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Lais Viera Trevisan[1] | Vitor Klein Schmidt[2]
Marissa Yanara de Godoy Lima[3] | Fernanda Maciel Reichert[4]

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[1] PhD student in Administration (UFRGS).
Porto Alegre – RS, Brazil.
Email: laisvtrevisan@gmail.com

[2] PhD student in Administration (UFRGS).
Porto Alegre – RS, Brazil.
Email: vitorks0123@gmail.com

[3] PhD student in Administration (UFRGS).
Porto Alegre – RS, Brazil.
Email: marissa-godoy@uol.com.br

[4] PhD in Business Administration (UFRGS).
Professor at the Federal University of Rio Grande do Sul.
Porto Alegre – RS, Brazil.
E-mail: fernanda.reichert@ufrgs.br

ABSTRACT

The COVID-19 pandemic has been affecting health and the global economy in an unprecedented way. From the economic resilience approach, this study sought to analyze the impacts of the Covid-19 crisis on the employability of Brazilian mesoregions from 2019 to 2020. More specifically, we aimed to compare the most and least affected Brazilian mesoregions by the pandemic to find explanations based on their economic structures. For that, we used econometric indices of economic resistance, structural change, economic specialization, and economic diversification. In general, we identified that less resilient mesoregions tend to present a highly specialized and less diversified economic structure, with greater participation of public administration and industrial services of public utility activities. The most resilient mesoregions, however, tend to have higher participation in the manufacturing industry and services sector and moderate diversification. Regarding public policies to face the pandemic, federative units with better economic resilience had lower lethality rates.

Keywords: Resiliência Econômica. Choque. Crise. Pandemia da COVID-19.

INTRODUCTION

Regional economic resilience is a term imported from the physical sciences and ecology; it has come to be used as a heuristic tool to describe how regions deal with the different shocks that occur during their development trajectory (BOSCHMA, 2015; MARTIN; SUNLEY, 2015). The shocks can assume different natures and dimensions and can be of economic and technological nature, arising from a natural disaster or even a pandemic.

Since 2020, the world has been facing a new shock on a global scale: the COVID-19 pandemic, which has become one of the greatest health crises in history and ushered in a new cycle of economic recession (GONG et al., 2020). In order to reduce the risk of contagion from the virus, governments have implemented restrictive measures to limit the circulation of people, close borders, and restricted economic activities (MATTEDI et al., 2020). Given this concerning scenario, it was necessary to create countercyclical policies of financial compensation to mitigate the pandemic's cessionary effects and avoid business bankruptcy and mass unemployment. Nevertheless, most countries reached the end of 2020 in a situation of economic recession, as economic and social development indicators dropped (NICOLA et al., 2020). In Brazil, the pandemic weakened the labor market which had already been deteriorating in recent years (BRIDI, 2020).

Given the COVID-19 pandemic, from 2019 to 2020, according to data from the Annual Social Information Report of the Ministry of Labor and Employment (RAIS/MTE, 2021), there was a decrease of 480,316 jobs in Brazil, with commerce lost 1.81%, the service sector, 1.68%, and the public administration, 2.28%. Although the public administration has adhered to the telework modality and has certain employment stability guaranteed to employees (BRIDI, 2020), it has shown, since 2017, a decrease in the number of jobs, which may have its origin in the impacts arising from the Constitutional Amendment nº 95 (BRASIL, 2016), which limits the growth of public spending in the country, and due to the break of public tenders (BRASIL, 2021).

Cattle raising, vegetal extraction, hunting and fishing showed a loss of 0.52%. In the agricultural sector, several actions were carried out to ensure the normal supply of the domestic and international markets. Furthermore, according to Schneider et al. (2020), the competitiveness

of agribusiness thrives regardless of government and, even in the pandemic scenario, remains an important catalyst for the Brazilian economy.

Even so, some sectors that showed growth in 2020 were: mineral extraction (2.43%), the transformation industry (0.75%), public utility industrial services (2.44%) and civil construction (6.48%). In this regard, Costa (2020) points out that the crisis calls for the State to carry out sectoral policies, mainly in social and urban infrastructure. Spending in this sector is primarily responsible for promoting sustainable economic growth, in addition to generating positive externalities, which allow for raising the productivity of other investments and adding gains in scale and scope to various activities.

Crises have always existed and will likely continue, requiring planning and resilience to cope with these events (SCHNEIDER et al., 2020). Hence, the effects of the crisis highlight the importance of regional economic resilience as this kind of shock can vary in terms of impact and recovery in regional economies according to the characteristics of each region (i.e., their technological, institutional, and sectoral specificities and political treatment) and the idiosyncrasies of the shock (BALLAND et al., 2015; DI PIETRO et al., 2021; MARTIN; SUNLEY, 2015). Therefore, it is highly relevant to analyze the impacts of the economic crisis triggered by COVID-19 on the employability of Brazilian mesoregions between 2019 and 2020. More specifically, this study sought to compare the most and least affected Brazilian mesoregions by the pandemic to find explanations based on their economic structures.

