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Effects of Diversification on Profitability and Operating Risk for Brazilian Publicly Traded Companies

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ABSTRACT

This study analyzed the effect of industrial and international diversification on the profitability and operational risk of Brazilian companies. The sample comprised 210 publicly traded Brazilian companies, who trade shares on the B3 stock exchange. The results of the study showed that industrially diversified companies both reduce operational risk and increase profitability in terms of return on assets, while companies that are internationally diversified reduce their profitability. As well, the companies that diversify both industrially and internationally, see increasedoperational risk. This study is relevant to the investigation of the relationship of industrial and international diversification in companies' operating results, as it indicates that, in the context of Brazil, industrial diversification tends to improve operating results, with an increase in profitability and a reduction in operating risk.

KEYWORDS

Industrial Diversification, Internationalization of Activities, Profitability, Operational Risk

1. INTRODUCTION

The relationship between corporate diversification and companies' operating results is a topic that has generated interest and discussion both in academia and in the market. This interest is driven by lack of consensus on whether diversification increases or reduces companies' operating results, or, whether this relationship does not exist or is curvilinear. In addition, due to these uncertainties, there are several discussions as to why companies pursue a diversification strategy, a strategy that guides expansion into new segments or markets (Bhatia & Thakur, 2018; Xiao & Xu, 2019; Zúñiga-Vicente et al., 2019).

Diversification is understood as the performance or movement of a company into various types of business in which there was no previous involvement. This expansion may be related either to products or in terms of geographic region (Gemba & Kodama, 2001; Delbufalo et al., 2016). In this study, diversification is understood from two perspectives: industrial and international. Industrial diversification, also called product diversification, is understood as the expansion of a company's product portfolio, both in related and unrelated fields (Wang et al., 2014). International diversification, also known as geographic diversification, is characterized as the expansion of the company's business to other places, sometimes to other countries (Song et al., 2017).

In Brazil, there are companies that are industrially and internationally diversified, with an emphasis on publicly held companies (Carvalho et al., 2012). According to the 2019 Financial Statements, BRF is one of the Brazilian multinationals with a considerable degree of product diversification (industrial) and geographic (international). The company is known for its operations in several countries, in addition to having a diversified portfolio of products, from animal husbandry to the industrialization and sale of in-natura meat, pasta and soy derivatives.

Following the example of BRF S.A. (2019), other companies are also now known for showing diversification in industrial and international definitions. These include Brazilian companies such as Weg, Vale and Gol Linhas Aereas. In this context, the question arises as to why these companies seek diversification, that is, what would be the advantages of adopting this strategy. In the literature, there are several explanations defended for industrial and international diversification. Among the main reasons are: market power advantages, resource sharing and efficiency, fiscal and financial advantages (George & Kabir, 2012; Wang et al., 2014).

Another important relationship studied as a result of corporate diversification concerns the operational risk of companies. Industrial and international diversification may be negatively related to the operational risk of companies, that is, it can reduce the volatility of their profits. It is understood that diversification allows for less exposure and dependence on a single market or segment. That is, as they are less sensitive to fluctuations, economic conditions or customer demands in a given market, they present lower levels of risk in operations (Kang et al., 2012; Song et al., 2017; Jafarinejad et al., 2018).

In addition to the possibility of being related to operational risk, diversification, both industrial and international, can also be linked to increased profitability. This positive relationship would be a consequence of the efficiency, synergy of resources, and growth potential, which is generated by diversification, both industrial and international. Furthermore, it is understood that diversification can be a strategy adopted by companies to combat the poor performance of the businesses in which they already operate (Delbufalo et al., 2016; Gyan et al., 2017; Zúñiga-Vicente et al., 2019).

In this context, while understanding that diversification, both at an industrial and international level, can be related to the operating result of companiesand operational risk, this study presents the following research question: what is the influence of diversification, both industrial and international, in the profitability and operational risk of Brazilian companies? Such, the objective

of analyzing the effect of industrial and international diversification on the profitability and operational risk of Brazilian companies is consolidated.

To meet the objective, we observed 210 publicly traded Brazilian companies with their shares traded on the B3 stock exchange. Hypothesis testing was performed using regression models with stacked panel data. The dependent variables of the study are profitability and operational risk, and the independent variables are related to industrial and international diversification. The results provide evidence that companies who expand their business segments reduce their operational risk and increase their profitability, while companies that internationalize their activities end up reducing profitability, and companies who diversify both industrially and internationally, increase their operational risk.

The study results provide an overview of diversified Brazilian publicly traded companies, indicating the effects of this organizational strategy on operating results. From this, the study aims to contribute to investors by providing support for their decision-making on the allocation of resources in diversified companies. The results are still relevant for the management of companies, bringing insights into diversification settings that increase profitability and reduce operational risk.

The study is relevant when working on the profitability and operational risk focuses that arise from industrial and international diversification strategies. Not considering the effect of these strategies on operational risk, tends to indicate a biased result, as it would not consider the full effect of diversification on companies' operational results, as highlighted by Song et al. (2017).

Additionally, the study is relevant when addressing the Brazilian context, which, according to Machado et al. (2015), has undergone several economic and financial changes in the last two decades, such as trade opening and currency stabilization, which directly impacts the issue of industrial and international diversification and, consequently, interferes in the operational results of these organizations.

In short, the study is relevant in analyzing an emerging economy such as Brazil. According to Lee et al. (2012), companies in emerging markets may have greater advantages with diversification than those in developed markets, as emerging markets prefer domestic financing due to the less developed capital market.

2. LITERATURE REVIEW AND HYPOTHESES

In recent years, most companies sought to diversify their markets, products, market segments, and industries simultaneously, especially due to the growing competitiveness faced in the business environment (Wang et al., 2014; Zúñiga-Vicente et al., 2019). In the literature, there is also such an emphasis on the two types of diversification, industrial and international. Industrial diversification is considered as the company's involvement in different segments, and occurs when companies in their origin country expand operations in different segments in order to diversify their income streams (Jafarinejad et al., 2018). International diversification is considered an expansion operation in several countries, reflecting the number of international markets in which the company operates (Delbufalo et al., 2016).

