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Theoretical-empirical Article

Longitudinal Effects of Sectoral Concentration on the Brazilian Insurance Market Performance

Efeitos Longitudinais da Concentração Setorial sobre o Desempenho do Mercado Segurador Brasileiro

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ABSTRACT

Objective: to evaluate the concentration in different Brazilian insurance lines of business (LOB) and analyze effects on premium revenues and profitability. There is evidence that the Brazilian insurance market holds the main characteristics of an oligopoly. **Theoretical approach:** it is based on Industrial Organization, a field of Economics that is dedicated to studying the market structure, importance, and arrangement of firms, in addition to impacts derived from concentration on competition. **Method:** regression models for panel data are used. The data are official from the Brazilian insurance market, arranged monthly between Feb./2003 and Dec./2018, totaling 82,443 observations from 135 insurers operating in 17 segments. For each segment, the main concentration indices in the literature were calculated and their effects on premiums and profits were estimated. **Results:** increases in concentration indices are related to reductions in insurance companies' premiums revenues, but without a reduction in profits. However, if an insurer is among the market's largest, and is part of an economic group, the effects are nullified and the concentration can generate increases in premiums' revenues and profits, suggesting that it exercises some market power by raising premiums, reinforcing the structure-conduct-performance hypothesis. **Conclusions:** the sectorial concentration is greater in life than in non-life LOB, with evidence pointing to the four largest insurance companies, with the highest collections between 2003 and 2018, holding 90% of the market share. In addition, the collection in the life LOB, is more than 80% of the average, concomitant with a drop in the total number of players.

Keywords: insurance market; market concentration; concentration indices.

RESUMO

Objetivo: avaliar a concentração em diferentes ramos do mercado segurador no Brasil e analisar seus efeitos sobre a arrecadação de prêmios e lucratividade. Há evidências de que o mercado segurador brasileiro apresenta as principais características de um oligopólio. **Marco teórico:** baseia-se na Organização Industrial, campo da Economia que se dedica a estudar a estrutura de mercado, importância e arranjo das firmas, além dos impactos derivados da concentração sobre a concorrência. **Método:** utilizam-se modelos de regressão para dados em painel. Os dados são oficiais do mercado segurador brasileiro, dispostos mensalmente entre fev./2003 e dez./2018, totalizando 82.443 observações de 135 seguradoras atuantes em 17 ramos. Para cada ramo, calcularam-se os principais índices de concentração da literatura e foram estimados seus efeitos sobre prêmios e lucros. **Resultados:** aumentos dos índices de concentração relacionam-se com redução da arrecadação das seguradoras, mas sem redução de lucro. No entanto, caso a seguradora esteja entre as maiores do mercado, e faça parte de algum grupo econômico, os efeitos são anulados e a concentração pode gerar aumentos de arrecadação de prêmios e lucros, sugerindo que ela exerce algum poder de mercado elevando os prêmios, reforçando a hipótese de estrutura-conduta-desempenho. **Conclusões:** a concentração setorial é maior nos segmentos de vida do que nos demais. As evidências apontam para as quatro maiores seguradoras do setor, com maiores arrecadações entre 2003 e 2018, detendo 90% do *market share*. Ademais, a arrecadação nos ramos vida, é superior a 80% da média total, concomitante a uma queda do total de *players*.

Palavras-chave: mercado segurador; concentração de mercado; índices de concentração.

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INTRODUCTION

The Brazilian insurance market, in the last decade, presented a significant expansion. There was a real growth of 69% in premiums between 2000 and 2018, which represents an average growth around 3% per year. This is an important performance, especially when compared to the Brazilian economy growth that, after the period of recession between 2015 and 2016, showed a real growth of 1.1% in 2017 and 0.5% in 2018. In addition, it should be noted that, between 2000 and 2018, the number of active insurers showed a drop of 11%, according to official data from Brazilian Superintendency of Private Insurance (Susep).

The insurance operation is, in general, guided by the establishment of an agreement in which the insured, in exchange for payment of a predefined premium, receives the guarantee, from the insurer, to indemnify him in case of adverse event materialization during the contract term (Euphasio & Carvalho, 2022). Insurance enables collectivization of losses based on mutualism. From an individual point of view, insurance operation allows the transfer of onus resulting from claim materialization, in face of personal or property risks, reducing uncertainties and the impact of large losses (Areias & Carvalho, 2021; Born & Klimaszewski-Blettner, 2013; Brouwer, Tinh, Tuan, Magnussen, & Navrud, 2014). From a macroeconomic point of view, the very existence of insurance sector implies efficient management of resources and consequent contribution to GDP, income, tax revenue, and economic growth (Cummins & Weiss, 2014; Olasehinde-Williams & Balcilar, 2020).

Given the insurance market relevance, either by the significant growth or the importance promoted to both society and economy (Balcilar, Gupta, Lee, & Olasehinde-Williams, 2020; Flores, Carvalho, & Sampaio, 2021; Pradhan, Arvin, Norman, Nair, & Hall, 2016), it is important to understand the conditions under which the market is organized (Altuntas & Rauch, 2017; Chidambaran, Pugel, & Saunders, 1997) and their impact on premiums and profitability of different insurance market lines of business (LOB) in Brazil.

Thus, the objective of this article is to analyze the concentration in different LOBs of the insurance market in Brazil and to evaluate its effects on premium collection and profitability. For this, four indices are constructed from three of the main concentration indices frequently used in current industrial organization literature: Herfindahl-Hirschman index (HHI), concentration ratio (CR), and Theil's entropy index (TE).

Especially, analyzing the market's competitive conditions, whether the sector is concentrated or not, is crucial to guarantee economic efficiency and promote greater collective well-being (Fungáčová, Shamshur, & Weill, 2017; Hankir, Rauch, & Umber, 2011). I.e., ensure that insurance companies can operate in free competition makes the organization of cartels unfeasible, allowing the premiums charged to be closer to actuarily fair; consequently, it contributes to a greater fraction of society being able to take advantage of financial protection in addition to providing opportunities for diversification and sophistication of products offered (Elyasiani, Staikouras, & Dontis-Charitos, 2016).

In general, concentrated markets have an oligopolistic structure. According to Bain (1956), an oligopolistic market has three main characteristics: cost advantages of already established firms; product differentiation; and scale economy. For Gosmann (2013), the Brazilian insurance market holds the main characteristics of an oligopoly, with market dominance by some leading companies and a certain power to determine the prices charged by these dominant companies.

The competition defense policy is established through the decisions of national antitrust bodies. In Brazil, they are issued by *Conselho Administrativo de Defesa Econômica* (Cade), a federal agency linked to the Ministry of Justice, which has three main functions: preventive, analyzing mergers, incorporations, splits, associations, and other acts of economic concentration between agents; repressive, judging conduct harmful to free competition; and educational, educating the public about anti-competitive conduct. There are several feasible ways to analyze market concentration. The most traditional, used by competition defense agencies, is based on concentration indices. Among the numerous advantages of using such indicators, two stand out: the need for little information to obtain them and the easy interpretation (Gosmann, 2013).

THEORETICAL BACKGROUND AND EMPIRICAL LITERATURE

Industrial organization (IO) is the field of economics dedicated to studying the structure and behavior of industries. Furthermore, it seeks to understand effects of the size and arrangement of firms, in addition to the impacts derived from concentration on competition. According to Bain (1956), the number of players in an industry, as well as the market share of these firms, can determine conditions of competition in the market: few companies holding great share of the market indicate that these firms may incur anticompetitive conduct.

Competition defense policy is traditionally supported by the IO theory, which argues that sector structure (market concentration) would determine conduct

of firms (prices), impacting their performance (revenue/profitability). This approach created the so-called 'structure-conduct-performance' (SCP) paradigm (George, Joll, & Lynk, 2005), which advocates that market structures may not be organized in a perfectly competitive environment, given the existence of factors as barriers to entry and market concentration. Bain (1956) argues that SCP is a model that operationalizes the concept of competitiveness.