Based on these analyses, this study aims to contribute to the literature in theoretical and methodological terms by associating the perspective of regional economic resilience to the COVID-19 shock through econometric indicators of economic resistance, structural change, economic specialization, and economic diversification calculated for the 137 Brazilian mesoregions. This study also has practical implications by presenting results that can guide public policies and organizational strategies to cope with the current crisis or shocks that may emerge in the future.

REGIONAL ECONOMIC RESILIENCE AND THE COVID-19 SHOCK

Sectoral economic composition is the most common element in research on regional economic resilience (BALLAND et al., 2015; DELGADO et al., 2015; ERAYDIN, 2016; HUNDT et al., 2019; PUDELKO et al., 2018). The structure analysis considers the type of externality accessed by

firms and the impact of economic concentration on how regions are affected by and respond to the shock. Location externalities are gains or costs acquired due to physical presence in a particular region (CRESPO, 2011); they can be divided into two main categories: specialization and diversification (MARSHALL, 1920; JACOBS, 1969).

The main externalities created by economic specialization are the reduction of monetary and transportation costs, ease of knowledge transmission, primarily tacitly, the presence of skilled labor and specialized suppliers, and the recognition and legitimization of the activity through political and institutional strength (HALBERT, 2012). However, high economic specialization can make regions more vulnerable to a shock and limit the possibilities of knowledge recombination, since the cognitive distance between economic actors tends to be lower (BOSCHMA, 2015; FRENKEN et al., 2007; KAHL; HUNDT, 2015).

Regarding the new COVID-19 crisis, as shown in a recent study by Ascani et al. (2020) in Italy, more economically specialized regions have a higher intensity of virus dissemination, given their dependence on tacit relationships that influence the creation of competitive advantages of the regions. In contrast, more economically diversified regions tend to have a broader range of possibilities for knowledge recombination due to multiple cross-fertilization possibilities (SEDITA et al., 2017), making them less vulnerable to sectoral shocks (KAHL; HUNDT, 2015).

Shocks, such as COVID-19, have different impacts according to the economic specificity of each sector; for instance, while pharmaceutical and health sciences-related sectors may show growth rates, sectors such as tourism are more affected by the reduced number of people circulating (ROMÃO, 2020). In this sense, countries and regions that rely on these activities naturally become more vulnerable to this type of crisis and experience more profound recessionary impacts and a slower recovery.

In addition to economic structure, the region's size can also influence resilience. Due to the cross-fertilization of knowledge, large and densely populated metropolitan regions tend to concentrate the most wealth and innovation generation (CAPELLO et al., 2015). Nonetheless, such regions tend to have greater sensitivity (i.e., less economic resilience), especially during economic and financial crises. Rural regions, in contrast, tend to present a lower growth rate, even during positive economic cycles, although they also present a greater resilience due to their structure

focused on the production of commodities (COURVISANOS et al., 2016; GIANNAKIS; BRUGGEMAN, 2020). This difference is called regional disequilibrium.

In Brazil, according to Cano (2008), regional disequilibrium is the result of the historical process of each region. Until 1930, the country was a large regional archipelago (OLIVEIRA, 2008) and the national economy was not integrated, so that each region followed its own economic path. Different in cultural, demographic, and economic terms (CANO, 2008), the Brazilian regions developed in different ways. This problem is attributed to the unequal evolution of capitalism in the inter-regional scope and the different relations of production and economic dynamism (CANO; GUIMARÃES NETO, 1986). Such inequalities were ratified by the 1929 Crisis, which, among other consequences, ended up showing the accelerated growth of the Southeast compared to other regions. At that time, São Paulo was responsible for facilitating the commercial articulation between different Brazilian regions, being recognized as the 'productive center' of the country (CANO, 2008) – a title it holds to this day. According to data from the Brazilian Institute of Geography and Statistics (IBGE) (2022), the Gross Domestic Product (GDP) of the State of São Paulo is R$ 2.3 trillion, which represents 31.2% of the national GDP.

Among the frameworks used in the literature for understanding regional economic resilience, Martin (2012) presented the most widely used model, dividing it into four main dimensions: vulnerability, resistance, robustness and recoverability. Vulnerability is the sensitivity or propensity of a region's firms and workers to different types of shock. Resistance refers to the degree of sensitivity of the region to the shock, and it begins with a fall in economic indicators and ends when these indicators reach their lowest point. Robustness refers to how the region recovers economically after the crisis, starting at the lowest point and ending when the economic indicator reaches values similar to those before its occurrence (HUNDT et al., 2019). Recoverability refers to the structural transformations that the region went through after facing a period of instability, that is, the extent and nature of recovery of the region's economy from shocks, and the nature of the path to which the region recovers.

The framework for understanding regional economic resilience has been reworked in order to present not only the dimensions but also the leading regional elements that can affect how

different crises are coped with (MARTIN, 2012; MARTIN; SUNLEY, 2015). The inherent elements refer to the pre-existing regional characteristics in the region that will determine the short- and medium-term effects of the shock on economic activity, including economic dynamism, economic openness, sectoral structure, export concentration, competitiveness/productivity, technological profile, political regime, and foreign relations. The adaptive elements indicate the major structural changes that occur due to the shock, such as productivity, sectorial structure, export orientation, technology, labor skills, business confidence, political regime, and foreign relations.

