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ARTICLE

How do operations with admitted and eventual reinsurers impact the credit risk of insurers?

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Abstract

Purpose – This study examines the profile of insurers that opted for admitted and eventual reinsurers following Complementary Law 126 and the increase in the cession limit established by Decree No. 10,167 and CNSP 451. It evaluates whether the new regulations increased the proportion of premiums ceded to these reinsurers and, consequently, insurers' credit risk, since these reinsurers are not fully subject to SUSEP supervision.

Theoretical framework – The study is grounded in the theoretical basis of risk management and insurance regulation, focusing on reinsurance as both a risk mitigation tool and a source of credit risk.

Design/methodology/approach – A quantitative approach is adopted, using panel data from 80 Brazilian insurers from 2013 to 2023.

Findings – The results indicate a positive correlation between Decree No. 10,167 and the proportion of premiums ceded to eventual reinsurers. In addition, a positive correlation is also observed between the proportion of premiums ceded to these reinsurers and the credit risk capital of insurers.

Practical & social implications of research – The study offers empirical evidence that Decree No. 10,167 may increase the credit risk of Brazilian insurers, affecting their solvency.

Originality/value – This research contributes to the understanding of how regulatory changes shape reinsurance practices and credit risk in Brazil, a market with distinct oversight for local and foreign reinsurers.

Keywords: Reinsurance, credit risk, regulatory changes.

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1 Introduction

Enacted on January 15, 2007, Complementary Law No. 126 (Brasil, 2007b) ended the almost seven-decade monopoly of the state-owned IRB Re in the Brazilian reinsurance market. Following this change, the market became structured around three types of reinsurers: local, which are headquartered in Brazil; admitted, which are headquartered abroad and have a representative office in Brazil; and eventual, which are headquartered abroad and do not have a representative office in Brazil.

According to De Faria (2007), the monopoly limited the supply of new products, impaired efficiency gains through better risk pricing, and restricted the entry of foreign capital necessary for national development. Thus, the main objectives of opening the market were to strengthen it, boost its capacity, and promote dynamism in the sector. The introduction of new products and the adoption of international best practices were thus expected (Galiza, 2015). This would stimulate the adoption of new technologies, reduce the price of reinsurance, and consequently, the price of insurance, leading to greater competitiveness (Silva et al., 2008).

However, the legislation also established protective measures for local reinsurers. Initially, insurers were required to preferentially allocate 60% of their reinsurance operations to these companies, a percentage that was later reduced to 40% in 2010. These safeguards aimed to protect the national economy, preserve local reinsurers, and maintain reserves in the country.

Reinsurance provides several benefits, including reducing exposure to losses exceeding the insurer's retention capacity, expanding underwriting potential and risk diversification, and lowering market volatility (Cummins et al., 2021). However, it is important to recognize that these benefits come at a cost, since reinsurance involves credit risk (Cummins & Trainar, 2009).

As Van Lelyveld et al. (2011) pointed out, credit risk is the most likely of the risks generated by reinsurance to threaten the financial stability of an already highly concentrated market. In this scenario, the bankruptcy of a reinsurer could cause significant losses, impacting both the reinsurance and insurance markets. These losses are particularly concerning because they can extend to the banking sector due to the strong links between insurers and banks, thereby increasing systemic risk (Baluch et al., 2011).

More recently, Decree No. 10,167 of December 10, 2019 (Brasil, 2019), stipulates that if local reinsurers reject the preferential offer, insurers may cede up to 95% of their reinsurance premiums based on their yearly operations to eventual reinsurers. Previously, the limit was only 10% in 2008. It is worth noting that the law does not impose limits on admitted reinsurers.

Another important legislative change is CNSP Resolution No. 451 of December 19, 2022 (Brasil, 2022). Under this resolution, insurance companies are allowed to have a reinsurance cession exceeding 90%, provided they submit a technical justification to SUSEP (Brasil, 2022). Previously, reinsurance cession could not exceed 50% of premiums written (Brasil, 2007a).

These changes resulted in a growth of approximately 70% in the volume of premiums ceded to foreign reinsurers (admitted and eventual) in 2020, as indicated in the 11th SUSEP Report on Supervised Markets Analysis and Monitoring (Superintendência de Seguros Privados, 2023). This growth continued in subsequent years, reaching 120% between 2021 and 2022 (Superintendência de Seguros Privados, 2023).

SUSEP (the National Superintendence of Private Insurance) is responsible for supervising reinsurers. However, admitted and eventual reinsurers are not fully subject to its oversight, as their solvency assessment is determined by the supervisory authority of their country of origin, which may result in a less stringent regulatory framework compared to that of local reinsurers.

Considering that Decree No. 10.167 allows for greater risk cession to eventual reinsurers and that there is no cession limit for admitted insurers, the following question arises: Can it be argued that the credit risk of insurers has increased?

In addition, the following is inquired: What intrinsic characteristics do insurers with a higher credit risk have? To what extent would the new regulations impact the capital requirements set by SUSEP?

An increase in credit risk would directly impact shareholders' profits because an increase in credit risk capital would lead to an increase in risk capital. Consequently, the minimum capital required that insurers must maintain to operate would increase, reducing the profit distributed to shareholders and decreasing their attractiveness to potential new investors.