Originally, SCP was used to support American antitrust policies to assess how the impact of market imperfections affect supply and demand (Bailey, 2015), as well as identify collusion to maximize profits, comparing profitability of concentrated market structures with the expected result of a market in free competition (Scarano, Muramatsu, & Francischini, 2019). Concentration, even when it does not make competition unfeasible, changes the level of competition in a sector, ultimately harming consumers (Matias-Pereira, 2006).

The classic SCP paradigm view points to a single sense of cause and effect (Siqueira, 2020). However, reviews carried out over time show causality problems, and it is not possible to point out a single direction of determination (Kupfer & Hasenclever, 2020). For example, a sector performance may encourage changes in firms' strategy/conduct, which may, or may not, cause changes in market structure. However, even though the dynamics of the model, which prevents one-way causality, is known, it is still recognized as an important reference for market analysis (Scarano et al., 2019). According to Siqueira (2020), SCP reinforces that companies, through their strategies, permanently seek to change the basic conditions of supply, demand, and market structure, in order to obtain a competitive advantage.

There are several papers in IO's empirical literature that aim to understand operating conditions of different economic sectors (Grubb, 2015). Grullon, Larkin and Michaely (2019), analyzing the evolution of concentration levels of American industries over time, identified that in the last two decades, more than 75% of these industries had an increase in concentration levels, evidenced by HHI. The authors emphasize that in concentrated markets, firms exercise market power by keeping prices above marginal costs. The data comprise the period 1972-2014, using regression method for panel data. For Wernerfelt and Montgomery (1988), there is a positive correlation between market share and company performance.

In Brazil, there is growing concern about the increase in market concentration and its subsequent effects. Cardoso, Azevedo and Barbosa (2018) argue that the process of market concentration, especially if resulting from mergers and acquisitions, has dubious effects: on one hand, increased concentration can facilitate the exercise of market power; on the other, mergers can generate efficiency gains. The authors empirically investigate effects of concentration (HHI) on bank loan markets. The results indicate that competition and the loans supply in this market are directly proportional: higher levels of HHI imply lower competition levels and, consequently, a reduction in supply. Silveira (2017) estimates that the concentration ratio (CR) for the 10 biggest Brazilian commercial banks in 2016 was 88.5%.

Discussions about insurance market concentration are also observed in the literature. Thorburn (2008) proposes the comparison of competitive conditions between insurance industries in different countries. They concluded that there is great dispersion of HHI among the analyzed countries and important patterns are evidenced: the highest concentration indices are in the personal insurance segment that, despite being dispersed, presents a tendency of approximation of these concentration indices among the observed countries. Shirinyan (2012) assesses the European insurance market competitive conditions using HHI as a concentration proxy. The author observed that, as in Brazil, Germany did not show decreases in premiums collected in face of financial crises. In addition, there was a drop in the total number of insurance companies for the analyzed period.

Tipurić, Bach and Pavić (2008) evaluated the European insurance market between 199 and 2006 and concluded that there was a decrease in market concentration. Likewise, Škuflić, Galetić and Gregurić (2011) also showed a reduction in Croatian insurance market concentration. For this, three insurance market concentration indices were used: HHI, CR, and Gini coefficient. Sharku and Shehu (2016) found similar results, as they found that competition in the insurance market in Albania has increased with different intensity among the various LOBs, according to the concentration indices tested (CR1, CR4, and HHI).

On the other hand, there are articles that focus the analysis on a single LOB (Gaynor, Ho, & Town, 2015). Dafny, Duggan and Ramanarayanan (2012), for example, examine the American health insurance industry. Using data from 1998-2006, they sought to understand the relationship between the growth of premiums collected and changes in market concentration via traditional regression models (i.e., ordinary least squares, OLS), considering mergers between insurers and the causal effect on premiums. The conclusion suggests that, during the analyzed period, the market was dominated by a few insurers and was becoming more concentrated over time. As a result, increased concentration has raised the premiums, suggesting that Americans are 'paying a premium on the premium.' These results corroborate a recent study[1] by Kaiser Family Foundation, analyzing this insurance sector by US state, which identified that in 2017, three insurers held 57% of the market share, carrying an HHI equivalent to 4.616.[2]

According to Murat, Tonkin and Jüttner (2002), if there is a market with a small number of large companies, at the limit, these companies may incur in the formation of a cartel and, consequently, dictate prices and market conditions. In this case, few dominant companies could act as market price makers, while others peripheral companies would end up accepting their price leadership, making competitiveness unfeasible and making insurance products less attractive. There is historical evidence that cartels do indeed promote inefficiency. Joskow (1973), for example, showed cartel behavior for the property and liability non-life insurance market in the 1960s-1970s. This behavior, concomitant with the legal peculiarities of that time, resulted in scarce offers of insurance products, as well as overcapitalization, i.e., premiums were excessive.

Economic stagnation favors mergers and acquisitions (Toole, 2003). Companies that face unfavorable economic scenario and, consequently, greater vulnerability of revenues may choose to restore their financial health through mergers or sale of the company (Gosmann, 2013). These facts are observed in Galiza (1997), who brought evidence from the 1970s-1980s, noting a relative increase in the Brazilian insurance market concentration, evidenced by the HHI increase. Especially in the 1970s, the entry of banking institutions into the national insurance sector occurred, although in many countries there are restrictions on the bancassurance movement, as in Spain and Greece (Kalsing & Farias-Filho, 2004). For Faria (2007), the concentration observed in the Brazilian insurance market can be explained by the concentration in the banking sector, and the entry of these institutions into insurance industry.

Rodriguez (2007) sought to understand the premiums evolution compared to the insurance market structure in Brazil. Using data between 1995 and 2006, he observed that markets regulated by Susep showed a decrease in the number of companies concomitantly with increase in HHI, signaling potential market concentration, especially in life and pensions LOBs. Regarding the main problems arising from market concentration, it is highlighted that few dominant companies can cause high market power, given the SCP paradigm, and, consequently, lower consumer well-being.

Gosmann (2013) presents concentration analysis of non-life insurance market, between 2000 and 2012, from the main concentration indices perspective (CR, HHI, TE). Her central hypothesis is that industry concentration has increased, and the market is highly concentrated. She concluded that there was a significant increase in concentration, but this movement is more relevant in the last five years of analysis, especially for housing and rural LOBs. The increase in concentration indices is due to two main factors: first, companies that are already consolidated in the market have greater sales capacity, through relationships either with brokers or with banking channels. Second, there are barriers to entry into the insurance market: depending on insurance company's framework, to operate throughout Brazil it is necessary to allocate a minimum capital that varies from BRL3,000,000.00 (microinsurance only) to BRL15,000,000.00 (if classified as S1 or S2, according to CNSP Res. No. 432/2021). In addition, Gosmann (2013) suggests that the industry growth, observed by the premiums revenues increase, was absorbed by companies that already held a large market share.

Peres, Maldonado and Candido (2019) analyzed only one LOB in Brazil: car insurance, determining the degree of competitiveness of firms. Using the classic concentration measures (HHI, extended concentration index, Hall and Tideman index, Linda index, Gini coefficient, Hannah-Kay index), they found that the evaluated sector has little concentration, i.e., the market share is well distributed among industry players. This absence of concentration implies more efficient prices, greater competitiveness, and sustained and balanced growth.

From what has been exposed, it is noted that there are few studies that aim to understand the concentration of insurance market in Brazil. Thus, the expected contributions of this paper will be made in at least two main aspects. The first of them is the use of a technique little explored in national papers with similar objectives: regression method for panel data. Second, there is a gain relative to the period of information available in relation to the main studies explored, allowing visualization of long-term impacts in all relevant LOBs, ignored by most studies that targeted specific LOB.

From literature, the use of concentration indices as proxies of competitiveness is commonplace (Grullon, Larkin, & Michaely, 2019; Liebenberg & Sommer, 2008), so they were incorporated in the present longitudinal analysis. Furthermore, it is noted that Brazilian literature lacks a paper that analyzes all main LOBs, for a long period and under the focus of more robust techniques (Rensi & Carvalho, 2021). On the other hand, the present study brings a similar analysis to that of Dafny et al. (2012) when evaluating the relationship between premium/earnings growth and market concentration, using the estimation technique via regression method for panel data.