Notably, resilience does not only involve the endogenous characteristics of the region; many explanations for the ability to adapt and cope with crises originate from governance and public policy activities (EVANS; KARECHA, 2014). In this sense, analyzing the different policy actions adopted by countries and regions during the COVID-19 shock can demonstrate the impact between such actions and levels of vulnerability and economic recovery (GONG et al., 2020; HALE et al., 2020; PUNESCU; MÁTYUS, 2020).

METHODOLOGY

This study was conducted based on the calculation of the econometric indices of economic resistance, structural change, economic specialization, and economic diversification for the 137 Brazilian mesoregions. Among the dimensions proposed by Martin (2012), only resistance could be calculated since the shock is still ongoing, and it is impossible to predict its duration and effects on the historical trajectories of each region.

The data used refer to the formal employment relationships according to the National Classification of Economic Activities (CNAE) obtained from the Annual Social Information Report of the Ministry of Labor and Employment (RAIS/MTE)[1] for 2019 (before the shock) and 2020 (year in which the shock affected the economy). After collection, the data were treated and analyzed using the R software; the calculation of the indices and statistical analyses were performed using the Shapiro-Wilk and Kruskal-Wallis tests. The results of the indicators for the mesoregions were grouped by quartiles, and five groups were created for each index: very high, high, moderate, low, and very low.

1 Available at: https://bi.mte.gov.br/bgcaged/login.php. Accessed on 01 Dec. 2021.

The first indicator — regional economic sensitivity index (β_r), or economic resistance — compares the percentage change in the loss in employability in one region (E_r) to the loss in employability in a larger region (E_n). A β_r value below 1 indicates that the region is more resistant to shocks than the compared region. Its formula can be expressed as: $\beta_r = (\Delta E_r/E_r) / (\Delta E_n/E_n)$. Where:

$\Delta E_r/E_r$ = percentage of the change in employability;

r = mesoregion;

n = Brazil.

The calculation of a region's structural change is determined by the Lilien index (LILIEN, 1982). The higher the value of the index, the greater the reallocation of employability among sectors, demonstrating how quickly an economy changes, resists, and/or adapts (MUSSIDA; PASTORE, 2014). For the calculation, the following formula was used:

$$Lilien_r^t = [\sum_i \left(\frac{E_{ir}^t}{E_r^t}\right)(\Delta log E_{ir}^t - \Delta log E_r^t)^2]^{\frac{1}{2}}$$

Where:

E_{ir}^t = Employment in a sector "i" from a mesoregion "r" in a period "t";

E_r^t = Total employment in a mesoregion "r" in a period "t";

$\Delta log E_{ir}^t$= Employability of a sector "i" from a region "r" in a period "t";

$\Delta log E_r^t$ = Employment growth in region "r" in a period "t."

The dissimilarity index proposed by Krugman (1991) measures the degree of specialization of a given mesoregion "r" in relation to its national counterpart. The index ranges from 0 (no dissimilarity) to 2 (maximum dissimilarity). Its formula can be expressed as:

$$D_r^t = \sum_i \left|\left(\frac{E_{ir}^t}{E_r^T}\right) - \left(\frac{E_{in}^t}{E_n^T}\right)\right|$$

Where:

E_{ir}^{t} = Employment in a sector "i" from a mesoregion "r" in a period "t";

E_{r}^{T} = Total employment in a mesoregion "r" in a period "t";

E_{in}^{t}= Employment in a sector "i" from a larger region "n" (in this case, Brazil) in a period "t";

E_{n}^{T} = Total employment of a larger region "n" (in this case, Brazil) in a period "t."

The Herfindahl index was used to calculate economic diversification. The lower the value of this index, the greater the diversification of employability in the sectors of the economy within the analyzed region (ERAYDIN, 2016). The formula for the index is:

$$H_i = \sum_{s=1}^{s_i} \left(\frac{e_{si}}{e_i}\right)^2$$

Where:

S_i = Defines the number of economic activities in a region;

e_{si} = the employees in an "s" sector;

e_i = the total working population in the region.

PRESENTATION AND DISCUSSION OF THE RESULTS

This section is divided into two subsections. The first one shows the results of the calculated indicators and the second analyzes the results of the indicators, highlighting the Brazilian mesoregions most and least affected by the Covid-19 crisis.

RESULTS OF THE ECONOMETRIC INDICES FOR THE BRAZILIAN MESOREGIONS

Table 1 lists the main mesoregions identified with the highest and lowest calculated indicators, which will be analyzed in the following subsection.

