Spatial distancing and regional economic resilience in the time of COVID-19: first impressions of an open discussion

Distanciamento espacial e resiliência econômica regional em tempos de COVID-19: primeiras impressões de uma discussão em aberto

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Abstract
Due to COVID-19, measures aimed at spatial distancing—the practice of avoiding physical proximity among people to prevent the spread of disease—likely negatively affected the level of employment and the generation of regional wealth because businesses in many sectors were closed. In this context, we analyzed spatial distancing data from a regional economic resilience perspective. Our only variable was a spatial distancing index collected for the Brazilian states from February 2020 until July 2020. We transformed the time series to guarantee stationarity, making it possible to calculate the Pearson linear correlation. The lowest coefficient was 0.85, which indicated a strong positive correlation among the series. Due to regional disparities, shocks affect distinct regions differently. However, our results showed that Brazilian states behave similarly to the spatial distancing index, suggesting that this index may not help us understand the determinants of the uneven regional economic resilience concerning the studied shock.
Keywords: resilience, covid-19, spatial distancing, shocks.

Resumo
Devido à COVID-19, medidas objetivando distanciamento espacial—prática de evitar proximidade física entre pessoas para conter a propagação de doenças—provavelmente afetaram negativamente o nível de emprego e a geração de riqueza regional, porque empresas em diversos setores foram fechadas. Nesse contexto, analisamos dados de distanciamento espacial sob uma ótica de resiliência econômica regional. Nossa única variável foi um índice de distanciamento espacial coletado para os estados brasileiros de fevereiro a julho de 2020. Transformamos as séries temporais para garantir a estacionariedade, possibilitando calcular a correlação linear de Pearson. O menor coeficiente encontrado foi 0,85, indicando correlação positiva forte entre as séries. Devido às disparidades regionais, choques afetam distintas regiões de formas diferentes. Todavia, nossos resultados mostraram que os estados brasileiros se comportam de modo semelhante em relação ao índice adotado, sugerindo que este índice pode não nos ajudar a compreender os determinantes da resiliência econômica regional considerando o choque estudado.
Palavras-chave: resiliência, covid-19, distanciamento espacial, choques.

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1 Introduction

Studies on regional economic resilience, conceived as the "ability of regions to resist and/or recover quickly from shocks" (Bristow & Healy, 2018, p. 266), have investigated why and how some regions return to or improve their performance following shocks, while others decline (Balland et al., 2015; Sensier et al., 2016). Although the study on resilience applied to the regional context emerged just over a decade ago because of the 2008 global financial crisis, there is already, in the research field of economic resilience, a reasonably extensive list of variables that are considered to determine the resilience capacity of regions (Miranda & Hoffmann, 2021). Furthermore, due to the characteristics of shocks, other variables emerge as possible determinants of regional economic resilience. In this case, an exploratory analysis can help us decide whether or not to proceed with testing a relationship between variables, as reported in this paper.

The discussion about resilience—whether in the context of inanimate and abstract beings or human beings—presupposes events with negative effects on the object or phenomenon under analysis, called shocks or disturbances. The literature highlights the existence of multiple resilience perspectives (equilibrium and evolutionary). In addition, shocks can be differentiated by types (e.g., economic, environmental, political). For example, a recent shock refers to the impact of COVID-19, an infectious disease first identified in China in December 2019 (WHO, 2020a) and considered a pandemic in March 2020 (WHO, 2020b).

Once there are different types of shocks, we believe that a range of promising variables influence the economic resilience of regions. Moreover, we assume there are determinants of regional economic resilience transversal to all or most types of shocks, while others are particularly applicable in specific contexts. As examples of transversal determinants, we consider the flexibility of labor relations (Balland et al., 2015), openness to new ideas and innovative practices (Clark et al., 2010), public spending (Raco & Street, 2012), and human capital (Di Caro, 2017; Eraydin, 2016a; Giannakis & Bruggeman, 2017a), evidenced in studies carried out from different types of shocks. Given their punctual presence in research, we suggest, as examples of determinants specific to certain types of shocks, the dispersion of the immigrant workforce among occupations (Lester & Nguyen, 2016), regional urbanization level (Brakman et al., 2015), and the existence of governance mechanisms (Rutherford & Holmes, 2008). As research on regional economic resilience involving shocks from pandemics is at an early stage (Appel & Hardaker, 2021; Gong et al., 2020), the question of what data can be used specifically for this type of shock is still open.