It is important to note that although admitted and eventual reinsurers are not subject to the same level of regulation as local reinsurers, CNSP Resolution No. 422 of November 11, 2021 (Brasil, 2021a), establishes minimum requirements for their operation in the Brazilian

market. These requirements include having a solvency rating issued by a credit rating agency in accordance with the minimum levels set out in the regulation and having individual net equity of at least USD 150,000,000.00.

There is still limited empirical evidence on how regulatory changes in the Brazilian reinsurance market have affected insurers' exposure to credit risk, and few studies have examined the consequences of regulatory updates, particularly Decree No. 10,167/2019 (Brasil, 2019) and CNSP 451 (Brasil, 2022). These measures substantially altered the risk cession structure, potentially increasing insurers' exposure to credit risk and impacting their capital requirements and overall solvency conditions. This justifies the need for this study.

2 Literature review

Reinsurance plays an extremely important role in the risk management strategy of insurers. Its ability to diversify risks, both nationally and globally, is crucial for underwriting risk managing, reducing the risk of insolvency, complying with strict regulatory requirements, and addressing uncertainties caused by regulatory changes or catastrophic losses (Park et al., 2019).

In addition, reinsurance and capital can be seen as substitutes for improving solvency. By sharing their risk with reinsurers, primary insurers can benefit from capital relief and enhance their overall financial stability (Bressan, 2018).

However, using reinsurance also increases credit risk for insurers. This risk arises when a company suffers losses due to a counterparty's failure to meet its contractual obligations or established deadlines (Gatumel & De Forges, 2013).

Moreover, when ceding premiums to reinsurers, insurers assume full responsibility for claim payments to their policyholders, even if reinsurance contracts cannot be enforced. Therefore, the use of reinsurance can increase an insurer's risk of insolvency if it fails to recover the amounts from its reinsurance contracts (Chen et al., 2001).

The bankruptcy of a reinsurer can arise from three areas: risk underwriting and investment policy, retrocession, and exposure to credit risk (Gatumel & De Forges, 2013). In the event of a reinsurer default, the insurer would face higher costs and difficulties reimbursing policyholders for high claims (Gatumel & De Forges, 2013). Thus, the greater the default risk of reinsurance contracts, the greater the probability that the insurer will face higher financial burdens (Chen et al., 2001).

Bodoff (2010) highlights one challenge in managing reinsurance credit risk: the deterioration of the reinsurer's credit rating over time. This occurs, in part, due to the considerable time lag between the signing of the contract and triggering reinsurance to indemnify losses. Thus, although it is possible to evaluate a reinsurer's rating at the time of contracting, this preliminary analysis does not guarantee effective protection against future downgrades. It is important to highlight that this rating is one of the criteria used by CNSP Resolution No. 422 to determine which foreign reinsurers are authorized to operate in Brazil.

Individually, reinsurers do not represent a substantial part of the aggregate systemic risk of the financial system. Even so, difficulties faced by some are associated with financial crises (Kaserer & Klein, 2019). This can be interpreted as evidence that the default of these reinsurers generates significant negative externalities, possibly due to their high level of interconnection with the insurance sector and financial system (Kaserer & Klein, 2019).

Additionally, the insurance sector is characterized by strong interdependencies: insurers share risks through co-insurance, transfer part of their exposures to reinsurers, and reinsurers mitigate their own exposures through retrocession. This structure makes the reinsurance market vulnerable to a retrocession spiral, in which the failure of major reinsurers can trigger the collapse of their counterparts and, consequently, primary insurers, leading to a systemic crisis on a global scale (Cummins & Weiss, 2014).

Burkart (2007) studied the interdependence of default risk among six of the world's largest reinsurance companies and points out that although the collapse of major players is not frequent, it is not a remote possibility. The author also argues that a shock affecting a large part of the sector can trigger financial problems in a reinsurer, creating the possibility of multiple simultaneous failures.

Euphasio Junior and Carvalho (2022) conducted an analysis to estimate the probability of an insurance company's ruin when incorporating reinsurance contracts. They concluded that choosing the right reinsurance contract enhances the exponential decay of the correlation between solvency capital associated with underwriting risk and the probability of ruin.

On the other hand, an insurer's excessive use of reinsurance may indicate financial difficulties, as a less solvent insurer tends to rely more on reinsurance due to its inability to raise sufficient capital in the financial market

(Chen et al., 2001). Furthermore, reinsurance encourages insurers to engage in high-risk business, which increases the risk of insolvency (Chen et al., 2001).

Another important point to highlight is the absence of centralized regulation in the reinsurance market, resulting in significant regulatory variations between countries. This disparity makes it difficult to obtain consistent information and hinders the assessment of reinsurers' default risk (Rossi & Lowe, 2002). To date, most information on the financial status of these companies is provided by credit rating agencies. However, as Rossi and Lowe (2002) point out, this source may not be sufficient to anticipate potential market failures.

Efficient regulation to ensure market stability is essential, as insurers often lack a quantitative system to accurately assess the trade-off between the credit risk associated with reinsurance and the costs of these operations (Bodoff, 2013).

To mitigate the risk of insolvency, strengthen consumer protection, and establish uniform regulatory standards among the member countries, the European Union implemented Solvency II, a new regulation for insurers and reinsurers, which has been in force since 2016 (Lorson et al., 2012). This regulation is based on three pillars: 1) quantitative capital requirements, 2) supervisory activities, and 3) financial reporting and public disclosure (Neves, 2010).