Table 1 | Brazilian mesoregions with more expressive econometric indices between 2019 and 2020

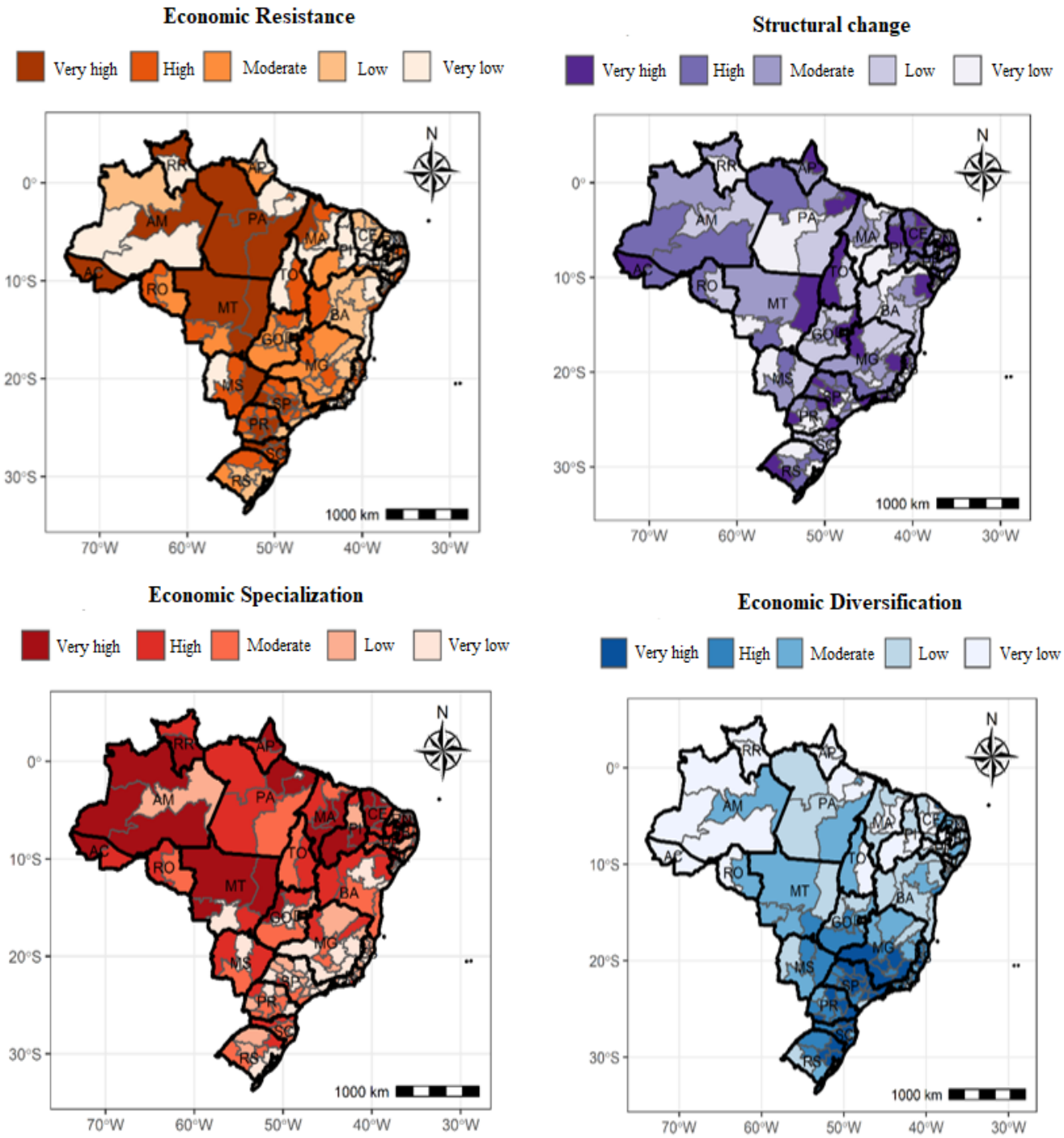
Indices	Interpretation	Mesoregions with more expressive indicators	Mesoregions with less expressive indicators
Index of economic resistance	The lower the index, the greater the resistance	Distrito Federal (-13.28), Vale do Acre (-5.87), Leste Sergipano (-5.08), Centro Oriental Paranaense (-4.85), and Grande Florianópolis (-3.42).	Northern Amapá (40.35), Marajó (25.32), Southwestern Amazonas (22.93), Southern Roraima (21.14), and Agreste Potiguar (12.16).
Lilien index	The higher the index, the greater the structural change	Northern-central Piauí (13.73), Norte Pioneiro Paranaense (5.39), Central Potiguar (5.08), Agreste Sergipano (4.91), and Sertão Sergipano (4.55).	São Francisco Pernambucano (0.16), Vale São-Franciscano da Bahia (0.19), Southwestern Paraná (0.23), Central Espírito Santo (0.24), and the Metropolitan area of Porto Alegre (0.31).
Krugman specialization index	The higher the index, the greater the specialization	Northern Amazonas (0.69), Southwestern Amazonas(0.68), Marajó (0.55), Southern Amazonas (0.55), and Borborema (0.55).	Metropolitan area of Curitiba (0.11), Metropolitan area of Porto Alegre (0.11), Central Goiás (0.12), Metropolitan area of Belo Horizonte (0.14), and Central Espírito Santo (0.15).
Herfindahl diversification index	The lower the index, the greater the diversification	Northern Santa Catarina (0.26), Northeastern Rio Grande do Sul (0.26), Campinas (0.26), Macro Metropolitan area of São Paulo (0.26), and Piracicaba (0.26).	Southwestern Amazonas (0.44), Northern Amazonas (0.43), Southern Amazonas (0.38), Borborema (0.37), and Sertão Alagoano (0.36).