METHOD AND DESCRIPTION OF VARIABLES

Concentration indexes

Studying market concentration becomes relevant insofar as it is desired to assess the conditions under which

firms operate, as well as to prevent anticompetitive behavior. These types of conduct tend to raise the products and services prices, consequently reducing collective well-being (Peres, Maldonado, & Candido, 2019; Rodriguez, 2007). Classic IO literature proposes the use of concentration indices to assess competitiveness and market concentration. In general, the indicators correspond to the relative market share, from which the market structures to which companies are subject are analyzed (Genakos, Valletti, & Verboven, 2018). From literature explored in the previous section, it is observed that some indices are frequently used: concentration ratio (CR), Herfindahl-Hirschman index (HHI), and Theil's entropy index (TE). Thus, the present article uses these indices in the analysis, whose definitions are presented in the next subsections.

Concentration ratio

Concentration ratio (CR) measures the participation share of a given number of firms within a market under analysis. Here, the volume of premiums issued was used. Equation 1 explains the methodology considering the k largest companies in the insurance industry ($k = 1, 2, \ldots, n$).

$$CR_k = \sum_{i=1}^{k} S_i \quad (1)$$

where S_i refers to the *i-th* firm participation present in the market. Two specific values for k are of interest: $k = 4$ and $k = 8$, because they are the most frequently used in the empirical literature. Regarding interpretation, there is no consensus. For Winseck (2008), for example, considering the application of CR_4, levels that exceed 50% can signal a highly concentrated and non-competitive market; under the application of CR_8, on the other hand, it is considered a highly concentrated market if the index is above 75%.

Herfindahl-Hirschman Index

This index was proposed by Herfindahl and Hirschman in the 1940s. It is measured as the sum of squares of the shares of each company, in market supply, considering all companies present in the evaluated industry. Mathematically, it is given by:

$$HHI = \sum_{i=1}^{N} S_i^2 \quad (2)$$

where N is the total number of firms participating in the market. In contrast to CR, HHI considers the relative size of firms, S_i, squaring each firm's share. The HHI value varies between 1/N (uniform distribution of market share) and 1 (absolute concentration, i.e., monopolistic). The higher the HHI, the more concentrated the market and, consequently, the less competitive; on the other hand, if $N \to \infty$ the market would be perfectly competitive. The frequent use of this index is due to conceptual relationship between market structure, good properties, and its performance (Hall & Tideman, 1967).

Theil's entropy index

As an alternative to sensitivity regarding the entry of new firms in the market, to which HHI is subject, the TE index is incorporated into this analysis. This index emerged in context of information theory and was adapted to IO studies by Theil (1967). Equation (3) shows its formulation.

$$TE = \sum_{i=1}^{N} S_i \ln\left(\frac{1}{S_i}\right) \quad (3)$$

TE is an inverse measure of concentration: its value decreases as the degree of concentration of firms increases, i.e., if $TE = 0$, there is an indication of maximum concentration, characterizing a monopolistic scenario. On the other hand, there is no consensus on maximum limit.

Models

Initially, it is estimated how market concentration, under the proxy of concentration indices, may be related to the variation of issued premiums over time. Among the various types of existing premiums, we chose to use premiums issued, as they most reliably reflect the assumption of responsibilities of each insurer. The issued premiums include all coinsurance operations (accepted and ceded), in force and unissued risk operations, DPVAT (a compulsory insurance for personal injury caused by motor vehicles), accepted retrocessions, recovery of initial contracting cost, and it is net of premiums assigned to consortia and funds, in addition to being gross of reinsurance.

Considering that the development of insurers' characteristics simultaneously involves cross-section (variation between firms) and temporal development (intra-firm), regression models are used for panel data (Fier & Liebenberg, 2014; Liebenberg & Sommer, 2008; Rensi & Carvalho, 2021). The most used methods to estimate this class of models with unobserved effects are: *pooled* (there are no attributes unique to each individual, nor effects that change over time), *fixed effects* (where intercept varies in cross-section, keeping constants slopes), and *random effects* (appropriate when individual effects are randomly distributed around a constant mean). For more technical details, we suggest Wooldridge (2017).

The first model is described by Equation (4).

$$\begin{aligned}\Delta ln(Premium_{i,s,t}) = \beta_0 + \beta_1 Size_{i,t} + \beta_2 GeoDiv_{i,t} + \\ \beta_3 PortDiv_{i,t} + \beta_4 EconScen_t + \\ + \beta_5 ConcInd_{s,t-1} + \beta_6 Group_{i,s,t} + \beta_7 Ranking8_{i,s,t} + \\ \beta_8 ConcInd_{s,t-1} * Ranking8_{i,s,t} + + \beta_9 ConcInd_{s,t-1} * Group_{i,s,t} + \\ \beta_{10} Group_{i,s,t} * Ranking8_{i,s,t} + \\ + \beta_{11} ConcInd_{s,t-1} * Group_{i,s,t} * Ranking8_{i,s,t} + \\ \beta_{12} ln(Premium_{i,s,t-1}).\end{aligned} \quad (4)$$

Subsequently, the effects of market concentration on profit ratio (Premiums Issued – Total Claims – Selling Expenses) and total assets were tested, i.e., the relative operational profit (RP), a traditional measure of insurance performance (Liebenberg & Sommer, 2008). The econometric model is given by Equation (5).

$$\begin{aligned}RP_{i,s,t} = \beta_0 + \beta_1 GeoDiv_{i,t} + \beta_2 PortDiv_{i,t} + \beta_3 EconScen_t + \\ + \beta_4 ConcInd_{s,t-1} + \beta_5 Group_{i,s,t} + \beta_6 Ranking8_{i,s,t} + \\ \beta_7 ConcInd_{s,t-1} * Ranking8_{i,s,t} + + \beta_8 ConcInd_{s,t-1} * Group_{i,s,t} + \\ \beta_9 Group_{i,s,t} * Ranking8_{i,s,t} + \\ + \beta_{10} ConcInd_{s,t-1} * Group_{i,s,t} * Ranking8_{i,s,t} + \beta_{11} RP_{i,s,t-1}.\end{aligned} \quad (5)$$

Models (4) and (5) aim at the longitudinal assessment of market concentration and its effects on firms, using the different concentration indices presented in the previous subsection. The dependent variable of Equation (4), $\Delta ln(\text{Premium}_{i,s,t})$, represents the growth of issued premiums of each insurer *i*, operating in the segment *s*, in the *t-th* period. On the other hand, the dependent variable of Equation (5), $\text{RP}_{i,s,t}$, represents the ratio of total operational profits over the total assets of each insurer *i,* in LOB *s* and over time *t*. Both the concentration indices ($\text{ConcInd}_{s,t-1}$) and the dependent variables are lagged by one period, similarly to Dafny et al. (2012). The logic of including lags for both dependent and independent variables in the model as instruments aims to minimize the endogeneity problem (Arellano & Bond, 1991), which refers to the loss of direction in impulse-response relationship between revenues from premiums/profits and concentration indices, which are contemporary. In this way, in addition to temporally separating the dependent variable (revenues/profits) from the independent (concentration index), the individual autoregressive effects that could bias results are controlled (Evans, Froeb, & Werden, 1993). About explanatory variables, except those referring to concentration indices brought in section "Concentration indexes", these are the definitions:

$\text{Size}_{i,t}$: natural logarithm of the total assets of each insurance company *i*, at time *t*, as a proxy for the firms' size.

$\text{GeoDiv}_{i,t}$: indicates the level of geographic dispersion in the 27 Brazilian federative units, ranging from 0 to 1. It aims to assess concentration in the whole market, having a parameter to control cases in which there is only one insurance company operating in a given region. The higher this index is, the more federative units *u* the insurer *i* operates in at time *t*, as expressed by Equation (8).

$$GeoDiv_{i,t} = 1 - \sum_{u=1}^{U} \left(\frac{Premiums_{i,t,u}}{Premiums_{i,t}} \right)^2 \quad (8)$$

$\text{PortDiv}_{i,t}$: denotes portfolio diversification, in terms of LOB, and ranges from 0 to 1. Incorporating this parameter in the model allows the control for insurers that are specialized in only one type of LOB. The higher this index is, the more LOBs *s* the insurer *i* operates in at time *t*. This parameter is given by Equation (9).

$$PortDiv_{i,t} = 1 - \sum_{r=1}^{R} \left(\frac{Premiums_{i,t,r}}{Premiums_{i,t}} \right)^2 \quad (9)$$

EconCen_t: indicates the log-level of the gross domestic product (GDP) at time *t*, as a proxy for the country's economic situation.