Solvency II was designed to address several challenges and gaps identified in the previous regulation. While Solvency I did not take market, credit, or operational risks into account when calculating capital requirements, the new regulation provides a more comprehensive and risk-sensitive approach (Rae et al., 2018).

In this context, the first pillar of Solvency II adopts a risk-based approach to determining the necessary capital standards (Boonen, 2017). The required capital is divided into two categories: the minimum capital requirement (MCR), which represents the minimum capital a company must maintain to operate; and the solvency capital requirement (SCR), which is based on the risks to which the insurer is exposed (Boonen, 2017).

In line with global trends, Brazil established new solvency rules for insurers, open supplementary pension entities, capitalization companies, and local reinsurers, defining guidelines for allocating capital to cover risks. In 2015, CNSP Resolution No. 321 (Brasil, 2015) was enacted, introducing criteria for calculating risk capital, a variable amount of capital that the supervised entity must maintain to cover the risks inherent to its operation. These risks include underwriting, credit, operational, and market risks.

These criteria are currently defined by CNSP Resolution No. 432, dated November 12, 2021 (Brasil, 2021b). The regulation also stipulates that entities must maintain an MCR greater than the adjusted equity (AE) at the end of each monthly financial statement.

The MCR is the higher of the base capital, a fixed amount that the supervised entity must maintain, or the risk capital. The AE, in turn, consists of equity adjusted by additions, exclusions, and limits to determine the available resources that enable supervised entities to carry out their activities amid fluctuations and adverse situations (Brasil, 2021b). Therefore, it must be net of assets with a high level of valuation subjectivity or that already guarantee similar financial activities, and other assets whose nature is considered inappropriate for safeguarding loss absorption capacity (Brasil, 2021b).

Using mitigation techniques such as reinsurance allows insurers to reduce their exposure to risk and consequently their SCR (Mayo & Heinen, 2013). This implies that an insurer whose portfolio is protected by reinsurance can consider this protection when calculating its solvency. However, insurers must ensure that risks arising from reinsurance contracts, such as default risk, are also considered in these calculations (Mayo & Heinen, 2013).

Liebwein (2006) emphasized that quantifying the default risk of a reinsurer, which is an essential component of credit risk, allows for a more precise reflection of the capital requirement. The author also demonstrated that reinsurance protection can significantly reduce the SCR.

Caporale et al. (2017) analyzed the insolvency risk of insurers in the United Kingdom using 30 years of data from 515 companies. Their empirical results suggest that both macroeconomic and company-specific factors play important roles. Furthermore, the degree to which these entities use reinsurance also affects their insolvency risk, as the counterparty risk of reinsurers increases their own insolvency risk.

3 Methodological procedures

Considering that Decree No. 10,167 allowed greater risk transfer to eventual reinsurers and that the regulation does not establish a cession limit for admitted reinsurers, this study aims to assess whether these factors have led to an increase in the credit risk of insurers, since

these reinsurers are not fully subject to SUSEP supervision. Additionally, the study investigates the characteristics of insurers with greater exposure to credit risk and to what extent the new regulation would impact the solvency of these entities and the capital requirements set by SUSEP.

The databases used to define the variables were extracted from the SUSEP Statistical System (SES). Data related to credit risk capital and risk transfer operations from insurers to local, admitted, or eventual reinsurers were taken from the explanatory notes in each entity's financial statements.

After identifying the endogenous characteristics of the behavior of the 80 insurers selected for the sample covering the period from 2013 to 2023, the information was structured in a panel format (Supplementary Data 1 – Database). This model was chosen because it allows for the analysis of data from multiple entities over time. In contrast, a cross-sectional model would only enable observation of data at a single point in time.

Moreover, the panel data model provides more information, greater variability in the data, lower collinearity between variables, more degrees of freedom, and greater estimation efficiency (Marques, 2000).

Thus, this study aims to assess the evolution of premiums ceded to admitted and eventual reinsurers and, subsequently, the impact these transactions have on the entities' exposure to credit risk. Since other variables also influence a company's credit risk capital, it is essential to consider the effect of control variables.

The selected control variables reflect aspects of insurers' operations that may influence credit risk capital beyond reinsurance strategy. These aspects include the impact of Decree No. 10,167 (Brasil, 2019) and CNSP Resolution No. 451 (Brasil, 2022), entity size (Carvalho & Bonetti, 2022; Cummins et al., 2012), geographic dispersion in relation to the states in which the entity operates (Chang, 2014; Cole & McCullough, 2006), portfolio diversification (Cole & McCullough, 2006; Silva et al., 2008), the proportion of life insurance premiums written (Carvalho & Song, 2024), association with bancassurance (Carvalho & Guimarães, 2022), affiliation with an economic group (Cheng & Weiss, 2012), capital structure (Shiu, 2011), the level of premiums ceded to reinsurers (Lin et al., 2015; Anand et al., 2021), the loss ratio (Lee & Lee, 2012), the retention limit (Euphasio Junior & Carvalho, 2022), and the impact of the COVID-19 pandemic (Babuna et al., 2020; Rus & Brici, 2021).