Based on the assumption of the efficiency of the internal capital market, there is an understanding that diversified companies have several advantages over companies that do not seek to diversify their business, as more diversified companies are able to use their resources in other companies with a higher degree of efficiency (Weston, 1970; Rudolph & Schwetzler, 2013; Berg, 2016; Bhatia & Thakur, 2018). Diversification provides the company with comfort against a business slowdown, as well as protection from setbacks that occur in a dynamic environment with high market competitiveness (Wade & Gravill, 2003; Bhatia & Thakur, 2018).

In addition, diversification allows the company to obtain and exploit economies of both scale and scope, amortize investments in critical areas, and thus provide location advantages, progressing with synergies towards reducing operational risks in different markets (Kim & Mathur, 2008; Lee et al., 2012; Delbufalo et al., 2016). As companies expand, they tend to face numerous challenges as well as different opportunities, and in the context of diversified companies it is no different (Jafarinejad et al., 2018). Among the opportunities arising from diversification, the advantages for the operating result stand out, considering the implications for operating risk and profitability.

Dealing specifically with operational risk, the study by Kang et al. (2012) investigated the relationship between international diversification and risk and found that more internationally diversified companies tend to have lower operational risk. This reduction is explained by the stability generated in the business when the company operates in different markets, which consequently may present economic conditions, customer demand, regulations and different environments. Thus, with diversification, companies can be less sensitive to deceleration and fluctuations in a segment or market.

Investigating publicly traded companies in the United States, Song et al. (2017) analyzed the effect of international diversification on the operational risk and market-based risk of companies and found that internationally diversified companies manage to reduce their risk. The reduction of the company's operational risk as seen in the reduction of the volatility of its profits, is achieved through diversification from the moment the company is no longer exposed to just one market, allowing it to accumulate experience in different markets.

Also, in the context of publicly held companies in the United States, Jafarinejad et al. (2018) investigated the impact of industrial diversification on companies' operational risk and found that this movement mitigates risks. This finding is explained by the ability of diversified companies to have access to various segments, which leads to greater operational and income flow flexibility, which consequently reduces operational risks. Therefore, given the above, it is understood that industrial and international diversification reduce the operational risk of companies. Thus, the following hypotheses for the study are proposed:

- **H1:** Industrial diversification negatively influences operational risk.
- **H2:** International diversification negatively influences operational risk.
- **H3:** Industrially and internationally diversified companies present lower operational risk.

In the literature, in addition to studies on operational risk, there are many studies which refer to industrial and international diversification while dealing with the performance of companies, and, more precisely, about profitability (Lee et al., 2012). In this context, there is an understanding that companies can opt for diversification as a strategy to combat poor performance in the main segments or products (Matsusaka, 2001). Thus, the possibility for the company to diversify its business provides an opportunity for its growth, profitability and survival (Wang et al., 2014).

Investigating manufacturing companies in Italy, Delbufalo et al. (2016) studied the relationship between industrial and international diversification and company profitability. Based on the results, they found that there is an inverted U-shaped relationship between the variables, and at a certain level of industrial and international diversification, not too high or too low, companies manage to maximize their profitability. However, after a certain level, profitability is reduced. For the authors, this behavior is justified because diversification, when it exceeds a certain limit, ends up becoming very complex to manage, generating high costs that outweigh the benefits.

The study by Bhatia and Thakur (2018) points out that industrial diversification can improve and contribute to the company's performance in different aspects, such as offering benefits from financial synergies for a more satisfactory company performance. It is considerable that companies with greater profitability have a greater number of residual resources that favor an advantageous possibility for the company's growth. Corroborating this point, Gyan et al. (2017) found that, in Malaysian companies, there is a positive relationship between industrial diversification and profitability, mainly justified through the efficiency caused by diversification.

In the context of companies in Spain, Zúñiga-Vicente et al. (2019) investigated the effects of industrial diversification on profitability and the moderating effect of international diversification on the relationship between industrial diversification and profitability. As findings, the study found that the more industrially diversified, the greater tends to be the profitability of companies, as they are able to benefit from the synergies of activities, through the complement or shared use of resources. International diversification was negatively related to profitability, probably because entry into international markets generates higher costs than the potential benefits themselves.

Given the above, it is understood that industrial and international diversification increase the profitability of companies. Thus, the following hypotheses for the study are also presented:

- **H4:** Industrial diversification positively influences profitability.
- **H5:** International diversification positively influences profitability.
- **H6:** Industrially and internationally diversified companies show greater profitability.

3. RESEARCH METHODOLOGY

Considering the objective of the research to analyze the effect of industrial and international diversification on profitability and operational risk, this study sought to observe publicly traded companies with shares traded on B3 (*Brasil, Bolsa, Balcão*). The study population comprises 424 publicly traded Brazilian companies with shares traded on the stock exchange, as information on the diversification of these companies is made available. After excluding companies from the financial sector and those that did not have sufficient data for the period analyzed, the study sample consisted of 210 companies. Data were collected in the Refinitiv Eikon database for the period between 2019 and 2010 (10 years). We worked, therefore, with unbalanced data, with an amount of 1755 observations.

Table 1 presents the specification of the variables, highlighting the measurement and studies that support its use. The dependent variables of the study are related to the operating result; more specifically, profitability, and operating risk. Profitability is measured from the ratio between EBITDA and total assets, while operational risk is measured by the standard deviation of the ROA over a 5-year window. The independent variables are related to diversification, industrial and international, highlighted from dichotomous and numerical variables. Industrial diversification considers the number of segments in which the company operates, using the four-digit NAICS code as classification. The international diversification variable examines the company's operations in the foreign market, considering the percentage of sales. Leverage, size, and fixed assets where used as control variables.