Source: The authors based on the research data.

By calculating the regional economic sensitivity index (economic resistance) for the 137 Brazilian mesoregions from 2019 to 2020, we identified that the results ranged from -13.28 (very high resistance) to 40.35 (very low resistance). The Lilien index ranged from 0.16 (very low employability structural change) to 13.73 (very high employability structural change). Krugman's specialization index ranged from 0.11 (very low) to 0.69 (very high). Finally, for Herfindahl's diversification index, the results ranged from 0.26 (very high) to 0.44 (very low).

Figure 1 was created to better present the results of the econometric indices calculated and shows the indicators on a variation scale for each mesoregion analyzed. The intensity of the colors corresponds to the classification according to the quartile in which each mesoregion is found. The results are analyzed in the following subsection.

Figure 1 | Maps of the econometric indices for the Brazilian mesoregions



Source: The authors, based on the research data.

The data revealed the relationship between the economic resistance index and other metrics analyzed herein. The linear relationship between the resistance index and specialization (Krugman) and economic diversification (Herfindahl) indices is positive and significant. As for the structural change index (Lilien), there was no linear pattern.

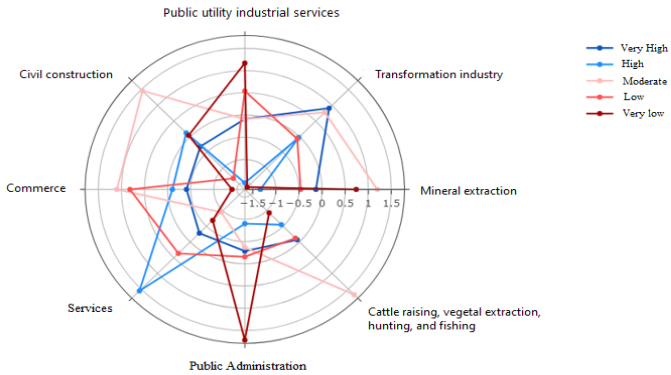
In order to verify whether the average differences between the mesoregions are statistically significant, we proceeded with the Kruskal-Wallis test due to the non-normality of the data. As independent variables, the metrics of diversification, specialization, and structural change were used. As a grouping variable, the quartile classification of economic strength was used. In addition to the value of the chi-square test and significance level, the value of the effect statistic is also reported as it allows the strength of the relationship established by the groups to be determined and reduces the biases imposed by the sample size in the significance calculation.

The Kruskal-Wallis test showed statistically significant differences in the clusters for the diversification metrics [χ^2 (4) = 35.1318; $p < 0.01$; $\eta^2(H) = 0.2358$] and economic specialization [χ^2 (4) = 27.1380; $p < 0.01$; $\eta^2(H) = 0.1753$]. In order to find in which of the clusters the difference is significant, we proceeded with Dunn's post-hoc analysis with Bonferroni adjustment for economic specialization and diversification. The results of the tests showed that the difference was only in the groups whose classification was considered "very low." Thus, one can note that poorly resistant mesoregions tend to present a more specialized and less diversified economic structure.

Still using the categories generated from the quartiles, the composition of the economic structure for each grouping is analyzed. In order to keep the data on the same scale, we proceeded with their standardization. During this process, the observations were subtracted from the mean and divided by the standard deviation of each variable. As a result, we have different variables in the same scale, whose mean is equal to 0 and the standard deviation is equal to 1.

The mesoregions that present greater resistance have proportionally greater participation in the transformation industry and the service sector in their sectorial composition than the other mesoregions, as shown in Figure 2.

Figure 2 | Sector composition by levels of economic strength



Source: The authors, based on the research data.

The mesoregions whose resistance was classified as “moderate” have higher participation in civil construction, commerce, agriculture and cattle raising, vegetal extraction, hunting, and fishing. The least resistant mesoregions were those with higher participation in public administration and public utility industrial services.

ANALYSIS OF THE BRAZILIAN MESOREGIONS MOST AND LEAST ECONOMICALLY AFFECTED BY COVID-19

When analyzing the calculated indices, our findings corroborate Bridi (2020), who identified that the COVID-19 pandemic affects all Brazilian regions, although not equally. Hence, mesoregions in the north and northeast presented higher unemployment rates and structural changes in employability in the analyzed period, resulting in a very low economic resistance compared to the rest of the country.

In this sense, regarding the mesoregions with lower resistance indices and, therefore, lower regional economic resistance, northern Amapá presented the worst economic resistance in the country, as well as very high specialization, very low diversification, and very high structural

change. According to RAIS/MTE (2021) data, from 2019 to 2020, the employability of the mesoregion decreased by about 30%, driven mainly by the decrease of roughly 48% of public administration jobs, which represented about 56% of the total jobs in the mesoregion in 2019, dropping to 42% in 2020.

