45
Wooldridge test	14.31***	461.48***	7491.05***	7.826e+06***	151.75***	3704.11***
Modified Wald test	5.7e+38***	1.1e+33***	4.6e+34***	2.7e+40***	1.8e+36***	6.1e+35***

Source: Elaborated by the authors

Note: *Significance of less than 10%; ** significance of less than 5%; *** significance of less than 1%; [a] values multiplied by the dummy of revenue reduction.

Table 5. Results – Regulation variables

Classification	**Medical cooperatives**			**Group medicine**		
Dependent variable	Cost of rendered services	Selling, general, and administrative expenses	Total costs	Cost of rendered services	Selling, general, and administrative expenses	Total costs
Model	Fixed effects	Random effects	Pooled ordinary least squares	Pooled ordinary least squares	Fixed effects	Fixed effects
Log of revenue variation	284344.10	0.47***	0.32***	2741.90	0.37***	0.47***
Dummy of revenue reduction	-115668.20	-0.01	-0.05***	-431.03	0.06	0.04
Log of proportion of collective plansa	-103677.30	0.02	-0.05	-110.54	0.04	-0.04
Log of proportion of old plansa	-48367.08	0.31	0.15	55.01	-0.01	0.08
Log of dependence ratioa	-239557.50	0.02	-0.14***	-130.96	0.14**	0.09
Dummy of owning a hospital	11318.99	0.01	0.02	-4.28	0.05	0.04
Intercept	-276460.10	-0.49	-0.31***	-2140.17	-0.36	-0.48***
Chow test	5.45***	0.87	1.05	0.70	2.09***	1.91***
Lagrange multiplier	0.00	8.25***	0.54	0.00	0.49	0.07
Hausman test	10.19	7.86	9.49	5.56	19.28***	11.55**
Wald and F test	0.18	178.78***	109.52***	2.26	4.02***	4.13***
Variance inflation factor	2.30	2.30	2.30	1.74	1.74	1.74
Wooldridge test	0.043***	443.347***	7954.52***	1.237e+07***	147.64***	3213.84***
Modified Wald test	5.4e+38***	1.0e+34***	4.6e+34***	1.2e+40***	5.4e+35***	4.1e+36***

Source: Elaborated by the authors
Note: *Significance of less than 10%; ** significance of less than 5%; *** significance of less than 1%; [a] values multiplied by the dummy of revenue reduction.

Hypothesis	**Medical cooperatives**			**Group medicine**		
	Cost of rendered services	Selling, general, and administrative expenses	Total costs	Cost of rendered services	Selling, general, and administrative expenses	Total costs
H_1	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected
H_2	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected
H_3	Rejected	Rejected	Confirmed	Rejected	Confirmed	Rejected

Chart 2. Hypotheses
Source: Elaborated by the authors

5 DISCUSSION

The models using the cost of rendered services as costs proxy did not present any significant variables, which is a result that contradicts the expectations based on the model by Anderson et al. (2003) and the studies by Avelar et al. (2019a), Holzhacker et al. (2014), and Richartz and Borgert (2016). Therefore, this proxy was not suitable to analyze sticky costs in the models applied to Brazilian private healthcare providers (PHP). This result confirms Shust and Weiss' (2014) findings on how the choice of proxies can influence the measurement of sticky costs through different statistical models. It is also aligned with findings by Zonatto et al. (2018), who showed the significance of models that used this same proxy in Brazilian companies.

On the other hand, the fact that the variables related to revenues are significant in the models where selling, general, and administrative (SG&A) expenses and total costs were used as cost proxies in both classes of PHP suggests a positive relationship between these proxies and revenue, which is aligned with findings of Porporato and Werbin (2012). Sticky costs were only observed in medical cooperatives, confirming the results of Avelar et al. (2019a). In this case, it appears that even when operating in the same sector, organizations with different legal nature may or may not present sticky costs.