For data analysis, descriptive statistics and multiple linear regression with OLS estimation (Greene, 2012) were used, and the statistical procedures were performed using STATA® software. The "industry" and "year" fixed effects control were included in the regression models. Thus, we worked with stacked Panel Data models (Pooled OLS – POLS). This treatment was adopted because the effects which are related to the companies are already controlled by the control variables, and also because it is considered that the temporal effects are of greater importance for the studied phenomenon (Wooldridge, 2010). According to Fávero et al. (2009), to verify the OLS estimation, some assumptions were observed, such as normality, absence of multicollinearity, absence of heteroscedasticity and absence of autocorrelation.

Table 1
Variables specification

Variable	Measurement	Authors
Dependent variables		
Profitability (ROA)	$ROA = \dfrac{EBITDA}{Total\ assets}$	Gyan (2017), Chou and Shih (2020) and Zheng and Tsai (2019)
Operational risk (RIS)	Standard deviation of ROA across a five-year period	Grzebieluckas et al. (2013), Alessandri and Seth (2014) and Song et al. (2017)
Independent variables		
Industrial diversification (DIVIND)	Dummy: 1 if the company operates in two or more different four-digit NAICS code segments, and 0 otherwise.	Ahn et al. (2006), Gyan et al. (2017), Xiao and Xu (2019)
Industrial diversification (DIVINDQTY)	Numerical: Number of segments that the company operates.	Adapted from Ahn et al. (2006), Gyan et al. (2017), Xiao and Xu (2019)
International diversification (DIVINT)	Dummy: 1 if the company has more than 10% of its sales with the foreign market, and 0 otherwise.	Fauver et al. (2004), Lee et al. (2012) and Gyan et al. (2017)
International diversification (DIVINTSA)	Numerical: Percentage of sales with the foreign market.	Adapted from Fauver et al. (2004), Lee et al. (2012) and Gyan et al. (2017)
Industrial and international diversification (DIVINDINT)	Dummy: 1 if the company has industrial and international diversification, and 0 otherwise. (Moderating variable between DIVIND and DIVINT)	Lee et al. (2012)
Industrial and international diversification (DIVINDQTY X DIVINTSA)	Numerical: Moderating variable between DIVINDQTY and DIVINTSA	Adapted from Lee et al. (2012)

Table 1
Cont.

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Variable	Measurement	Authors
Industrial diversification (DIVIND23)	Dummy: 1 if the company operates on two or three different four-digit NAICS code segments, 0 otherwise.	
Industrial diversification (DIVIND45)	Dummy: 1 if the company operates on four or five different four-digit NAICS code segments, and 0 otherwise.	
Industrial diversification (DIVIND5)	Dummy: 1 if the company operates in more than 5 different four-digit NAICS code segments, and 0 otherwise.	Adapted from Carvalho et al. (2012)
International diversification (DIVINT1130)	Dummy: 1 if the company presents from 11 to 30% of its sales with the foreign market, and 0 otherwise.	
International diversification (DIVINT3150)	Dummy: 1 if the company presents from 11 to 30% of its sales with the foreign market, and 0 otherwise.	
International diversification (DIVINT50)	Dummy: 1 if the company has more than 50% of its sales with the foreign market, and 0 otherwise.	
Control variables		
Leverage (LEV)	$\dfrac{Debt}{Total\ assets}$	Gyan (2017) and Bhatia and Thakur (2018)
SIZE	Natural logarithm of sales revenue	Delbufalo et al. (2016) and Gyan (2017)
Fixed assets (FA)	$\dfrac{Fixed\ assets}{Total\ assets}$	Zheng and Tsai (2019)

Source: Prepared by the authors.

The testing of the research hypotheses took place considering the models proposed below.

$$RIS = \beta_0 + \beta_1 DIVIND + \beta_2 DIVINT + \beta_3 LEV + \beta_4 SIZE$$
$$+\beta_5 FA + \sum IndustryFixedEffects + \sum YearFixedEffects + \varepsilon \tag{1}$$

$$RIS = \beta_0 + \beta_1 DIVIND + \beta_2 DIVINT + \beta_3 DIVINDINT + \beta_4 LEV$$
$$+\beta_5 SIZE + \beta_6 FA + \sum IndustryFixedEffects + \sum YearFixedEffects + \varepsilon \tag{2}$$

$$RIS = \beta_0 + \beta_1 DIVIND23 + \beta_2 DIVIND45 + \beta_3 DIVIND5 + \beta_4 LEV$$
$$+\beta_5 SIZE + \beta_6 FA + \sum IndustryFixedEffects + \sum YearFixedEffects + \varepsilon \tag{3}$$

$$RIS = \beta_0 + \beta_1 DIVINT1130 + \beta_2 DIVINT3150 + \beta_3 DIVINT50 + \beta_4 LEV$$
$$+\beta_5 SIZE + \beta_6 FA + \sum IndustryFixedEffects + \sum YearFixedEffects + \varepsilon \tag{4}$$

$$RIS = \beta_0 + \beta_1 DIVINDQTY + \beta_2 DIVINTSA + \beta_3 LEV + \beta_4 SIZE$$
$$+ \beta_5 FA + \sum IndustryFixedEffects + \sum YearFixedEffects + \varepsilon \qquad (5)$$

$$RIS = \beta_0 + \beta_1 DIVINDQTY + \beta_2 DIVINTSA + \beta_3 DIVINDQTY \; X \; DIVINTSA +$$
$$\beta_4 LEV + \beta_5 SIZE + \beta_6 FA + \sum IndustryFixedEffects + \sum YearFixedEffects + \varepsilon \qquad (6)$$

$$ROA = \beta_0 + \beta_1 DIVIND + \beta_2 DIVINT + \beta_3 LEV + \beta_4 SIZE$$
$$+ \beta_5 FA + \sum IndustryFixedEffects + \sum YearFixedEffects + \varepsilon \qquad (7)$$