The mesoregion of Marajó, located in Pará, showed the second worst economic resistance in the country, with very high specialization, very low diversification, and moderate structural change. The employability of the mesoregion, which covers 16 municipalities and 564,000 inhabitants, decreased by about 21% from 2019 to 2020 and, similar to the mesoregion analyzed earlier, was influenced by the decrease in public administration jobs; this activity has the largest share in the sectoral composition of the mesoregion. These data are in line with the results illustrated in Figure 2.

Southwestern Amazonas showed the third worst resistance in Brazil, with very high specialization, very low diversification, and high structural change. Nevertheless, it is important to note that the Central Amazonas showed very high resistance. This mesoregion includes the state capital and the Manaus Free Trade Zone, which gathers various large companies and concentrates 88.45% of the state's jobs. In the other municipalities of Amazonas, the economy is based on primary sectors, consisting of activities such as mineral extraction and agriculture, which explains the high specialization rates of the mesoregion with the third lowest resistance (RAIS/MTE, 2021).

Roraima is divided into two mesoregions: the north and the south. Although these areas have similarities regarding the specialization and diversification indices (the first very high and the second very low), they present a discrepancy in resistance, as the southern mesoregion showed very low resistance and the northern very high resistance. Such results are because the northern mesoregion includes the state capital (Boa Vista), which concentrates around 95% of the state's jobs and maintains its economic activities stable during the pandemic period, in addition to presenting a growth of almost 50% in civil construction in the same period (the main activity of the state's economic base). Southern Roraima, nonetheless, the fourth mesoregion with the least economic resistance in the country, is composed of seven municipalities and had an almost 20% drop in employability between 2019 and 2020; this was mainly a result of the decrease in public administration jobs (about 30%), which, in 2019, made up 65% of the mesoregion's workforce (RAIS/MTE, 2021).

The mesoregion of Agreste Potiguar in Rio Grande do Norte, the fifth mesoregion with the lowest economic resistance index in Brazil, also presented the characteristics of very high specialization, very low diversification, and moderate structural change. Although some other mesoregions in the state show moderate diversification and very low specialization, the resistance for the state was low and/or very low overall. These findings also stem from the decrease in public administration jobs, in addition to the restrictions on exports during 2020, which obtained a negative variation for the state of 13.7% compared to 2019 (MINISTÉRIO DA INDÚSTRIA, COMÉRCIO EXTERIOR E SERVIÇOS, 2021), and the decrease in tourism activities, especially in the eastern Potiguar. According to De Aquino and Nunes (2020), a large part of the economy of Rio Grande do Norte is concentrated in Grande Natal and in the localities that host the dynamic activities of oil and irrigated fruit farming (the main products exported by the state). Meanwhile, most Potiguar municipalities survive thanks to the income provided by social policies.

Regarding the mesoregions with the highest resistance to the COVID-19 shock, Distrito Federal presented the highest index in the country (i.e., the highest regional economic resistance), in addition to moderate specialization, low diversification, and moderate structural change. According to RAIS/MTE (2021) data, the federal capital obtained a positive variation of 16% in 2020 compared to 2019. Such a fact was influenced by a 70% growth in public administration jobs, representing 37% of the jobs in the mesoregion.

The Vale do Acre, Acre's mesoregion composed of 14 municipalities, including the capital (Rio Branco), showed the second highest resistance in the country, with a ~6% growth in employability from 2019 to 2020. The specialization index and structural change are high while the diversification is very low, a similar result to the state performance, which varied only in terms of specialization. The positive result for the mesoregion's resistance is due to the growth in jobs in activities such as public administration, services, trade, and construction. In addition, according to data from IBGE (2020), the economy of Acre is vegetal extraction, especially in wood and rubber, which moved about R$ 57 million in 2020.

The mesoregion of Leste Sergipano, in Sergipe State, obtained the third-highest resistance

in the country. We found that the region's specialization is very low, diversification is moderate, and the structural change in employability is low. The mesoregion showed a growth of 11.46% in jobs in 2020, while Sergipe State grew by 3.73%. In this aspect, it is noteworthy that the mesoregion is composed of the state capital, Aracaju, which concentrates 92.32% of the state's jobs and, therefore, corroborates the positive result of the mesoregion in evidence. In addition, the growth of industry and public administration activities in the mesoregion can also be observed.

The mesoregion Centro Oriental Paranaense, located in Paraná State, presented the fourth highest resistance in the country, with moderate specialization and diversification and a low structural change index, in line with the other mesoregions of the state, except for the metropolitan area of Curitiba. Such positive results for the resistance of the state's mesoregions, according to RAIS/MTE data (2021), are due to the growth of the industrial sector (3.03%), which, in 2020, corresponded to 21.39% of the state's jobs, to the civil construction sector, which presented a positive variation of 16.28%, and to agriculture and cattle raising (positive variation of 2.25%). Paraná varied almost 1% negatively in terms of employment in 2020, while the mesoregion Centro Oriental Paraná grew by 4.54%, mainly supported by industrial and civil construction activities. The state capital, Curitiba, however, experienced a more significant negative impact from the services and commerce sector, leading to a 3.93% reduction in jobs, contributing to the low resistance of the metropolitan area of Curitiba.