First, we assessed the behavior of premiums ceded to admitted and eventual reinsurers, taking the control variables into account, as shown in Equations (1) and (2).

$$PremAdRein_{i,t} = \alpha + \beta_1 Decree_{i,t} + \beta_2 CNSP451_{i,t} + \beta_3 Size_{i,t} + \beta_4 GeoDiv_{i,t} + \beta_5 PortDiv_{i,t} + \beta_6 LifePrem_{i,t} + \beta_7 Bancassur_{i,t} + \beta_8 EcoGroup_{i,t} + \beta_9 CapStru_{i,t} + \beta_{10} PremDet_{i,t} + \beta_{11} LossR_{i,t} + \beta_{12} RetLim_{i,t} + \beta_{13} COVID_{i,t} + \varepsilon_{i,t} \quad (1)$$

$$PremEvRein_{i,t} = \alpha + \beta_1 Decree_{i,t} + \beta_2 CNSP451_{i,t} + \beta_3 Size_{i,t} + \beta_4 GeoDiv_{i,t} + \beta_5 PortDiv_{i,t} + \beta_6 LifePrem_{i,t} + \beta_7 Bancassur_{i,t} + \beta_8 EcoGroup_{i,t} + \beta_9 CapStru_{i,t} + \beta_{10} PremDet_{i,t} + \beta_{11} LossR_{i,t} + \beta_{12} RetLim_{i,t} + \beta_{13} COVID_{i,t} + \varepsilon_{i,t} \quad (2)$$

The variables $PremAdRein_{i,t}$ and $PremEvRein_{i,t}$ represent the amount of premiums ceded to admitted and eventual reinsurers, respectively, relative to the total premiums ceded to reinsurers. Their mathematical formulations are given by Equations (3) and (4).

$$PremAdRein_{i,t} = \frac{Premiums\ ceded\ to\ admitted\ reinsurers_{i,t}}{Total\ premiums\ ceded\ to\ reinsurers_{i,t}} \quad (3)$$

$$PremEvRein_{i,t} = \frac{Premiums\ ceded\ to\ eventual\ reinsurers_{i,t}}{Total\ premiums\ ceded\ to\ reinsurers_{i,t}} \quad (4)$$

The variables $Decree_{i,t}$ and $CNSP451_{i,t}$ are the variables of interest in the model and represent:

$Decree_{i,t}$**:** a dummy variable that indicates whether Decree No. 10,167 was already in force at time *t*, since this decree allowed insurers to cede up to 95% of their reinsurance premiums to eventual reinsurers.

$CNSP451_{i,t}$ **:** a dummy variable that identifies whether CNSP Resolution No. 451 (Brasil, 2022) was already in force at time *t*, as this resolution allowed insurance companies to cede more than 90% of their written premiums in reinsurance.

The control variables are:

$Size_{i,t}$ **:** a variable that estimates the impact of the entity's size on credit risk capital. Similarly, Carvalho and Bonetti (2022) examined the influence of this variable when investigating the effects of sectoral concentration on the revenues and profits of the Brazilian insurance market.

Cummins et al. (2012) also used this variable when investigating the characteristics of insurers that determine a higher level of reinsurance usage and concluded that larger insurers tend to rely less on reinsurance than smaller ones due to their greater financial capacity and better diversification.

This parameter is obtained through the natural logarithm of the total assets of insurer *i* at time *t*.

$GeoDiv_{i,t}$ **:** a variable that assesses the geographic diversification of insurer *i* at time *t*, where *s* represents

one of the 27 federative units in which the premium was underwritten. This index ranges from 0 to 1, with higher values indicating greater diversification.

Chang (2014) analyzed the determinants of reinsurance demand and concluded that insurers with greater geographic diversification tend to purchase more reinsurance. This result aligns with those of Cole and McCullough (2006), who also argue that insurers with less business variety or geographic concentration tend to benefit more from the experience and expertise of reinsurers. This variable is given by Equation (5):

$$GeoDiv_{i,t} = 1 - \sum_{s=1}^{S} \left(\frac{Written\ premiums_{i,t,s}}{Total\ written\ premiums_{i,t}} \right)^2 \quad (5)$$

$PortDiv_{i,t}$ **:** a variable that assesses the portfolio diversification of insurer *i* at time *t*, relative to its lines of business *r*. This index ranges from 0 to 1, with higher values indicating greater diversification.

Cole and McCullough (2006) examined the effect of the international reinsurance market on reinsurance demand in the U.S., finding that the more concentrated an insurer is in relation to its lines of business, the lower its demand for reinsurance will be.

Similarly, Silva et al. (2008) investigated the factors that influence reinsurance demand in Brazil and concluded that business concentration negatively affects demand. In other words, the more concentrated the insurer, the lower its demand for reinsurance. This variable is given by Equation (6):

$$PortDiv_{i,t} = 1 - \sum_{r=1}^{R} \left(\frac{Written\ premiums_{i,t,r}}{Total\ written\ premiums_{i,t}} \right)^2 \quad (6)$$

$LifePrem_{i,t}$**:** a variable that represents the proportion of life insurance premiums written by insurer *i* at time *t* relative to the total premiums written. This variable was selected because insurers that are more concentrated in the life segment tend to engage in fewer reinsurance transactions. As Carvalho and Song (2024) noted, the reinsurance market in the non-life segment in Brazil is approximately 14 times larger than in the life segment. Its expression is given by Equation (7):

$$LifePrem_{i,t} = \frac{Total\ life\ insurance\ written\ premiums_{i,t}}{Total\ written\ premiums_{i,t}} \quad (7)$$

$Bancassur_{i,t}$ **:** a dummy variable that identifies whether insurer *i* is associated with a bank at time *t*. Bancassurance is a strategic partnership between banks and insurers for the commercialization of insurance products (Carvalho & Guimarães, 2022). According to the authors, insurers affiliated with banks primarily operate in the life segment with mass-market products and are less exposed to reinsurance transactions. They also do not assume high levels of exposure in relation to their net EA.