$$ROA = \beta_0 + \beta_1 DIVIND + \beta_2 DIVINT + \beta_3 DIVINDINT + \beta_4 LEV$$
$$+ \beta_5 SIZE + \beta_6 FA + \sum IndustryFixedEffects + \sum YearFixedEffects + \varepsilon \qquad (8)$$

$$ROA = \beta_0 + \beta_1 DIVIND23 + \beta_2 DIVIND45 + \beta_3 DIVIND5 + \beta_4 LEV$$
$$+ \beta_5 SIZE + \beta_6 FA + \sum IndustryFixedEffects + \sum YearFixedEffects + \varepsilon \qquad (9)$$

$$ROA = \beta_0 + \beta_1 DIVINT1130 + \beta_2 DIVINT3150 + \beta_3 DIVINT50 + \beta_4 LEV$$
$$+ \beta_5 SIZE + \beta_6 FA + \sum IndustryFixedEffects + \sum YearFixedEffects + \varepsilon \qquad (10)$$

$$ROA = \beta_0 + \beta_1 DIVINDQTY + \beta_2 DIVINTSA + \beta_3 LEV + \beta_4 SIZE$$
$$+ \beta_5 FA + \sum IndustryFixedEffects + \sum YearFixedEffects + \varepsilon \qquad (11)$$

$$ROA = \beta_0 + \beta_1 DIVINDQTY + \beta_2 DIVINTSA + \beta_3 DIVINDQTY \; X \; DIVINTSA$$
$$+ \beta_4 LEV + \beta_5 SIZE + \beta_6 FA + \sum IndustryFixedEffects + \sum YearFixedEffects + \varepsilon \qquad (12)$$

4. RESULTS

In this section, we present the empirical results for the research, paying special attention to the tested hypotheses. Table 2 presents the statistics that describe the behavior of the variables' sampled data, based on the mean, median, standard deviation, minimum, and maximum. As for diversification, it appears that 38.1% of publicly traded Brazilian companies have industrial diversification, 23.5% international diversification and 13.3% industrial and international diversification. The companies operate with 1 to 8 segments and the mean percentage of sales to the foreign market is 9.6%. Regarding profitability, companies generate on average of 5% return on capital invested in total assets, with this return on assets varying around 6.8%. Furthermore, publicly traded Brazilian companies have on average of 34.8% of their assets financed by third-party capital and 30% of their assets are accounted for as fixed assets.

Table 2

Descriptive analysis of variables

VARIABLE	Mean	Median	Standard deviation	Min	Max
DIVIND[a]	0.381	-	-	-	-
DIVINT[a]	0.235	-	-	-	-
DIVINDINT[a]	0.133	-	-	-	-
DIVINDQTY	1.740	1	1.195	1	8
DIVINTSA	0.096	0	0.199	0	1
ROA	0.055	0.065	0.118	-0.987	0.959
RIS	0.068	0.043	0.100	0.006	1.213
LEV	0.348	0.308	0.331	0.006	3.776
SIZE	21.067	21.128	1.998	10.463	26.544
FA	0.300	0.253	0.227	-0.398	0.927

Note. [a] Dummy variable. DIVIND: Industrial diversification; DIVINT: international diversification; DIVINDINT: Industrial and international diversification; DIVINDQTY: number of segments that the company operates; DIVINTSA: percentage of sales with the foreign market; ROA: Profitability; RIS: Operational risk; LEV: Leverage; SIZE: Natural logarithm of sales revenue; FA: Fixed assets.

Source: Research data.

Figure 1 shows the degree of industrial diversification, international diversification, and industrial and international diversification, of companies with shares traded on B3, indicating the values per year. It appears that for all types of diversification, there was an increase between the years 2010 to 2011, a reduction between the years 2012 to 2017 and an increase between the years 2018 to 2019. Corroborating the results in Table 2, industrial diversification presented as the most representative in companies over the years 2010 to 2019, ranging from 44.3% to 33.5%. International diversification comes next, with the second-highest representation, ranging from 29.1% to 19.5%. As for the companies that adopt both types of diversification, there is a representation that varies between 16.3% and 11.7% over the 10 years analyzed.
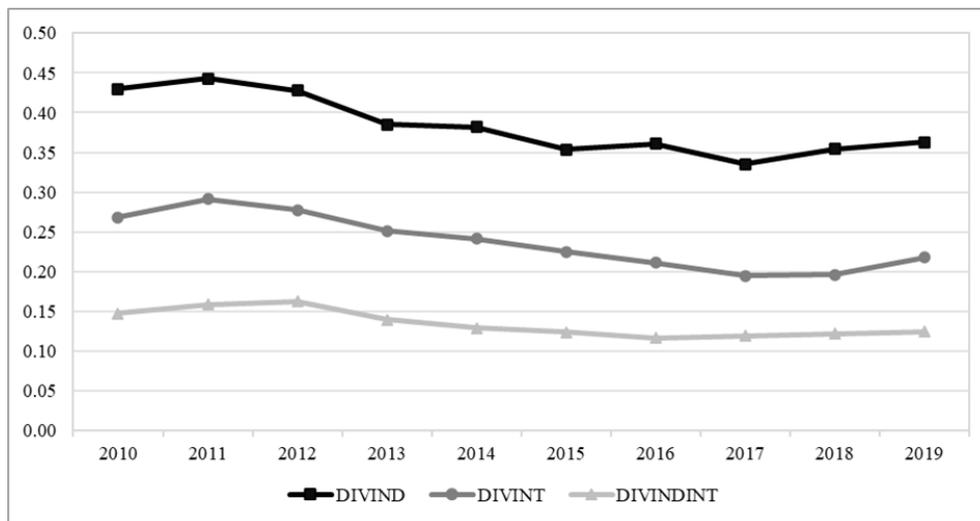

Figure 1. Diversification per year

Note. DIVIND: Industrial diversification; DIVINT: international diversification; DIVINDINT: Industrial and international diversification.

Source: Research data.