$\text{Group}_{i,s,t}$: dummy variable that identifies whether insurer *i* belongs to some economic group at time *t*.

$\text{Ranking8}_{i,s,t}$: binary variable that indicates whether insurer *i* is among the eight largest, under the criterion of collected premiums, in the insurance industry *s* at time *t*.

ANALYSIS OF RESULTS

Database

The official data from the Brazilian insurance market used were arranged in a panel: for each insurer active in the market, the operations in each LOB of activity over time are evaluated. This methodology makes it possible to identify and measure effects that cannot be captured in cross-sections or isolated time series. The temporal evaluation focuses on the period Feb./2003-Dec./2018, monthly, period in which complete information on all variables is available.

The sectorial analysis, however, will consider those LOBs with greater relevance to the insurance market, since, according to SES/Susep data, there are currently more than 150 existing LOBs, some of them with only one operating firm, not characterizing a relevant market. Thus, we considered the LOBs that, in aggregate, make up at least 90% of the total of issued premiums collected in at least 50% of the analyzed period. In addition to these criteria, there are two important LOBs in the market that should be considered: 1391 and 1392, which replaced those LOBs currently in run-off. Such LOBs have been in force since 2011 due to conceptual changes and, according to the criteria constructed, are identified as not relevant due to the

short exposure time. Given the relevance of these LOBs in the insurance market (e.g., 1392 is the line with the highest premium collection), they were considered in exception to the established criteria.

It is important to highlight that the definition of what a 'relevant market' is involves the discussion of geographical scope of firms' activities. However, our focus is on the product (insurance LOB), for two main reasons. First, insurance is a product with very specific characteristics (perhaps it is the only one in the whole economic theory in which the buyer does not intend to use it) and contractual conditions are generally very standardized (price-controlled, i.e., higher coverage, higher prices, but with approximately homogeneous tariffs) within the same industry. A LOB is understood to be the smallest grouping of contractual coverage contained in insurance plans, for accounting purposes. The second reason is about scarcity of available information: although it is possible to obtain the premium collections of each insurance company by LOB and by UF separately in Susep databases (so it was possible to calculate a measure of geographic diversification, to control some effects of this operational dispersion in Brazil), unfortunately it is not possible to merge both information.

The concept of premium issued was used in the calculation of all indices and equations, since it incorporates premiums obtained and ceded on in coinsurance. The database used to extract premiums issued by LOB and by federative unit, as well as total assets of each company, in each month, was obtained from SES, *Sistema de Estatísticas da Susep* (Susep Statistics System), while GDP data were extracted from the official website of BCB/Depec, *Banco Central do Brasil* (Central Bank of Brazil). All amounts were brought to constant values of Dec./2018, by IPCA, *Índice Nacional de Preços ao Consumidor Amplo* (Broad National Consumer Price Index).

Descriptive statistics

The database, after processing incomplete information, disregarding negative and null premiums, as well as LOBs related to health and mandatory insurance (e.g., DPVAT), applying the previous definition of 'relevant market,' totaled 82,443 historical observations of 135 insurance companies operating in 17 LOBs. Table 1 shows the average aggregate revenue of each insurance market LOB in the analyzed period, justifying the selection of the most financially relevant LOBs.

Table 1. Average monthly collections of premiums, by relevant insurance line in Brazil, between 2003 and 2018.

LOB description	Susep LOB Code	Segment	Monthly average premium revenues (BRL)
VGBL/VAGP/VRGP/VRSA/VRI	1392	Life	307,538,543
VGBL/VAGP/VRGP/VRSA/PRI	992	Life	97,630,394
VGBL/VAGP/VRGP/VRSA/VRI	994	Life	11,724,078
Group Life Insurance	993	Life	10,858,166
Credit Life Insurance	977	Life	9,983,206
Life Insurance (Collective)	1391	Life	7,596,930
Collective Personal Accident	982	Life	4,256,106
Life Insurance (Individual)	991	Life	3,112,962
Auto — Hull	531	Non-Life	46,502,900
Extended Guarantee	195	Non-Life	16,282,766
Motor Third-Party Liability	553	Non-Life	13,588,819
Named and Operational Risks	196	Non-Life	7,416,298
Mortgage Insurance	1068	Non-Life	5,011,519
Business Insurance	118	Non-Life	3,852,460
Homeowners	114	Non-Life	3,658,392
Sundry Risks	171	Non-Life	3,229,461
National Transportation	621	Non-Life	2,153,264

Note. Source: Own elaboration.

Life segment market is, in quantitative terms, smaller. However, it represents more than 80% of the total average of premiums collection during the period Feb./2003-Dec./2018, indicating that the premiums charged by these types of insurance are higher and/or these products are more traded when compared to products in the non-life segment. Still, under the main characteristics of these markets (Table 2), it can be noted that, on average, Brazilian insurers are large, have a diversified portfolio, and are geographically dispersed.

Analogously to the analysis presented in Table 2, the same survey was carried out for the largest lines of each insurance category, life and non-life, under the criterion of higher average amounts of premiums collected in the period, respectively, VGBL/VAGP/VRGP/ VRSA/VRI (LOB 1392) and Automobile — Hull (LOB 0531) according to Tables 3 and 4.

On average, insurers operating in private pension business (VGBL) are significantly larger than those operating in auto segment are. In addition, on average, insurance companies operating in the auto segment have a more diversified portfolio, i.e., they operate in more LOBs than the insurance companies operating in LOB 1392, showing that they are more specialized. Furthermore, these LOBs have approximately the same level of geographic dispersion. In general, there is a tendency for life insurance companies to have a more concentrated operation, since life insurance companies and EAPC, *entidades abertas de previdência complementar* (open supplementary pension entities), can only issue risks in life segment under the legal framework adopted in Brazil.

Table 2. Main characteristics of the players in the Brazilian insurance market between 2003 and 2018.

Variable	Average total assets	PortDiv	GeoDiv
Mean	BRL4,740,361,038	0.81	0.75
Standard deviation	BRL18,289,701,134	0.24	0.31

Note. Source: Own elaboration.

Table 3. Main characteristics of the Auto — Hull segment (0531) in Brazil between 2003 and 2018.

Variable	Average total assets	PortDiv	GeoDiv
Mean	BRL 1,951,013,370	0.87	0.79
Standard deviation	BRL 2,397,985,359	0.15	0.28

Note. Source: Own elaboration.

Table 4. Main characteristics of the VGBL/VAGP/VRGP/VRSA/VRI segment (1392) in Brazil between 2003 and 2018.

Variable	Average total assets	PortDiv	GeoDiv
Mean	BRL 26,364,433,352	0.59	0.80
Standard deviation	BRL 52,455,391,006	0.38	0.27

Note. Source: Own elaboration.

In general, from a competitive perspective, the insurance market presented a stationary trend on average, for all average concentration indices (HHI, CR4, CR8, and TE), as shown in Figure 1. However, there was a slight increase in HHI index, and TE index drops in the first three years of analysis, which means that between 2003 and 2006 the concentration increased. In part, this is explained by the fact that, during the first nine years of analysis, there was a progressive decline in the total number of players in the market. During the last seven years, all concentration indices, for the entire insurance market, have been more stable.

Furthermore, examining the evolution of the average rates for two major insurance LOBs in non-life and life segments — respectively, Auto (0531) and VGBL/VAGP/VRGP/VRSA/VRI (0994[3]) –, Figures 2 and 3 are presented.

While LOB 0531 shows stationary trend in all indices (Figure 2), the indices for LOB 0994 showed more variations over time (Figure 3). Figure 2 shows evolution of HHI closer to 0 and TE of great magnitude, which means that this market is more competitive, while Figure 3 shows evolution of HHI index closer to 1 and TE close to 0. There is evidence that this market is more concentrated, corroborating the results of Thorburn (2008) and Rodriguez (2007) that the life segment is more concentrated in relation to other sectors. Another evidence is that the four largest insurers operating in LOB 0994 hold almost 100% of the market, while CR8 for LOB 0531 is 81.7%.