$EcoGroup_{i,t}$ **:** a dummy variable that determines whether insurer *i* is affiliated with an economic group at time *t*. Insurers that are part of a group may have advantages, as they can diversify risks internally through reinsurance arrangements with other companies in the same economic group (Cheng & Weiss, 2012).

In addition, they can operate with relatively lower levels of capital and higher underwritten risks, as they can benefit from the group's resources (Cheng & Weiss, 2012). These factors may translate into reduced demand for reinsurance.

$CapStru_{i,t}$ **:** a variable that measures the capital structure of insurers, that is, the ratio of third-party capital to equity of insurer *i* at time *t*. Shiu (2011) tested the effects of capital structure on reinsurance acquisition using data from UK non-life insurers from 1985 to 2002 and states that insurers with higher leverage tend to acquire more reinsurance, and that insurers with greater reliance on reinsurance tend to have a higher level of debt. Additionally, he notes that an insurer's capital structure may impact its reinsurance demand, and vice versa, indicating endogeneity. The $CapStru_{i,t}$ expression is as follows Equation (8):

$$CapStru_{i,t} = \frac{Current\ Liabilities_{i,t} + Non\ Current\ Liabilities_{i,t}}{Equity_{i,t}} \quad (8)$$

$PremDet_{i,t}$ **:** a variable that measures the level of premiums ceded to reinsurers, reflecting the proportion of premiums written by insurer *i* that were ceded to reinsurers at time *t*. Similarly, Lin et al. (2015) and Anand et al. (2021) applied this variable to measure the level of reinsurance usage by insurers. It is expressed by Equation (9):

$$PremDet_{i,t} = \frac{Total\ premiums\ ceded\ to\ reinsurers_{i,t}}{Total\ written\ premiums_{i,t}} \quad (9)$$

$LossR_{i,t}$ **:** a variable that denotes the loss ratio of insurers. It is calculated by dividing claims incurred by total premiums earned by insurer *i* at time *t*. Lee and Lee

(2012) adopted the loss ratio as a measure of underwriting risk when investigating the connection between reinsurance and the performance of these entities. They concluded that insurers with higher underwriting risk, i.e., a higher loss ratio, are more likely to acquire greater amounts of reinsurance. Equation (10) presents its formulation:

$$LossR_{i,t} = \frac{Claims\,incurred_{i,t}}{Earned\,Premiums_{i,t}} \quad (10)$$

$RetLim_{i,t}$ **:** a variable that assesses the maximum retention limit across all lines of business r in which insurer i operates at time t relative to its AE. According to Euphasio Junior and Carvalho (2022), implementing a reinsurance treaty allows the cedent to cover extreme claims and increase its gross underwriting beyond the retention level established by regulation. Currently, these limits are defined by CNSP No. 432 (Brasil, 2021b). This parameter is estimated by Equation (11):

$$RetLim_{i,t,r} = \frac{\sum_{r=1}^{R} Retention\,Limit_{i,t,r}}{AE_{i,t}} \quad (11)$$

$COVID_{i,t}$ **:** a dummy variable that indicates whether the COVID-19 pandemic was ongoing at time t. During this period, there was an economic recession characterized by declining profits and increasing claims for insurers (Babuna et al., 2020). Furthermore, the crisis triggered by the pandemic had a significant impact, also destabilizing the reinsurance market (Rus & Brici, 2021).

Subsequently, Equation (12) was formulated to explain the variation in credit risk capital (CredRCap), which is calculated as the natural logarithm of the credit risk capital of insurer i at time t, as a function of the control variables.

$$\begin{aligned} CredRCap_{i,t} = {} & \alpha + \beta_1\, PremAdRein_{i,t} + \beta_2\, PremEvRein_{i,t} + \\ & \beta_3\, Decree_{i,t} + \beta_4\, CNSP_{451}l_{i,t} + \\ & \beta_5\, Size_{i,t} + \beta_6\, GeoDiv_{i,t} + \beta_7\, PortDiv_{i,t} + \\ & \beta_8\, LifePrem_{i,t} + \beta_9\, Bancassur_{i,t} + \\ & \beta_{10}\, EcoGroup_{i,t} + \beta_{11}\, CapStru_{i,t} + \beta_{12}\, PremDet_{i,t} + \\ & \beta_{13}\, LossR_{i,t} + \beta_{14}\, RetLim_{i,t} + \\ & \beta_{15}\, COVID_{i,t} + \varepsilon_{i,t} \end{aligned} \quad (12)$$

The main objective of this model is to analyze the impact of the new regulatory instruments on the credit risk capital of insurers. To this end, the respective indicator and control variables were considered, along with the percentage of risk ceded to admitted and eventual reinsurers.