Table 3 presents industrial diversification, international diversification, and industrial and international diversification by sector. It appears that companies in the sectors of Telecommunications Services, Technology, and Utilities have only industrial diversification. Companies in the Healthcare sector have industrial diversification and international diversification, but they do not have both types of diversification simultaneously. As for industrial diversification, the Industrials and the Technology sectors stand out as the most diversified, given the verification of more than 50% of the companies. On the other hand, the sectors Healthcare and Utilities have the lowest industrial diversification.

Regarding international diversification, the Basic Materials sector stands out with 47% of diversified companies. The Healthcare and Energy sectors are the ones that are least diversified internationally, with only 2% and 8.8% of diversification respectively. Regarding companies with industrial and international diversification simultaneously, the Industrials and Basic Materials sectors stand out. While the Energy and Consumer Cyclicals sectors are the ones with the least diversification, with 4.4% and 11.7% of the companies, respectively.

Table 3
Diversification by sector

Sector	Proportion of Diversified Companies		
	DIVIND[a]	DIVINT[a]	DIVINDINT[a]
Industrials	0,533	0,325	0,239
Telecommunications Services	0,472	0	0
Consumer Cyclicals	0,315	0,255	0,117
Consumer Non-Cyclicals	0,441	0,297	0,168
Basic Materials	0,338	0,471	0,243
Energy	0,455	0,088	0,044
Healthcare	0,224	0,020	0
Technology	0,531	0	0
Utilities	0,270	0	0

Note. [a] Dummy variable. DIVIND: Industrial diversification; DIVINT: international diversification; DIVINDINT: Industrial and international diversification.
Source: Research data.

Table 4 shows the correlation matrix between the variables. Pearson's Correlation (parametric) and Spearman's Correlation (non-parametric) were calculated. For the Pearson Correlation, there are negative and significant correlations of up to 1% between Industrial Diversification (DIVINDQTY) and Operational Risk (RIS), and positive correlations between Industrial Diversification (DIVINDQTY) and the variables International Diversification (DIVINTSA), Profitability (ROA), and SIZE, indicating that the greater the number of segments in which the company operates, the lower the operational risk and the higher the percentage of sales with the foreign market, the profitability and the size of the company. Regarding International Diversification (DIVINTSA), there was a negative correlation with Operational Risk (RIS) and positive correlations with SIZE and Fixed Assets (FA), indicating that the higher the percentage of sales with the foreign market, the lower the risk operational and larger the size of the company and fixed assets.

As for Profitability (ROA), negative correlations were identified with Operational Risk (RIS), Leverage (LEV) and Fixed Assets (FA), indicating that the more profitable the company, in relation to its assets, the lower the risk (variation in profitability), leverage, and fixed assets. Furthermore, a positive correlation was found between Profitability (ROA) and SIZE, indicating that the greater the profitability against the return on assets, the greater the size of the company. Regarding the Operational Risk (RIS) variable, there was a positive correlation with Leverage (LEV) and a negative correlation with SIZE, indicating that the greater the variation in profitability, the greater the leverage and the smaller the size of the company. As for the variable Leverage (LEV), there was a negative correlation with SIZE, indicating that the more leveraged the company, the smaller its size from the perspective of sales revenue. Regarding the SIZE variable, there was a negative correlation with the Fixed Assets (FA) ratio, indicating that the larger the company in relation to sales revenue, the smaller the fixed assets.

For Spearman's Correlation, relationships similar to those verified by the estimation according to Pearson were found, however, there were some exceptions with the variable Leverage (LEV). The variables Industrial Diversification (DIVINDQTY) and International Diversification (DIVINTSA) were positively correlated with Leverage (LEV) and Profitability (ROA) was not correlated with Leverage (LEV). In addition, Leverage (LEV) showed positive correlations with SIZE and Fixed Assets (FA) and negative with Operational Risk (RIS).

Table 4

Correlation matrix

	DIVINDQTY	DIVINTSA	ROA	RIS	LEV	SIZE	FA
DIVINDQTY	1	0.289***	0.178***	-0.161***	0.107***	0.354***	0.023
DIVINTSA	0.182***	1	0.008	-0.058***	0.088***	0.243***	0.248***
ROA	0.139***	0.000	1	-0.226***	-0.029	0.336***	-0.128***
RIS	-0.157***	-0.102***	-0.292***	1	-0.071***	-0.387***	0.021
LEV	0.021	0.015	-0.097***	0.136***	1	0.148***	0.068***
SIZE	0.354***	0.267***	0.280***	-0.333***	-0.150***	1	-0.142***
FA	0.030	0.152***	-0.098***	0.026	0.031	-0.127***	1

Note. ***$p<0.01$. The superior triangle corresponds to Spearman's Correlation and the inferior triangle to Pearson's Correlation. DIVINDQTY: number of segments that the company operates; DIVINTSA: percentage of sales with the foreign market; ROA: Profitability; RIS: Operational risk; LEV: Leverage; SIZE: Natural logarithm of sales revenue; FA: Fixed assets.
Source: Research data.

Table 5 presents the estimated regression models, as proposed in the methods section, for diversification and operational risk. The adjusted R^2 of models (1), (2), (3), (4), (5) and (6) was 23.5%, 23.8%, 24%, 22.9%, 24% and 24.4% respectively. For the model of Equation (1), it is verified that the variable industrial diversification (DIVIND) presented a negative and significant relationship at the level of 1% with Operational Risk (RIS). Thus, it appears that companies that are industrially diversified reduce their operational risk. According to the study by Jafarinejad et al. (2018), the authors found that companies that were industrially and globally diversified during the 2007-2009 financial crisis offered less risk to the market.