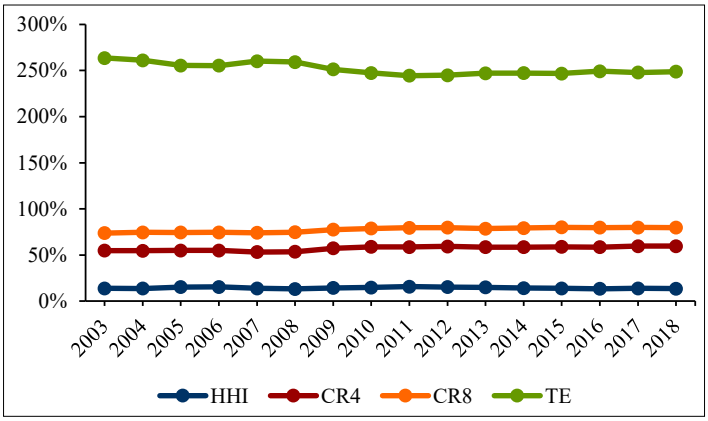

Figure 1. Evolution of the average concentration indices of the Brazilian insurance market between 2003 and 2018.

Source: Own elaboration.

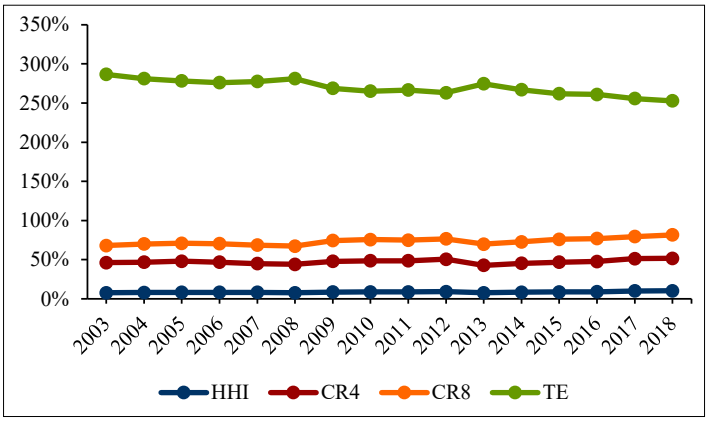

Figure 2. Evolution of the average concentration indices of the Brazilian Auto — Hull (0531) LOB between 2003 and 2018.

Source: Own elaboration.

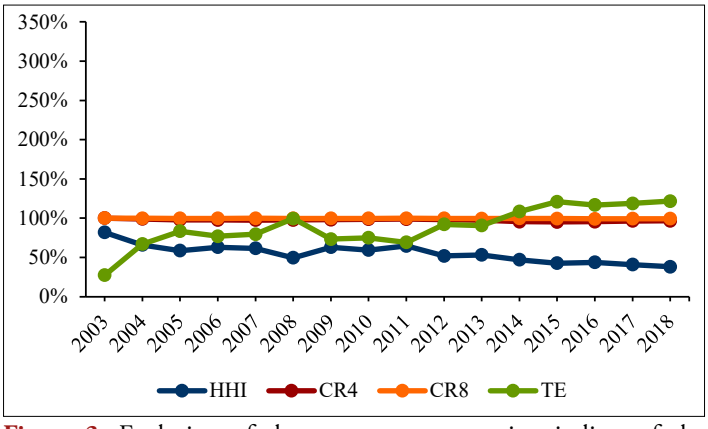

Figure 3. Evolution of the average concentration indices of the Brazilian VGBL/VAGP/VRGP/VRSA/VRI LOB (0994) between 2003 and 2018.

Source: Own elaboration.

Results of model estimates

The longitudinal analysis essentially aims to assess whether the temporal evolution of concentration in the insurance market has any effects on the growth of premiums or relative profits, for each insurance line deemed relevant. For this, regression models for panel data are considered. First, dynamic models of panel data were estimated by

generalized method of moments (GMM) to address endogeneity problems. This method includes lags of the dependent (and independent) variables as instruments (in the form of explanatory variables), controlling for individual autoregressive effects that could bias the results. However, due to the concentration indices properties, it was not possible to adopt this strategy, because the concentration indices are invariant between firms, as they represent the market configuration, fixed to a given period and a LOB (Arellano & Bond, 1991).

The models for each LOB were generated twice: by fixed effects and by random effects. The Hausman test was used to verify which estimation type is more consistent (Wooldridge, 2017). Tables 5 and 6 show the results for the best model. Finally, we decided to present results considering only HHI index as a control variable. All modeling results, for all other concentration indices, in all LOBs were obtained and can be provided upon request. The sample size is not the same for each LOB of insurance industry, leading to non-balancing of the panel. This occurs because not all insurers operate in all LOBs, and there are insurers that, in the same LOB, did not operate in all periods of analysis. In addition, there are new entrants in specific markets, as well as exits.

The results in Table 5 suggest that the autoregressive component is persistent in both models and for almost all LOBs: larger firms tend to collect more premiums, *ceteris paribus*, except for LOBs 0991, 1068, and 0114. On the other hand, measures of geographic diversification and operating portfolio are less unanimous. After all, it is an individual and internal decision of each company, and there is no right or wrong strategy, nor the only one, to obtain advantages for itself (i.e., exercise of market power).

The results reveal patterns internal to each LOB. The first is that, when significant, the main effect of the HHI (Table 5) on premium revenues is negative. When the main effect is positive and significant (LOBs 1391, 0195, and 0196), a pattern is observed: the coefficient of the group dummy is negative, and the interaction coefficient of the group dummy with HHI is also negative. Therefore, increases in concentration in these lines are detrimental to the revenues of insurers that belong to economic groups. Carrying out a thorough database analysis, one can see that in these sectors rarely a company that belongs to an economic group is among the four main companies, precisely those that could benefit from increases in collection in case of increases in concentration. Therefore, the result is consistent: increases in concentration are associated with decreases in revenues.

Furthermore, the results obtained for LOB 0994 are highlighted: the triple interaction between $HHI_{s,t-1}$, $Ranking8_{i,s,t}$ and Group reveals that a small or null effect of the HHI on the insurer's revenue can become strongly positive, if the firm belongs to some economic group and it is among the eight largest insurers. As for LOB 0993, the exact opposite occurs: the HHI effects were already negative or insignificant per se, and indicate a strong reduction in the revenues of insurers that are classified among the eight largest, and belong to an economic group.

As for Table 6, which presents the estimates considering RP as a dependent variable, portfolio diversification is relevant for most LOBs, in the sense of reducing insurer's profits the more lines it encompasses. However, the effects are small. In addition, for most LOBs analyzed, if the insurer is very geographically dispersed, its profits tend to be lower, also with small magnitude effects.

Few LOBs showed significant HHI effects to explain the ratio of profit over assets (RP). This result reveals that higher levels of concentration tend to keep insurer's profits margins stable, *ceteris paribus*. However, when interacted with variables $Ranking8_{i,s,t}$ and $Group_{i,s,t}$, some LOBs (0977, 0195, and 0621) showed significance: the insurer's profit margin is reduced if it is among the eight largest insurance companies in LOB and if it belongs to an economic group. The exact opposite occurs in LOBs 1391, 0531, and 0553.

Combining the parameters estimates of Equations (4) and (5), presented in Tables 5 and 6, the results suggest that, although increases in concentration tend to produce effects on insurers' revenue, their profit margins remain stable, as a rule. Even in those LOBs in which the relationship between HHI and RP is positive, total revenue tends to decrease. However, unfortunately, nothing can be said about the prices charged, since information on total number of insured individuals is not available on official Susep databases.

For a better comparison of the effects promoted by the concentration indices, the results obtained, in particular for the pension LOBs 0992 (currently in run-off), 0994, and 1392, are highlighted. The choice of these lines is justified as they are LOBs with the highest average premiums collection, especially after the Brazilian Complementary Law No. 109/2001: around 75% of the total volume of premiums over time. In addition, there are few insurance companies operating in the lines (around 27), which, consequently, reflects in high levels of concentration. Tables 7 and 8 show the estimates behavior of the other variables when HHI is replaced by the other concentration indices.