4 Results

The data analysis was conducted using the R software (Supplementary Data 2 – R script). To assess the impact of the change in the cession limit introduced by Decree No. 10,167 (Brasil, 2019) on the cession of premiums to eventual reinsurers and to understand the characteristics of insurers that changed their reinsurance strategy and the potential effect of these changes on credit risk capital and the solvency of these entities, descriptive statistics were calculated for the model's quantitative variables, as illustrated in Table 1.

As shown in Table 1, the means of the variables *PremAdRein* and *PremEvRein* indicate a high concentration of risk cession to local reinsurers. This phenomenon aligns with the findings of Carvalho and Song (2024), who examined

Table 1
Descriptive Statistics of the Quantitative Variables

Variable	Mean	1st Q[(1)]	Median	3rd Q[(2)]	Min.	Max.	SD[(3)]	Asymmetry	Kurtosis
PremAdRein	0.19	0.00	0.10	0.32	-0.09	1.00	0.23	1.52	5.43
PremEvRein	0.04	0.00	0.00	0.04	-0.02	0.94	0.10	3.63	19.31
CredRCap	16.10	14.91	16.51	17.79	7.20	20.12	2.21	-1.09	4.61
PremDet	0.83	0.00	0.06	0.24	-119.06	524.91	20.94	23.40	594.67
Size	20.84	19.31	20.85	22.26	14.25	30.59	2.43	0.24	3.80
GeoDiv	0.58	0.42	0.68	0.81	0.00	0.93	0.28	-0.91	2.65
PortDiv	0.60	0.46	0.68	0.80	0.00	0.95	0.27	-0.99	2.94
LifePrem	0.36	0.00	0.08	0.86	0.00	1.00	0.42	0.58	1.52
CapStru	8.14	2.11	3.60	6.33	0.01	382.05	25.13	10.49	129.72
LossR	0.47	0.24	0.46	0.62	-0.03	4.50	0.35	4.04	37.42
RetLim	0.56	0.10	0.27	0.70	0.00	5.34	0.73	2.52	10.83

(1) First Quartile; (2) Third Quartile; (3) Standard deviation.
Source: own elaboration.

how the concentration or decentralization of the Brazilian reinsurance market affects the financial performance of reinsurers. According to the authors, the evidence suggests that, due to the legal and economic scenario of market protectionism, local reinsurers have been favored at the expense of admitted and eventual reinsurers.

However, it is important to note that the standard deviations of both *PremAdRein* and *PremEvRein* are high compared to the mean, indicating high variability in insurers' behavior regarding risk cession to admitted and eventual reinsurers.

Moreover, the kurtosis of the *PremEvRein* variable indicates heavy tails, suggesting that some insurers engage in a high volume of reinsurance with eventual reinsurers.

Additionally, the descriptive statistics of the *PremDet* variable reveal significant heterogeneity in risk transfer in reinsurance operations by insurers. The extremely high standard deviation (compared to the mean), combined with an elevated kurtosis, reflects the presence of outliers in the variable in question. This dispersion can be partially explained by the fact that life insurers engage in less reinsurance, as they face lower uncertainty due to the long-term nature of their contracts and the greater predictability of the insured risks (Van Lelyveld et al., 2011).

The analysis of the third quartile of the *LifePrem* variable reinforces this explanation and is consistent with the findings of Carvalho and Bonetti (2022). They state that the life insurance segment accounted for more than 53% of average premium revenue from February 2003 to December 2018, suggesting that premiums for these insurances are higher and/or these products are more widely marketed.

The analysis of the descriptive statistics of the qualitative variables *Bancassur* and *EcoGroup* revealed relative frequencies of 0.37 and 0.81 for category 1, respectively. The results indicate that 81% of the sample is affiliated with an economic group and 37% is associated with banks. The results are in line with SUSEP's 2022 data, which reported that 86% of companies were associated with large economic conglomerates, particularly in the banking sector (Superintendência de Seguros Privados, 2023). These figures reflect the concentration of the insurance market in the hands of large financial groups.

The data were structured in a panel format, and under Hausman's (1978) framework, a test was applied to determine the most appropriate model for each equation. For Equations 1 and 2, which evaluate the behavior of premium cession to admitted and eventual reinsurers, respectively, the test indicated that the random effects model is the most appropriate. For Equation 12, which analyzes variation in credit risk capital, the fixed effects model proved to be more appropriate.

Based on the consistent estimator of the covariance matrix proposed by White (1980), the models were implemented using White's robust estimators to correct issues of heteroscedasticity and autocorrelation in the residuals.

The results of models (1), (2) and (3), which evaluate premium cessions to admitted and eventual reinsurers, as well as credit risk capital, respectively, are presented in Table 2.

First, it is important to discuss the main findings of models (1) and (2).

The first statistically significant variable analyzed is *Size*. The data from models (1) and (2) indicate a positive correlation between firm size and premiums ceded to admitted and eventual reinsurers. This suggests that larger insurers tend to cede more premiums to these reinsurers.

Although Cummins et al. (2012) found a negative correlation between insurer size and reinsurance demand, Cole and McCullough (2006) observed a positive correlation when analyzing U.S. insurers' use of foreign reinsurers. In other words, larger insurers are more likely to use foreign reinsurers, possibly due to the limited capacity of the domestic market to meet their needs (Cole & McCullough, 2006). This aligns with the results of this study.