Table 5

OLS Regression - Diversification and Operational Risk

	RIS					
	Eq. (1)	Eq. (2)	Eq. (3)	Eq. (4)	Eq. (5)	Eq. (6)
Independent variables						
_intercept	0.445*** (0.028)	0.440*** (0.028)	0.432*** (0.027)	0.480*** (0.027)	0.445*** (0.028)	0.436*** (0.028)
DIVIND[a]	**-0.019*** (0.005)**	-0.026*** (0.006)				
DIVINT[a]	0.003 (0.006)	-0.010 (0.008)				
DIVINDINT[a]		**0.026**** (0.010)				
DIVIND23[a]			**-0.013**** (0.005)			
DIVIND45[a]			**-0.045*** (0.009)**			
DIVIND5[a]			**-0.042**** (0.018)			
DIVINT1130[a]				-0.004 (0.007)		
DIVINT3150[a]				0.001 (0.009)		
DIVINT50[a]				0.011 (0.009)		
DIVINDQTY					**-0.010*** (0.002)**	-0.014*** (0.002)
DIVINTSA					0.012 (0.012)	-0.047** (0.022)
DIVINDQTY X DIVINTSA						**0.027*** (0.008)**
Control variables						
LEV	0.024*** (0.007)	0.023*** (0.007)	0.025*** (0.007)	0.023*** (0.007)	0.025*** (0.007)	0.024*** (0.007)
SIZE	-0.017*** (0.001)	-0.017*** (0.001)	-0.017*** (0.001)	-0.019*** (0.001)	-0.017*** (0.001)	-0.016*** (0.001)
FA	-0.018* (0.010)	-0.019* (0.010)	-0.016 (0.010)	-0.019* (0.010)	-0.016 (0.010)	-0.016 (0.010)
Model information						
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000
R^2	0.245	0.248	0.250	0.239	0.250	0.254
R^2 adjusted	0.235	0.238	0.240	0.229	0.240	0.244
Durbin Watson	1.981	1.975	1.997	1.980	1.999	1.986
VIF[b]	2.21	2.80	2.07	2.22	2.22	4.93
Observations	1755	1755	1755	1755	1755	1755

Note. *p<0.1. **p<0.05. ***p<0.01. [a] Dummy variable. [b] maximum VIF. The value without parentheses refers to the coefficient, and the value with parentheses refers to the standard error. RIS: Operational risk; DIVIND: Industrial diversification; DIVINT: international diversification; DIVINDINT: Industrial and international diversification;

DIVIND23: Industrial diversification with 2 or 3 segments; DIVIND45: Industrial diversification with 4 or 5 segments; DIVIND5: Industrial diversification with more than 5 segments; DIVINT1130: International diversification with 11 to 30% of sales to the foreign market; DIVINT3150: International diversification with 31 to 50% of sales to the foreign market; DIVINT50: International diversification with more than 50% of sales to the foreign market; DIVINDQTY: number of segments that the company operates; DIVINTSA: percentage of sales with the foreign market; DIVINDQTY X DIVINTSA: moderating variable between DIVINDQTY and DIVINTSA; LEV: leverage; SIZE: Natural logarithm of sales revenue; FA: fixed assets. The assumption of normality of the residues was carried out using the Shapiro Francia test. According to the number of observations and considering the Central Limit Theorem, the assumption of normality is relaxed. As for the homoscedasticity assumption, the White test was used.
Source: Research data.

As for the model of Equation (2), there was a positive and significant relationship at the 5% level between the variables industrial and international diversification (DIVINDINT) and the Operational Risk (RIS), suggesting that companies that are industrially and internationally diversified increase their operational risk. This result corroborates the study by Alessandri and Seth (2014), who found that international diversification can be associated with increased operational risks. However, the results are also in line with the results of Kwok and Reeb (2000), who investigated the international diversification of American and emerging companies and found that as emerging companies get involved with international diversification, they tend to reduce their total risks.

Therefore, it is understood that international diversification may be associated with increased uncertainties, as processes become more complex when managed in a global environment (Hitt et al., 2006). It is understood that international diversification can be a strategy linked to increasing returns and, consequently, increasing operational risks (Alessandri & Seth, 2014).

In the model of Equation (3), there is a negative relationship between Operational Risk (RIS) and industrial diversification of 2 to 3 segments (DIVIND23), industrial diversification of 4 and 5 segments (DIVIND45) and industrial diversification with more than 5 segments (DIVIND5) at the 5%, 1% and 5% level respectively. Thus, companies that are industrially diversified with 2 to 3 segments, with 4 and 5 segments or more than 5 segments present lower operational risk. It is noteworthy that the variable DIVIND45 had the highest coefficient and the highest significance. This result corroborates the finding of the model in Equation (1). Thus, it is understood that industrial diversification can be a strategy adopted so that companies can be less dependent on a single sector, reducing risks (Kang et al., 2012).

In order to complement the results of models (1) and (2), industrial and international diversification was analyzed using numerical variables, according to model (5) and (6). In relation to model (5), it appears that there is a negative and significant relationship at the level of 1% between DIVINDQTY and Operational Risk (RIS), indicating that the greater the number of segments a company operates, the lower the operational risk tends to be. This result corroborates the model (1). As for model (6), there is a positive and significant relationship at the 1% level between DIVINDQTY X DIVINTSA and Operational Risk (RIS), suggesting that companies that are industrially and internationally diversified tend to increase their operational risk. That is, companies that operate in various segments, and at the same time, increase their percentage of sales with the foreign market, and tend to increase the volatility of their profits, which corroborates the model (2).

As for the control variables, models (1), (2), (3), (4), (5) and (6) showed a positive and significant relationship, at the level of 1%, between Operational Risk (RIS) and the variable Leverage (LEV) and a negative relationship with SIZE. Thus, the greater the leverage and the smaller the size of the company, the greater the operational risk. It was also found that for models (1), (2) and

(4), the variable Fixed Assets (FA) presented a negative and significant relationship, at the level of 10%, with the Operational Risk (RIS), indicating that how much the smaller the company's fixed assets, the greater the operational risk.