The LOB 0992 regressions show that the results presented by Tables 5 and 6 are consistent for the other concentration indices (except for TE index) presented in Tables 7 and 8. Thus, *ceteris paribus*, the greater the market concentration, the lower will be the collection of premiums and the profits of insurance companies operating in pensions reduce.

Table 5. Results of fixed-effects panel regression models for the growth of premiums issued, by LOB, given the Herfindahl-Hirschman index.

Variable / LOB	1392	0992	0994	0993	0977	1391	0982	0991	0531	0195	0553	0196	1068	0118	0114	0171	0621
Intercept						6.56											
						(12.15)											
Size	0.66***	0.34***	0.49***	0.04***	0.06***	0.07***	0.10***	-0.13**	0.13***	0.23***	0.10***	0.53***	-0.34***	0.11***	-0.03	0.41***	0.31***
	(0.06)	(0.05)	(0.04)	(0.01)	(0.02)	(0.01)	(0.01)	(0.07)	(0.02)	(0.05)	(0.02)	(0.05)	(0.07)	(0.03)	(0.02)	(0.03)	(0.03)
GeoDiv	-1.00***	-0.39***	-0.30***	-0.01	-0.03	-0.27***	0.02	-0.22	0.14***	-0.12	0.12***	-0.29*	0.25	0.34***	0.08	-0.09	0.12
	(0.14)	(0.08)	(0.09)	(0.02)	(0.04)	(0.09)	(0.03)	(0.15)	(0.04)	(0.08)	(0.04)	(0.15)	(0.19)	(0.08)	(0.06)	(0.07)	(0.09)
PortDiv	-0.81***	-0.33***	0.57***	0.28***	0.45***	0.33***	0.55***	0.44***	-0.25**	0.03	0.02	1.89***	-0.58	0.68***	0.47***	2.15***	2.68***
	(0.24)	(0.09)	(0.11)	(0.03)	(0.07)	(0.07)	(0.05)	(0.13)	(0.10)	(0.26)	(0.10)	(0.41)	(0.41)	(0.15)	(0.09)	(0.14)	(0.18)
log(GDP)	0.58	0.45**	0.22	-0.02	0.25***	-0.24	0.15***	0.09	0.19***	0.90***	0.31***	0.74***	0.90***	0.43***	0.53***	-0.41***	-0.06
	(0.39)	(0.21)	(0.17)	(0.04)	(0.07)	(0.45)	(0.06)	(0.22)	(0.05)	(0.27)	(0.05)	(0.20)	(0.27)	(0.11)	(0.07)	(0.11)	(0.11)
log(HHI t-1)	0.26	-0.26*	-0.11	-0.08**	-0.05	0.27**	-0.14***	-0.29***	-0.08	0.23*	0.12	0.51***	-1.25***	-0.29***	0.07	0.02	-0.15*
	(0.19)	(0.15)	(0.11)	(0.04)	(0.04)	(0.13)	(0.05)	(0.09)	(0.10)	(0.13)	(0.07)	(0.12)	(0.36)	(0.10)	(0.05)	(0.03)	(0.08)
Group	-1.32	(B)	-0.37	-0.66**	0.39	-1.42**	-0.76	-0.06	0.46	-0.56	-2.32	-1.05**	5.95***	0.33	-1.54**	0.96**	0.15
	(3.85)	(B)	(0.72)	(0.31)	(0.43)	(0.67)	(0.82)	(0.21)	(0.95)	(0.42)	(1.61)	(0.51)	(0.75)	(1.07)	(0.75)	(0.46)	(0.45)
Ranking8	0.90**	0.10	1.11***	0.08	0.55***	0.30	0.67**	0.39***	0.47	0.35*	0.01	1.74***	1.33***	1.06***	-0.11	0.95***	0.95***
	(0.37)	(0.24)	(0.10)	(0.22)	(0.18)	(0.29)	(0.27)	(0.12)	(0.38)	(0.19)	(0.35)	(0.31)	(0.24)	(0.38)	(0.24)	(0.14)	(0.31)
log(Premium t-1)	0.48***	0.63***	0.55***	0.89***	0.86***	0.89***	0.84***	0.75***	0.75***	0.73***	0.77***	0.12***	0.63***	0.58***	0.81***	0.51***	0.49***
	(0.02)	(0.02)	(0.02)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
*log(HHI t-1)*Ranking8*	0.21	-0.08	0.10	-0.06	0.06	-0.08	0.14	-0.15	0.12	-0.08	-0.08	-0.12	1.29***	0.18	-0.17	0.01	0.00
	(0.29)	(0.16)	(0.13)	(0.08)	(0.08)	(0.19)	(0.11)	(0.12)	(0.15)	(0.14)	(0.14)	(0.17)	(0.33)	(0.15)	(0.11)	(0.06)	(0.13)
*log(HHI t-1)*Group*	-0.90	(B)	-0.58	-0.28**	0.19	-0.89*	-0.25	0.28	0.15	-0.54*	-0.99	-0.78***	19.25***	-0.06	-0.65*	0.38**	0.20
	(3.03)	(B)	(0.78)	(0.12)	(0.20)	(0.48)	(0.34)	(0.42)	(0.38)	(0.28)	(0.63)	(0.26)	(1.79)	(0.45)	(0.34)	(0.19)	(0.19)
Ranking8-Group*	0.80	(B)	1.26	-2.03***	-1.27*	0.27	-1.27	(B)	-0.43	0.56	2.83	0.10	(B)	-1.05	1.73	-0.66	0.66
	(3.94)	(B)	(0.90)	(0.72)	(0.74)	(1.59)	(1.77)	(B)	(2.13)	(0.64)	(2.18)	(0.90)	(B)	(2.95)	(1.28)	(0.80)	(0.99)
*log(HHI t-1)*Rankin-g8*Group*	0.48	(B)	1.86*	-0.82***	-0.58	0.22	-0.65	(B)	-0.16	0.58	1.17	0.26	(B)	-0.25	0.74	-0.10	0.10
	(3.10)	(B)	(1.06)	(0.29)	(0.36)	(1.00)	(0.73)	(B)	(0.86)	(0.48)	(0.86)	(0.48)	(B)	(1.24)	(0.58)	(0.34)	(0.42)
Number of firms	24	31	26	100	74	32	95	29	52	19	52	52	28	70	63	73	52
Number of observations	1833	1952	2408	11542	7399	1971	10837	1867	5471	1625	5562	3478	1852	6416	6730	6775	4725
Observation period	1-95	3-130	2-177	1-191	1-191	6-95	3-191	7-116	2-191	11-149	1-191	1-183	1-191	2-191	1-191	3-191	2-191
R^2	0.44	0.70	0.72	0.84	0.84	0.94	0.83	0.69	0.75	0.71	0.78	0.39	0.46	0.44	0.74	0.57	0.58
Adj R^2	0.42	0.69	0.71	0.84	0.84	0.94	0.82	0.68	0.75	0.71	0.78	0.38	0.45	0.43	0.74	0.57	0.57
Hausman test (p-value)	(A)	(A)	(A)	0.00	0.00	0.00	0.00	(A)	0.00	0.00	0.00	0.00	(A)	0.00	0.00	0.00	0.00
Estimation type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed

Note. Standard errors in parentheses. '*' significant at 10%; '**' at 5%; '***' at 1% levels. (A) Regression under random effects is not feasible; (B) the regression did not present an estimate.
Source: Own elaboration.

Table 6. Results of fixed-effects panel regression models for the profit over assets, by LOB, given the Herfindahl-Hirschman index.