Finally, the mesoregion of Grande Florianópolis, in Santa Catarina, obtained the fifth highest resistance index in the country, a very low specialization of economic activities, moderate diversification, and a low structural change of employability. This mesoregion possesses, therefore, economic dynamism and stands out in the sectors of technology, tourism, services, and civil construction (GOVERNO DO ESTADO DE SANTA CATARINA, 2021; RAIS/MTE, 2021). Good economic resistance for all the mesoregions of Santa Catarina was also observed, which obtained a growth of 1.79% of jobs in 2020, the result of a good performance in all sectors of economic activity. In this perspective, it is pointed out that, according to the Brazilian Service of Support to Micro and Small Enterprises (SEBRAE), this state has maintained a pace of economic growth fostered by its export

potential and the technological condominiums and incubators as elements to stimulate the digital transformation of Santa Catarina's businesses (SEBRAE, 2019).

By analyzing the results of the econometric indices for the 137 Brazilian mesoregions with the statistical tests and sectoral composition by levels of economic resistance (Figure 2), we found a statistically significant difference for the mesoregions whose resistance was at the lowest quartile among the others. Such mesoregions tend to present a very specialized and less diversified economic structure, with higher participation of public administration and industrial services of public utility activities. The most resistant mesoregions, nonetheless, tend to have higher participation of the manufacturing industry and services and moderate diversification.

These findings corroborate Di Pietro et al. (2021), who reported that regions or countries with a set of elements that make them more vulnerable (e.g., weaker economic structures, decision-makers' ineptitude, and more backward technological routines), as they suffer most the impacts in the economic recovery, unlike those that traditionally have a high absorptive capacity and greater ease to explore and disseminate innovations, therefore recovering faster.

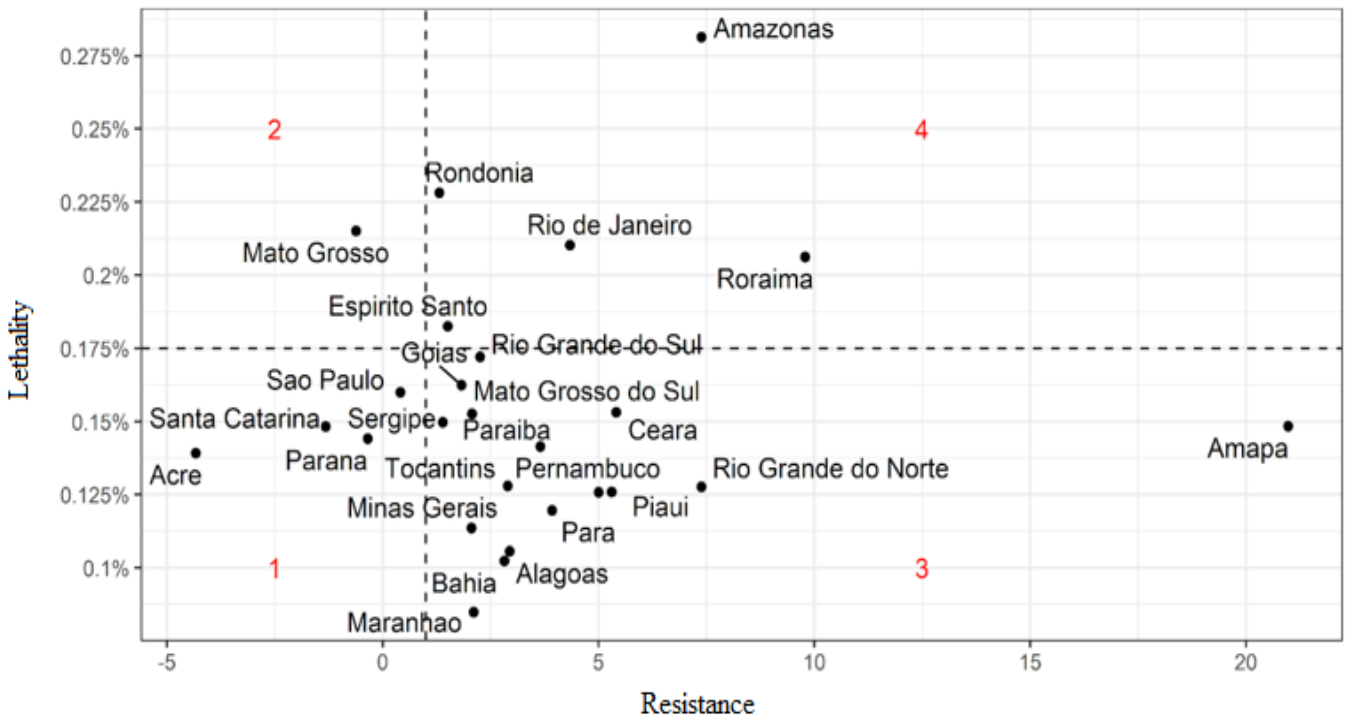
In this sense, the results converge to the importance of the industrial sector but not its specialization. In this regard, various studies have pointed to the importance of related variety for regional economic resilience (FARHAUER; KRÖLL, 2012; NEFFKE; HENNING; BOSCHMA, 2012; XIAO; BOSCHMA; ANDERSSON, 2018). This is understood as a range of economic sectors that share competencies and exchange knowledge (FRENKEN et al., 2007). Thus, regions with cohesive but diversified economic structures tend to have higher growth and productivity rates (FARHAUER; KRÖLL, 2012).