Table 6 shows the estimates of the models that compare diversification with profitability. The adjusted R^2 of models (7), (8), (9), (10), (11) and (12) was 14.4%, 14.4%, 14.4%, 14.8%, 15.1% and 15.1%, respectively. For the model of Equation (7), a negative and significant relationship was found at the 1% level between the variable international diversification (DIVINT) and profitability (ROA), suggesting that internationally diversified companies reduce their ROA. Similar to the results of Zúñiga-Vicente et al. (2019), who found that international diversification has a negative effect on the profitability of Spanish manufacturing companies. Thus, this negative relationship of international diversification on company profitability points out that as companies diversify in international markets, there is an increase in costs associated with international dispersion and, therefore, profit margins decrease (Geringer et al., 1989; Qian, 2002; Zúñiga-Vicente et al., 2019).

As for model (9), there was a positive and significant relationship at the 1% level between the variable industrial diversification of 4 to 5 segments (DIVIND45) with Profitability (ROA), suggesting that companies that have industrial diversification with 4 to 5 segments tend to increase their ROA. This finding is in line with the study by Lee et al. (2012), who examined the relationship between company value and the international and industrial diversification of companies listed in Malaysia and found that industrially diversified companies with multi-sectors are the most valued. Therefore, it is highlighted that the company's profitability increases as the level of industrial diversification increases (Qian, 2002).

Regarding model (10), there is a negative and significant relationship, at the level of 5% and 1% respectively, between Profitability (ROA) and the variables international diversification with 31% to 50% of sales in the foreign market (DIVINT3150) and international diversification with more than 50% of sales in the foreign market (DIVINT50), indicating that companies that are internationally diversified and have 31 to 50% or more than 50% of their sales in international markets reduce their profitability against the return of active. It is noteworthy that the variable DIVINT50 had the highest coefficient and the highest significance, and that the results are in line with the model (7). This negative effect may be associated with competition against competitors that are already in the international market (Gyan et al., 2017).

In order to complement models (7) and (8), industrial and international diversification was analyzed using numerical variables, according to model (11) and (12). For the model of Equation (11), it is verified that the variable DIVINDQTY presented a positive and significant relationship at the 1% level with ROA, indicating that the greater the number of segments that a company operates, the greater the profitability relative to the return on assets. These results are consistent with the study by Gyan et al. (2017), who analyzed industrial and international diversification in the context of Malaysian companies and found that industrial diversification has a positive and significant relationship with company profitability. This positive relationship can be understood because industrially diversified companies are able to expand their area of operations and thus increase their sales and profitability (Lien & Li, 2013). It is also understood that industrial diversification offers some benefit to companies, such as financial and managerial synergies, cost reduction, and greater capacity to contract debt, which promotes increased profitability (Bhatia & Thakur, 2018).

Table 6
OLS Regression - Diversification and Profitability

	ROA					
	Eq. (7)	Eq. (8)	Eq. (9)	Eq. (10)	Eq. (11)	Eq. (12)
Independent variables						
_intercept	-0.332*** (0.035)	-0.332*** (0.035)	-0.304*** (0.035)	-0.359*** (0.034)	-0.333*** (0.035)	-0.334*** (0.035)
DIVIND[a]	0.007 (0.006)	0.007 (0.007)				
DIVINT[a]	**-0.023***** (0.007)	-0.023** (0.010)				
DIVINDINT[a]		0.000 (0.013)				
DIVIND23[a]			0.000 (0.006)			
DIVIND45[a]			**0.039***** (0.012)			
DIVIND5[a]			0.001 (0.022)			
DIVINT1130[a]				-0.005 (0.009)		
DIVINT3150[a]				**-0.026**** (0.012)		
DIVINT50[a]				**-0.047***** (0.011)		
DIVINDQTY					**0.007***** (0.002)	0.007** (0.003)
DIVINTSA					**-0.063***** (0.015)	-0.069** (0.028)
DIVINDQTY X DIVINTSA						0.003 (0.011)
Control variables						
LEV	-0.016** (0.008)	-0.016** (0.008)	-0.019** (0.008)	-0.014* (0.008)	-0.017** (0.008)	-0.017** (0.008)
SIZE	0.020*** (0.002)	0.020*** (0.002)	0.018*** (0.002)	0.021*** (0.002)	0.019*** (0.002)	0.019*** (0.002)
FA	-0.016 (0.012)	-0.016 (0.012)	-0.021* (0.012)	-0.014 (0.012)	-0.016 (0.012)	-0.016 (0.012)
Model information						
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000
R^2	0.155	0.155	0.155	0.159	0.162	0.162
R^2 adjusted	0.144	0.144	0.144	0.148	0.151	0.151
Durbin Watson	1.917	1.917	1.916	1.924	1.923	1.922
VIF[b]	2.21	2.80	2.07	2.22	2.22	4.93
Observations	1755	1755	1755	1755	1755	1755

Note. *$p<0.1$. **$p<0.05$. ***$p<0.01$. [a] Dummy variable. [b] maximum VIF. The value without parentheses refers to the coefficient, and the value with parentheses refers to the standard error. ROA: Profitability; DIVIND: Industrial diversification; DIVINT: international diversification; DIVINDINT: Industrial and international diversification;

DIVIND23: Industrial diversification with 2 or 3 segments; DIVIND45: Industrial diversification with 4 or 5 segments; DIVIND5: Industrial diversification with more than 5 segments; DIVINT1130: International diversification with 11 to 30% of sales to the foreign market; DIVINT3150: International diversification with 31 to 50% of sales to the foreign market; DIVINT50: International diversification with more than 50% of sales to the foreign market; DIVINDQTY: number of segments that the company operates; DIVINTSA: percentage of sales with the foreign market; DIVINDQTY X DIVINTSA: moderating variable between DIVINDQTY and DIVINTSA; LEV: leverage; SIZE: Natural logarithm of sales revenue; FA: fixed assets. The assumption of normality of the residues was carried out using the Shapiro Francia test. According to the number of observations and considering the Central Limit Theorem, the assumption of normality is relaxed. As for the homoscedasticity assumption, the White test was used. *Source:* Research data.