Variable / LOB	1392	0992	0994	0993	0977	1391	0982	0991	0531	0195	0553	0196	1068	0118	0114	0171	0621
GeoDiv	-0.01***	-0.00	-0.00***	-0.00	0.00	-0.00***	-0.00***	0.00	-0.00	-0.00*	-0.00	-0.00**	-0.00	-0.00	-0.00***	-0.00***	-0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
PortDiv	-0.01***	-0.01***	0.00***	-0.00***	-0.01***	-0.00	-0.00**	-0.00**	-0.01***	-0.01***	-0.00**	-0.02***	-0.02***	-0.00***	-0.00*	-0.00***	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
log(GDP)	0.00	-0.00	0.00	-0.00***	-0.00	-0.00	-0.00	-0.00	0.00***	0.00	-0.00***	-0.01***	-0.00	-0.00	-0.00*	-0.00**	-0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
log(HHI t-1)	-0.00	-0.01*	0.00	0.00	0.00	-0.00	-0.00	-0.00	-0.00	0.00	0.00	0.00	0.00	0.00**	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Group	0.00	(B)	0.00	-0.00	0.01*	-0.00	-0.00	0.00	-0.12***	-0.00	-0.03**	-0.00	0.00	-0.01	-0.00	-0.00	-0.00
	(0.03)	(B)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)
Ranking8	0.01***	0.01	0.00***	-0.01**	0.00**	0.00***	0.00	0.00	0.01	0.00*	0.00	0.01***	-0.00	-0.00	0.00	0.01***	0.00**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
RP t-1	0.18***	0.18***	0.35***	0.53***	0.44***	0.03	0.72***	0.21***	0.52***	0.64***	0.37***	0.01	0.42***	0.10***	0.38***	0.10***	0.02*
	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
*log(HHI t-1)*Ranking8*	0.01***	-0.00	-0.00	-0.00***	-0.00	0.00*	-0.00	-0.00	0.00	0.00	-0.00	0.00	-0.00	-0.00	-0.00*	0.00***	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
*log(HHI t-1)*Group*	0.00	(B)	-0.00	-0.00	0.00	-0.00	-0.00	0.00	-0.05***	-0.00	-0.01**	-0.00	0.01	-0.00	-0.00	0.00	0.00
	(0.02)	(B)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
Ranking8-Group*	-0.01	(B)	-0.00	-0.01	-0.02**	0.03***	0.00	(B)	0.11***	-0.02**	0.05**	0.01	(B)	-0.00	-0.00	-0.00	-0.01*
	(0.03)	(B)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(B)	(0.04)	(0.01)	(0.02)	(0.01)	(B)	(0.02)	(0.00)	(0.00)	(0.00)
*log(HHI t-1)*Ranking8*Group*	-0.01	(B)	0.00	-0.00	-0.01**	0.02***	0.00	(B)	0.04***	-0.02**	0.02**	0.00	(B)	-0.00	-0.00	-0.00	-0.00***
	(0.02)	(B)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(B)	(0.01)	(0.01)	(0.01)	(0.00)	(B)	(0.01)	(0.00)	(0.00)	(0.00)
Number of firms	24	31	26	100	74	32	95	29	52	19	52	52	28	70	63	73	52
Number of observations	1833	1952	2408	11542	7399	1971	10837	1867	5471	1625	5562	3478	1852	6416	6730	6775	4725
Observation period	1-95	3-130	2-177	1-191	1-191	6-95	3-191	7-116	2-191	11-149	1-191	1-183	1-191	2-191	1-191	3-191	2-191
R^2	0.15	0.08	0.19	0.32	0.29	0.05	0.59	0.05	0.33	0.34	0.16	0.5	0.29	0.22	0.22	0.08	0.08
Adj R^2	0.13	0.07	0.18	0.31	0.28	0.03	0.59	0.03	0.32	0.1	0.15	0.47	0.28	0.21	0.21	0.07	0.07
Hausman test (p-value)	(A)	(A)	(A)	0.00	0.00	0.00	0.00	(A)	0.00	(A)	0.00	0.00	(A)	0.00	0.00	0.00	0.00
Estimation type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed

Note. Standard errors in parentheses. '*' significant at 10%; '**' at 5%; '***' at 1% levels. (A) Regression under random effects is not feasible; (B) the regression did not present an estimate.
Source: Own elaboration.

Table 7. Results of fixed-effects panel regression models for the growth of premiums issued, by LOB and market concentration index.

Variable / Index	LOB 1392				LOB0992				LOB 0994			
	HHI	CR4	CR8	TE	HHI	CR4	CR8	TE	HHI	CR4	CR8	TE
Size	0.66***	0.61***	0.61***	0.63***	0.34***	0.35***	0.35***	0.36***	0.49***	0.49***	0.51***	(C)
	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.04)	(0.04)	(0.05)	(C)
GeoDiv	-1.00***	-1.00***	-1.00***	-1.00***	-0.39***	-0.38***	-0.37***	-0.39***	-0.30***	-0.30***	-0.30***	(C)
	(0.14)	(0.14)	(0.14)	(0.14)	(0.08)	(0.08)	(0.08)	(0.08)	(0.09)	(0.09)	(0.09)	(C)
PortDivt	-0.81***	-0.85***	-0.90***	-0.80***	-0.33***	-0.27***	-0.23**	-0.36***	0.57***	0.59***	0.57***	(C)
	(0.24)	(0.23)	(0.24)	(0.24)	(0.09)	(0.09)	(0.09)	(0.10)	(0.11)	(0.12)	(0.11)	(C)
log(GDP)	0.58	0.85**	0.82**	0.61	0.45**	0.42**	0.42**	0.57***	0.22	0.25	0.21	(C)
	(0.39)	(0.38)	(0.38)	(0.39)	(0.21)	(0.20)	(0.20)	(0.21)	(0.17)	(0.17)	(0.18)	(C)
ConcInd	0.26	0.98	8.88*	-0.59	-0.26*	-1.40***	-1.89	0.52*	-0.11	2.79	0.54	(C)
	(0.19)	(1.39)	(4.95)	(0.38)	(0.15)	(0.50)	(1.21)	(0.27)	(0.11)	(1.76)	(6.47)	(C)
Group	-1.32	18.39	-48.05	-1.23	(B)	(B)	(B)	(B)	-0.37	15.39	51.15	(C)
	(3.85)	(32.30)	(44.80)	(3.17)	(B)	(B)	(B)	(B)	(0.72)	(13.10)	(33.41)	(C)
Ranking8	0.90**	4.46**	20.20***	0.61**	0.10	0.47	2.47	0.45**	1.11***	4.81**	-2.96	(C)
	(0.37)	(2.02)	(7.49)	(0.27)	(0.24)	(0.53)	(1.71)	(0.17)	(0.10)	(2.18)	(7.88)	(C)
log(Premium t-1)	0.48***	0.49***	0.49***	0.49***	0.63***	0.63***	0.64***	0.62***	0.55***	0.55***	0.55***	(C)
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(C)
*ConcInd*Ranking8*	0.21	-4.22*	-19.83***	0.04	-0.08	-0.31	-2.37	-0.39	0.10	-3.86*	4.02	(C)
	(0.29)	(2.22)	(7.59)	(0.58)	(0.16)	(0.62)	(1.76)	(0.27)	(0.13)	(2.23)	(7.89)	(C)
*ConcInd*Group*	-0.90	-20.59	48.52	2.43	(B)	(B)	(B)	(B)	-0.58	-15.77	-51.38	(C)
	(3.03)	(35.80)	(45.46)	(7.34)	(B)	(B)	(B)	(B)	(0.78)	(13.58)	(33.67)	(C)
*Ranking8*Group*	0.80	-21.52	41.26	1.02	(B)	(B)	(B)	(B)	1.26	-39.96**	-116.82**	(C)
	(3.94)	(32.65)	(48.99)	(3.22)	(B)	(B)	(B)	(B)	(0.90)	(18.69)	(52.55)	(C)
*ConcInd*Ranking8*Group*	0.48	24.08	-41.56	-1.89	(B)	(B)	(B)	(B)	1.86*	41.00**	117.32**	(C)
	(3.10)	(36.18)	(49.69)	(7.45)	(B)	(B)	(B)	(B)	(1.06)	(19.32)	(52.86)	(C)
Number of firms	24	24	24	24	31	31	31	31	26	26	26	(C)
Number of observations	1833	1833	1833	1833	1952	1952	1952	1952	2408	2408	2408	(C)
Observation period	1-95	1-95	1-95	1-95	3-130	3-130	3-130	3-130	2-177	2-177	2-177	(C)
R^2	0.44	0.44	0.44	0.44	0.7	0.69	0.69	0.7	0.72	0.72	0.72	(C)
Adj R^2	0.42	0.42	0.43	0.42	0.69	0.69	0.69	0.69	0.71	0.71	0.71	(C)
Hausman test (p-value)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(C)
Estimation type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	(C)

Note. Standard errors in parentheses. '*' significant at 10%; '**' at 5%; '***' at 1% levels. (A) Regression under random effects is not feasible; (B) the regression did not present an estimate; (C) regressions under fixed and random effects are not feasible. Source: Own elaboration.