Regarding model (1), the variable *PremDet* indicates a negative association between premiums ceded to reinsurers and those ceded to admitted reinsurers. This means that insurers that transfer a higher proportion of premiums to reinsurers tend to work less with admitted reinsurers.

Furthermore, model (1) reveals that the variable *Bancassur* has a negative correlation between affiliation with banks and the proportion of premiums ceded to admitted reinsurers, indicating that insurers associated with banking institutions tend to cede fewer risks to these reinsurers. Carvalho and Guimarães (2022) corroborate these findings, highlighting that insurers connected to banks are less exposed to reinsurance operations, as they predominantly operate in the life insurance sector and offer mass-market products.

In relation to model (2), the variable *LifePrem* shows a negative correlation between the level of operations in

Table 2
Results of models (1), (2), and (3)

Variable		*PremAdRein (1)*	*PremEvRein (2)*	*CredRCap (3)*
Decree	Coefficient	-0.0228	0.0561***	0.0545
	Standard Error	0.0252	0.0122	0.1017
CNSP451	Coefficient	-0.0047	0.0099	-0.2074**
	Standard Error	0.0103	0.0081	0.0715
Size	Coefficient	0.0212*	0.0092*	0.8834***
	Standard Error	0.0107	0.0041	0.1334
GeoDiv	Coefficient	0.0184	-0.0139	0.1779
	Standard Error	0.0646	0.0252	0.3954
PortDiv	Coefficient	-0.1018	0.0046	0.5136
	Standard Error	0.0787	0.0218	0.4051
LifePrem	Coefficient	-0.0668	-0.0365·	-0.5100·
	Standard Error	0.0625	0.0194	0.2871
Bancassur	Coefficient	-0.1107·	-0.0309	N/A(1)
	Standard Error	0.0570	0.0247	N/A(1)
EcoGroup	Coefficient	0.0519	0.0170	N/A(1)
	Standard Error	0.0458	0.0126	N/A(1)
CapStru	Coefficient	-0.0003	-0.0002·	-0.0025
	Standard Error	0.0003	0.0001	0.0027
PremDet	Coefficient	-0.0002***	0.0000	0.0002
	Standard Error	0.000	0.0000	0.0004
LossR	Coefficient	-0.0076	-0.0124**	0.1741
	Standard Error	0.0126	0.0047	0.1208
RetLim	Coefficient	-0.0011	0.0168	0.0729
	Standard Error	0.0159	0.0108	0.0637
COVID	Coefficient	0.0191	-0.0344*	-0.2414*
	Standard Error	0.0225	0.0153	0.0989
PremAdRein	Coefficient	N/A	N/A	-0.0043
	Standard Error	N/A	N/A	0.1931
PremEvRein	Coefficient	N/A	N/A	1.0797**
	Standard Error	N/A	N/A	0.3799
R^2 of the regression		0.0277	0.1398	0.4791
p-value of the Hausman test		0.1575	0.1976	0.0005
Type of estimation		Random	Random	Fixed

Statistical significance: ***p<0.001; **p<0.01; *p<0.05 and ·p<0.1

Since the fixed-effects model is based on variation within each unit over time, constant variables were excluded from the model.
Source: own elaboration.

the life insurance sector and the proportion of premiums ceded to eventual reinsurers. This result reinforces the hypothesis that insurers with a significant presence in the life insurance sector tend to engage in less reinsurance (Van Lelyveld et al., 2011; Carvalho & Song, 2024).

Shiu (2011) suggests that more leveraged insurers engage in more reinsurance. However, contrary evidence was found in model (2) of this study. The variable *CapStru* indicates a negative correlation between insurer leverage and cession of premiums to eventual reinsurers. In other words, more leveraged insurers tend to cede fewer premiums to eventual reinsurers.

It can be hypothesized that this phenomenon occurs to avoid an increase in credit risk when dealing with eventual reinsurers. In this context, already leveraged insurers would not be willing to further increase their risk. However, model (3) clarifies that the capital structure was not statistically significant (even at the 10% level) in explaining the level of credit risk capital, which makes this finding ambiguous.

The variable *LossR* shows a negative correlation between the insurer's loss ratio and the cession of premiums to eventual reinsurers. This contrasts with the findings of Lee and Lee (2012), who found that insurers with higher

loss ratios tend to acquire larger amounts of reinsurance. However, it is important to note that this finding refers to reinsurance purchasing from a general perspective, regardless of the reinsurer's classification (local, admitted, or eventual), as seen in the Brazilian scenario.

Still regarding model (2), the *COVID* variable shows a negative correlation between the COVID-19 pandemic and the cession of premiums to eventual reinsurers, so while the pandemic was ongoing, insurers were less likely to cede premiums to these reinsurers. Considering the increased risk and instability caused by the pandemic (Babuna et al., 2020; Candido & Salotti, 2022), it can be hypothesized that this result stems from insurers' desire to avoid additional exposure, given that eventual reinsurers are associated with higher levels of risk.

In turn, the analysis of the *Decree* variable shows a positive correlation between Decree No. 10,167 and premiums ceded to eventual reinsurers, indicating that the new regulation effectively led to an increase in premium cession to these reinsurers.

However, it is important to note that the *Decree* variable may also capture the effect of the accounting fraud scandal involving financial indicators related to IRB Brazil Reinsurance in 2020, as the event occurred in the same year the decree came into force.