Still on model (11), it was found that the variable DIVINTSA showed a negative and significant relationship at the level of 1% with ROA, indicating that the higher the percentage of sales to the foreign market of a company, the greater the profitability relative to the return assets, which corroborates the model (7).

For models (7), (8), (9), (10), (11) and (12), there are negative and significant relationships between the variable Profitability (ROA) and Leverage (LEV) and positive relationships with SIZE. In this way, the lower the leverage and the larger the size of the company, the greater the profitability. It is noteworthy that only for model (9) is there a negative and significant relationship between Profitability (ROA) and Fixed Assets (FA), indicating that the smaller the company's fixed assets, the greater its profitability.

According to Table 7, hypotheses H1 and H4 were supported, while hypotheses H2, H3, H5, and H6 were not supported. Thus, the study finds that Brazilian companies that are industrially diversified reduce operational risk and increase profitability in terms of return on assets. Companies that are internationally diversified reduce profitability. On the other hand, operational risk increases in companies that diversify both industrially and internationally. Findings regarding industrial diversification corroborate much of the literature (eg, Lien & Li, 2013; Gyan et al., 2017; Bhatia & Thakur, 2018).

However, findings on international diversification differ from studies that investigated companies from developed countries (e.g., Kang et al., 2012), which found that international diversification tends to reduce operational risk by allowing participation in a variety of savings. Thus, there are indications that the phenomenon of diversification in Brazilian companies, which are inserted in an emerging market, may have different effects on the operating result compared to companies in developed markets, as companies in emerging markets have different stages of economic development, and they usually have limited resources and capacity, which can influence the entry of these companies into international markets (Bhagat et al., 2011; Lee et al., 2012).

As a secondary analysis, the study found that companies that industrially diversify with 4 to 5 segments are the ones that most manage to reduce their operational risk. Companies that diversify industrially with 4 to 5 segments are the ones that show the greatest growth in profitability. In this sense, the results indicate that the benefits of industrial diversification (lower risk and greater profitability) may be more significant for companies that adopt an intermediate diversification, that is, neither very low (from 2 to 3 segments) nor very high (above 5 segments).

Table 7
Summary of hypotheses

Hypothesis	Description	Result
H1	Industrial diversification negatively influences operational risk.	Supported
H2	International diversification negatively influences operational risk.	Unsupported
H3	Industrially and internationally diversified companies present lower operational risk.	Unsupported
H4	Industrial diversification positively influences profitability.	Supported
H5	International diversification positively influences profitability.	Unsupported
H6	Industrially and internationally diversified companies show greater profitability.	Unsupported

Source: Research data.

Furthermore, it was found that companies with international diversification that have more than half of their sales in the international market are the ones with the greatest reduction in profitability. This result may be an indication that excessive dependence on the foreign market (more than 50% of sales) can be detrimental to the profitability of a company's assets. Therefore, in order not to compromise profitability, the percentage of international diversification needs to be carefully analyzed before any strategic decision is made.

In this way, the study contributes to theory by complementing the findings that there is a linear relationship between diversification and operating results. In general, the study indicates that there is a proportional relationship, that is, the greater the industrial diversification, the lower the operational risk and the greater the profitability; the greater the international diversification, the lower the profitability; and the greater the industrial and international diversification, the greater the operational risk.

5. CONCLUSION

This research analyzed the effect of industrial and international diversification on the profitability and operational risk of Brazilian companies. Regarding operational risk, the results show that Brazilian companies that are industrially diversified reduce their operational risk. Furthermore, it was found that the operational risk reduces even more for companies that industrially diversify with 4 to 5 segments. It was also found that companies that are industrially and internationally diversified increase their operational risk.

As for profitability, the results show that industrial diversification increases the profitability of companies. It is noteworthy that industrially diversified companies with 4 to 5 segments increase the profitability relative to the return on assets. In contrast, companies that diversify internationally reduce their profitability. In turn, this reduction is even more expressive in companies that have international diversification, with more than 50% of sales abroad.

This paper's investigations are relevant in some aspects, mainly because they bring to analysis an important corporate strategy, diversification, whether industrial or international (Song et al., 2017). The study is also able to contribute to the literature by examining in a way the degrees of industrial and international diversification that are aspects considered important by the study by Kang et al. (2011). Furthermore, it is considered relevant to study companies with industrial and international diversification simultaneously, as there are some companies that have this characteristic (Benito-Osorio et al., 2015).

When analyzing the relationship between diversification and profitability, the study corroborates area research which still has controversial results, despite numerous studies (Delbufalo et al., 2016). This paper could also be considered important for analyzing the relationship between diversification and operational risk, a topic that has not yet been explored to the same extent as the diversification-performance nexus (Kang et al., 2011). Based on the findings, the study is relevant in indicating that, possibly, Brazilian companies are not able to stabilize their profits or benefit from the economies of different markets, with international diversification, due to the structure or context in which they are inserted (Bhagat et al., 2011; Lee et al., 2012).

The study also extends the investigations proposed in the research carried out by Lee et al. (2012), who recommend that more studies on the theme of diversification be carried out in emerging markets, so that the results can be validated in this context and that there is more evidence that diversified companies from emerging countries may present structures that are different from those observed in developed countries, requiring other bases of explanation. Furthermore, according to Kellner and Rösch (2019), the benefits arising from diversification are smaller for emerging countries, as there is greater integration between developed markets than in emerging markets.

The study has some limitations. It is not possible to generalize the study results to all diversified Brazilian companies, as the study sample focuses on publicly traded companies. Furthermore, the operationalization of the study variables regarding industrial diversification does not allow analyzing whether the various segments adopted by a company are related or not. Therefore, for future research, it is suggested to continue investigations of diversification in Brazilian companies, especially in the environment of privately held companies, which represent the majority of Brazilian companies. Finally, research should be conducted that explores diversification, industrial and international, from other measures or levels of analysis is important.

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CONFLICTS OF INTEREST

The authors confirm that there is no conflict of interest.