Table 8. Results of fixed-effects panel regression models for the profit over assets (RP), by LOB and market concentration index.

Variable / Index	LOB 1392				LOB 0992				LOB 0994			
	HHI	CR4	CR8	TE	HHI	CR4	CR8	TE	HHI	CR4	CR8	TE
GeoDiv	-0.01***	-0.01***	-0.01***	-0.01***	-0.00	-0.00	-0.00	-0.00	-0.00***	-0.00***	-0.00***	(C)
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(C)
PortDiv	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	0.00***	0.00***	0.00***	(C)
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(C)
log(GDP)	0.00	0.01**	0.01**	0.00	-0.00	-0.00	-0.00	0.00	0.00	0.00	0.00*	(C)
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(C)
ConcInd	-0.00	-0.00	0.01	0.00	-0.01*	-0.02**	-0.03	0.01	0.00	0.00	0.00	(C)
	(0.00)	(0.01)	(0.04)	(0.00)	(0.00)	(0.01)	(0.03)	(0.01)	(0.00)	(0.00)	(0.00)	(C)
Group	0.00	0.10	-0.18	-0.00	(B)	(B)	(B)	(B)	0.00	0.00	0.00	(C)
	(0.03)	(0.24)	(0.34)	(0.02)	(B)	(B)	(B)	(B)	(0.00)	(0.01)	(0.02)	(C)
Ranking8	0.01***	0.02	0.08	0.01***	0.01	0.01	0.04	0.01***	0.00***	0.00	-0.01	(C)
	(0.00)	(0.02)	(0.06)	(0.00)	(0.00)	(0.01)	(0.04)	(0.00)	(0.00)	(0.00)	(0.01)	(C)
RP t-1	0.18***	0.19***	0.19***	(B)	0.18***	0.18***	0.19***	(B)	0.35***	0.35***	0.35***	(C)
	(0.02)	(0.02)	(0.02)	(B)	(0.02)	(0.02)	(0.02)	(B)	(0.02)	(0.02)	(0.02)	(C)
ConcInd*Ranking8	0.01***	-0.02	-0.08	-0.01**	-0.00	-0.01	-0.04	-0.01	-0.00	-0.00	0.01	(C)
	(0.00)	(0.02)	(0.06)	(0.00)	(0.00)	(0.01)	(0.04)	(0.01)	(0.00)	(0.00)	(0.01)	(C)
ConcInd*Group	0.00	-0.11	0.18	-0.00	(B)	(B)	(B)	(B)	-0.00	-0.00	-0.00	(C)
	(0.02)	(0.27)	(0.34)	(0.05)	(B)	(B)	(B)	(B)	(0.00)	(0.01)	(0.02)	(C)
*Ranking8*Group*	-0.01	-0.13	0.07	-0.00	(B)	(B)	(B)	(B)	-0.00	-0.01	-0.01	(C)
	(0.03)	(0.24)	(0.37)	(0.02)	(B)	(B)	(B)	(B)	(0.00)	(0.01)	(0.03)	(C)
ConcInd*Ranking8*Group	-0.01	0.14	-0.07	0.01	(B)	(B)	(B)	(B)	0.00	0.01	0.01	(C)
	(0.02)	(0.27)	(0.37)	(0.06)	(B)	(B)	(B)	(B)	(0.00)	(0.01)	(0.03)	(C)
Number of firms	24	24	24	24	31	31	31	31	26	26	26	(C)
Number of observations	1833	1833	1833	1833	1952	1952	1952	1952	2408	2408	2408	(C)
Observation period	1-95	1-95	1-95	1-95	3-130	3-130	3-130	3-130	2-177	2-177	2-177	(C)
R^2	0.15	0.14	0.14	0.14	0.08	0.08	0.08	0.08	0.19	0.19	0.20	(C)
Adj R^2	0.13	0.13	0.12	0.13	0.07	0.06	0.06	0.07	0.18	0.18	0.18	(C)
Hausman test (p-value)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(C)
Estimation type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	(C)

Note. Standard errors in parentheses. '*' significant at 10%; '**' at 5%; '***' at 1% levels. (A) Regression under random effects is not feasible; (B) the regression did not present an estimate; (C) regressions under fixed and random effects are not feasible. Source: Own elaboration.

On the other hand, results for LOB 1392 (which succeeds 0992) indicate that the more varied the insurer's portfolio and the more geographically dispersed, the lower the collection of premiums, as well as profits, suggesting that insurers in life segment should focus on the offer on pensions, in addition to operating in a few federation units. As for the concentration indices, especially when interacted with the group dummy and ranking position, it does not show a pattern: sometimes it favors the premiums collection and profits, sometimes it disfavors. Furthermore, index CR_8 presented in Table 7 shows that the market concentration scenario favors the gains of insurers as long as they are not among the largest in the market, *ceteris paribus*.

FINAL REMARKS

The insurance industry is of great importance for the country's economic activity, regardless of its economic situation. In this paper, we sought to evaluate the evolution of concentration in the insurance market and subsequent effects on the growth of premiums and on the ratio of operational profits over assets (RP), for each relevant Brazilian insurance

market LOB. To assess market concentration, main classical concentration indices from the empirical literature were used: Herfindahl-Hirschman, concentration ratio, and Theil's entropy.

The concentration indices proved to be relevant to explain the variation in revenues. Contrary to what was initially expected, the general effects of increases in concentration indices are to reduce insurance revenues, but without reducing profit margins. However, if the insurer is among the largest in the market and it is part of an economic group, these effects can be nullified, and concentration, under these conditions, generates increases in the premiums collection and profits, suggesting that these entities exercise some market power, raising premiums, when convenient, reinforcing the structure-conduct-performance hypothesis (causal link between the degree of sectoral concentration, market power, and firms' performance).

For Rodriguez (2007), a highly concentrated market is less subject to competition, providing negative effects for the economic environment, free competition, and the final consumer, with the establishment of barriers to entry and/or the practice of arbitrary prices, so that it is up to the antitrust organizations to establish a balance between free enterprise and free competition. The results obtained can serve as a warning to Cade, especially with regard to life segment, since the concentration, evidenced by CR, HHI, and TE indexes, is significantly higher when compared to non-life segment. In addition, average premiums collection in this industry, between 2003 and 2018, is more than 80% of the market's average premium collection, concomitant with the fall in the total number of players. Thus, based on Rodriguez (2007), hypothesis, it can be said that the life insurance market is less subject to competition when compared to the non-life insurance market.

Due to the lack of information about the number of policies sold by LOB, and the unavailability of prices, this paper has the limitation of not allowing the estimation of the effects resulting from market concentration on the insurer's balance sheet on the level of prices practiced in each market. In addition, it should be noted that Susep has sometimes changed the regulatory accounting standard, so that concepts of premiums issued are not necessarily the same at all times. For future papers, complementary studies on effective competition in these insurance markets are suggested, using Lerner's and Boone's indicators (Azevedo & Gartner, 2020), or even other techniques (e.g., multilevel panel) to add robustness to the findings.

NOTES

1. *Individual Insurance Market Competition*, available at: https://www.kff.org/other/state-indicator/individual-insurance-market-competition/?currentTimeframe=0&sortModel=%7B%22colId%22:%22Location%22,%22sort%22:%22asc%22%7D
2. According to scale adopted in the study, the estimated HHI ranges from 0 to 10,000 and the range above 2,500 indicates a highly concentrated and non-competitive market.
3. In order to follow the evolution of the entire period, we chose to present branch 0994 instead of 0992, since the panel is unbalanced.

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