The model with accounting variables estimated for medical cooperatives identified the contribution of the organization's earnings available and fixed assets to sticky costs. This result confirms that obtained in Grejo et al. (2019) and Richartz and Borgert (2016) and, partially, the health sector findings by Avelar et al. (2019a) and Holzhacker et al. (2014). There was anti-sticky cost behavior when the cost proxy was the total cost, contrary to what was observed in Avelar et al. (2019a).

Finally, the results regarding the regulation variable providers' dependency ratio showed different sticky costs depending on the classification of the PHP and the cost proxy used, demonstrating the complexity of this asymmetry. This phenomenon seems to be sensitive to the legal nature of organizations, which is a variable that is not usually present in national or international studies. Usually, such studies focus on the sector (cost structure proxy) as a way to obtain evidence of sticky cost, as observed in the studies by Carmo and Xavier (2016), Santos et al. (2017), Stimolo and Porporato (2019), and Zhang et al. (2019). However, this research demonstrated that sticky cost could differ significantly among organizations in the same sector; in this case, Brazilian supplementary healthcare. Thus, the use of different models to analyze organizations of distinct legal nature can capture such heterogeneity.

6 CONCLUSION

The research results show the unsuitability of costs of rendered services as a proxy to analyze sticky costs in the proposed models. Other proxies such as SG&A expenses and total costs demonstrated significant relationships in all estimated models, as expected based on the literature. In these cases, significant results were found regarding the level of revenue (a proxy for the level of activity). Also, when estimating the original model by Anderson et al. (2003), sticky costs were found only for medical cooperatives. When other accounting variables were inserted in the models, some of them presented significant relationships, indicating their effects on medical cooperatives' sticky costs. As for PHP classified as group medicine, none of these variables were significant.

For the regulation variables, providers' dependency ratio was considered significant in both classes of PHP. The effect on sticky costs was expected, considering that this measure indicates a lower margin for price management (and consequently lower revenue). However, the hypotheses related to greater flexibility in price management – considering the variables related to the proportion of old and collective plans in the providers' portfolios and their relationship with sticky costs – were rejected. The smaller number of variables contributing to the PHP's sticky costs compared to companies in other sectors can be related to the healthcare providers' lean structure in the face of an uncertain environment, with limited management mechanisms in a regulated context, as highlighted by Holzhacker et al. (2015).

The findings obtained in this study contribute to improving the work of different stakeholders in the sector of supplementary health. First, the National Supplementary Health Agency has evidence that regulation may affect the sticky cost of the PHP in different ways. Several variables are involved in the phenomenon of costs asymmetric behavior, and regulation must consider the organizations' sticky costs to avoid measures that can harm their economic-financial sustainability. From the perspective of the PHP managers, the awareness that different variables influence sticky costs enables them to make informed decisions and reduce the risks associated with such asymmetry. Finally, society as a whole can benefit from these findings since they lead to better management and regulation in the supplementary health sector, which serves tens of millions of Brazilians (ANS, 2020).

This study innovated by noting the importance of the organizations' legal nature, even within a single sector, when exploring the phenomenon of sticky costs, which is something previous studies did not consider. Different regulation variables were also proposed to understand the asymmetric behavior of costs, exploring their influence in highly regulated sectors. The study particularly revealed the different effects of a regulation variable related to prices on the different classes of PHP, demonstrating the relevance of the variable for decision-making. Finally, the importance of using different proxies to measure sticky costs was highlighted, a condition often ignored in research. Despite the innovation and advances, the study also presented limitations. First, the sample was relatively small in terms of available data, and because only two classes of PHP were investigated. Second, the limitation of available data led to a reduced number of regulation variables.

Future research could test the same or other regulation variables linked to prices in PHP classified as self-management, philanthropic, dental cooperative, or group dentistry, or in other time horizons, overcoming the limitations of this endeavor. Finally, further research is needed to capture the point of view of regulators and managers and better understand the effects of their decisions on sticky costs.

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