IRB is a market leader with a share of around 30% of the Brazilian reinsurance sector since the end of the monopoly (Carvalho & Guimarães, 2024). Therefore, events of this nature can lead to a deterioration of the business environment and a prolonged loss of trust, especially among investors, in the affected institutions and industries, or even in the economy as a whole (Van Driel, 2019). This could justify a shift in premium cession to other reinsurers.

The statistically significant variables in relation to model (3) are analyzed below.

The *Size* variable indicates that larger insurers tend to have higher credit risk capital. According to the literature, large insurers operate with a greater proportion of foreign reinsurers (Cole & McCullough, 2006). Similarly, the results of this study show that larger insurers tend to work more with admitted and eventual reinsurers. In this context, it can be argued that the observed increase in credit risk capital is a consequence of the higher premium cession to these reinsurers.

On the other hand, the *LifePrem* variable reveals a negative correlation between operating in life insurance and credit risk capital, meaning that insurers operating widely in life insurance tend to have lower credit risk capital. This occurs because these entities engage in less reinsurance (Van Lelyveld et al., 2011; Carvalho & Song, 2024) and consequently exhibit lower credit risk.

Contrary to expectations, the *COVID* variable shows a negative correlation between the COVID-19 pandemic and credit risk capital, such that a decrease in the credit risk capital of insurers was observed during the pandemic. According to CNSP Resolution No. 432, credit risk capital consists of two components. The first component refers to the credit risk of risk transfer operations with insurance companies, reinsurers, EAPCs (private pension entities), and capitalization companies as counterparties. The second component refers to the credit risk of exposures in operations where the counterparties are not these entities (Brasil, 2021b).

Thus, it can be hypothesized that this decrease may also be associated with a reduction in the second component of credit risk capital because, during this crisis period, insurers underwrote fewer contracts (Candido & Salotti, 2022). With fewer contracts underwritten, it may not have been necessary to maintain guarantee assets at such high levels, possibly lowering the credit risk associated with these financial instruments, which represent a significant portion of the second component of credit risk capital.

Moreover, the results of this study reveal a negative correlation between the proportion of premiums ceded to eventual reinsurers and the COVID-19 pandemic. Thus, the lower credit risk capital observed during this period may also be partly explained by the reduced cession of premiums to these reinsurers.

Regarding the *CNSP451* variable, a negative correlation is observed between the new regulation and insurers' credit risk capital. This indicates that despite the regulation allowing insurance companies to have a reinsurance cession percentage exceeding 90%, this change did not lead to an increase in credit risk. It can be argued that this occurs because insurers did not increase their reinsurance cession percentage.

The last variable analyzed, *PremEvRein* from model (3), indicates a positive correlation between the proportion of premiums ceded to eventual reinsurers and credit risk capital. In other words, insurers that engage more with these reinsurers tend to have higher credit risk capital. This result aligns with expectations, as these reinsurers are not fully subject to SUSEP supervision and may operate under more lenient regulations than local reinsurers.

Consequently, a higher credit risk capital implies greater overall risk capital, which directly impacts the minimum capital required. This means that by taking on greater exposure to this type of risk, the insurer would need to maintain a higher minimum capital level to meet regulatory requirements and ensure solvency, which would reduce the profit distributed to shareholders, thereby decreasing the company's attractiveness to potential new investors.

5 Conclusion

The objective of this study was to analyze the profile of insurers that chose to transfer their premiums to eventual reinsurers after the enactment of Decree No. 10,167, as well as those that opted for admitted reinsurers, considering the absence of a cession limit for these reinsurers. The study then investigated how this change affected the credit risk capital of insurers.

Among the results, it was observed that larger insurers tend to cede more premiums to foreign reinsurers (admitted and eventual). On the other hand, insurers associated with banking institutions tend to cede a smaller portion of premiums to admitted reinsurers. Meanwhile, those that predominantly operate in the life insurance sector and have a higher loss ratio or leverage tend to cede fewer premiums to eventual reinsurers.

It was also observed that the decree effectively led to a greater cession of premiums to eventual reinsurers. Evidence showed that operating extensively with these reinsurers is directly associated with an increase in credit risk capital, highlighting that Decree No. 10,167 may increase the credit risk of Brazilian insurers and affect their solvency.

This study has several limitations. First, it was difficult to obtain insurers' financial statements prior to 2014 because these data were unavailable in the SUSEP system. This restricted the time frame analyzed. Another limitation is the lack of segregation of ceded premiums among local, admitted, and eventual reinsurers in some statements, which reduced the number of entities in the sample. Additionally, the financial statements do not report premiums ceded exclusively to IRB, preventing the isolated capture of the effect of the accounting fraud scandal.

Future research should investigate the impact of Decree No. 10,167 across different lines of business and the impact of each line on decisions regarding reinsurance strategies, solvency, and the capital requirements set by SUSEP.

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(X) Enhancing Readability and Proofreading – ChatGPT platform
The author(s) declare that, after using this tool/service, they reviewed and edited the content as needed and take (s) full responsibility for the content of the publication.

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2nd author: Definition of the research problem; development of hypothesis or research questions (empirical studies); development of theoretical propositions (theoretical work); theoretical foundation/literature review; definition of methodological procedures; statistical analysis; analysis and interpretation of data; critical revision of the manuscript; manuscript writing.