Additionally, the relationship between the economic performance of the states and the pandemic can be verified through a comparative analysis of the economic resistance index and lethality. The Brazilian federal government's choices were far from prioritizing a set of coordinated actions (BRASIL; CAPELLA; FERREIRA, 2021). This absence of integrated political strategies for effectively fighting the pandemic generated an uncoordinated action of states and municipalities and a lack of clear direction for the population (MAGALHÃES; CARDOSO, 2020). Therefore, differences were observed concerning the rigor of policies to confront the pandemic and lethality in Brazilian

states. Figure 3 presents such results, and it is possible to position the states in four main quadrants.

The quadrants were divided based on the average lethality value in the y-axis and the value of 1 for the resistance index since this value indicates the mesoregions with a higher or lower level of resistance compared to Brazil. In the first quadrant, we have the states with the highest resistance and lowest lethality: Acre, Paraná, and Santa Catarina. In the second quadrant, with higher resistance and higher lethality, is Mato Grosso. The third quadrant is composed of the states with lower resistance and lower lethality: such as Pará, Bahia, and Minas Gerais. The fourth quadrant indicates the states with the worst performance in terms of economic resistance and lethality: Amazonas, Roraima, Rio de Janeiro, and Rondônia.

Figure 3 | Relationship between the lethality of the COVID-19 pandemic and economic resistance per Brazilian state



Source: The authors based on the research data.

FINAL CONSIDERATIONS

This study contributes to consolidating the area in theoretical, methodological, and practical terms, given its innovation in analyzing, from the perspective of economic resilience, the impacts of the COVID-19 pandemic on the employability of the Brazilian mesoregions and associating the econometric indices of resistance, structural change, specialization, and economic diversification. Furthermore, no other study was found to have performed such analyses in the Brazilian context until this study was completed.

As a result, we found that the mesoregions with greater economic resistance and, consequently, greater regional economic resilience were Distrito Federal, Vale do Acre, Leste Sergipano, Centro Oriental Paranaense, and Grande Florianópolis. The mesoregions that showed less resistance were: Northern Amapá, Marajó, Southwestern Amazonas, Southern Roraima, and Agreste Potiguar.

When analyzing the results of the indices of resistance, structural change, specialization, and diversification for the 137 Brazilian mesoregions, together with the statistical tests and sectoral composition by levels of resistance, we identified that mesoregions with lower economic resistance tend to present a very specialized and less diversified economic structure, with higher participation of public administration activities and industrial services of public utility. However, the more resistant mesoregions tend to have a larger share of employment in the manufacturing and services sectors and moderate diversification. In this perspective, the results converge to the importance of the industrial sector but not its specialization.

The action of the regions occurred in a decentralized way. In this sense, the states that obtained higher resistance and lower lethality were Acre, Paraná, and Santa Catarina, while the ones with the worst performance were: Amazonas, Roraima, and Rio de Janeiro. Hence, given the observation that the pandemic of the new coronavirus has affected all Brazilian regions, but in different ways, it is highly relevant to highlight the economic structures and practices of the mesoregions less affected by the crisis evidenced in the study so they can serve as examples and encourage political and organizational strategies at the national and global levels. In this context, greater economic

diversification of the region and greater employability in sectors such as manufacturing and services seem to be determining factors for more expressive results in economic resilience. Similarly, a greater rigor of public policies for dealing with the pandemic associated with a lower lethality shows a positive impact on the economic resilience of the Brazilian federative units.

Notably, this study does not seek to exhaust the theme; on the contrary, it intends to foster the debate in the face of an everlasting pandemic scenario, with the emergence of new variants of the coronavirus and considering that the shock is still ongoing, it is not possible to predict its duration and the effects on the historical trajectories of each region. It is worth, therefore, highlighting this as a limitation of this study, which makes further research necessary to shed more light on the economic resilience of the mesoregions through the other dimensions of the model besides resistance (i.e., robustness and recoverability). Moreover, as a suggestion for future studies, we propose that researchers analyze the effects of the COVID-19 pandemic at the level of employability in relation to different social classes, color, sex, and level of education, in addition to extending the analysis to other countries and observing the phenomenon through the perspective of opening and closing of companies during the pandemic event. Lastly, the methodology adopted in this study can be useful to measure the impact of other crises that may emerge in the future.

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