Given the COVID-19 pandemic, it could be assumed that measures aimed at increasing spatial distancing negatively influence the level of employment and the generation of regional wealth due to closed firms in different sectors and restrictions to access firms (Appel & Hardaker, 2021). Hence, this research aimed to analyze spatial distancing data from a regional economic resilience perspective. To accomplish that, we conducted a descriptive study based on the exploratory analysis of the time series of the spatial distancing index in Brazilian states from February to July 2020. We tabulated data from the InLoco (2020) website, which is widely used to address spatial distancing in Brazil (e.g., Barberia et al., 2021; Heck et al., 2021; Peixoto et al., 2020). The referred index makes it possible to assess people's movement patterns based on geolocation data collected from mobile devices, such as cell phones (Peixoto et al., 2020). The higher the index, the less the movement of people whose data is being collected.

The present paper provides empirical evidence that the spatial distancing variable, addressed in this study once it represents one of the main strategies suggested by health experts

to face COVID-19, may not be helpful in understanding the uneven regional economic resilience to a pandemic shock. In public policy, assessing regional economic resilience in the short term enables public agents' localized and targeted responses. A quick reaction contributes to the mitigation of the impacts and to a faster regional recovery, which leads us to explore potential determinants or predictors of regional economic resilience.

2 Theoretical framework

2.1 Resilience: a look at the state of the art

We carried out a systematic search to construct the initial foundation of the theoretical framework for the present study concerning two of the main academic databases (Zhu & Liu, 2020): Scopus and Web of Science (WoS). The string (sequence of characters) used was "regional resilience" or "regional economic resilience," also adopted in the research by Fröhlich and Hassink (2018). The search included title, abstract, keywords, as well as keyword-plus for WoS, and it considered articles published in journals in English, as it is the most used language in the scientific community (Oliveira et al., 2019), and from 2015 to 2020 to cover state of the art on the subject. After removing duplicates, the search carried out in mid-September 2020 resulted in 224 articles from both databases. Considering citations as a measure of influence (Zupic & Čater, 2015), articles with ten or more citations were selected, resulting in 61 papers. After reading the abstracts, titles, and keywords to verify the articles' eligibility for the topic, 17 were removed. Then, following the same criteria, we read all papers in full, removing one, resulting in 43 articles.

When it comes to regional economic resilience, multiple concepts can be adopted. According to Martin and Sunley (2015), resilience can be conceived from three perspectives: (i) engineering resilience; (ii) ecological, or (iii) adaptive. Engineering resilience refers to regional economic recovery, returning to the pre-shock growth path (Martin & Sunley, 2015), which can be measured by the speed through which a system returns to equilibrium (Modica & Reggiani, 2015). Ecological resilience is related to the ability of a region to absorb shocks, which results in a new equilibrium point (Martin & Sunley, 2015), measuring the elasticity of a system (Modica & Reggiani, 2015). Adaptive resilience, on the other hand, refers to the regional capacity for structural adaptation in response to or anticipation of shocks (Martin et al., 2016; Nyström, 2018). Some authors, such as Di Caro (2015), suggest that engineering and ecological resiliencies are part of the broader concept of adaptive resilience, related to the short term. In this sense, the same region could present more than one type of resilience, depending on the shock it suffered.

Regional economic resilience has four interrelated dimensions (Martin et al., 2016; Martin & Sunley, 2015): (i) risk or vulnerability; (ii) resistance; (iii) reorientation; and (iv) recovery. According to these authors, vulnerability is the sensitivity or propensity of a regional economy to be affected by shocks. Reorientation and reorganization refer to adjustment to shock. Recovery refers to the post-shock regional development path. Adopting the concept of engineering resilience or ecological resilience means emphasizing the dimensions of resistance and recovery while adopting the concept of adaptive resilience results in additionally understanding the mechanisms by which reorientation occurs (Evenhuis, 2017), which can be carried out from an evolutionary perspective (Boschma, 2015).

In the 43 selected articles, quantitative studies based on secondary sources predominate, with few studies taking a qualitative approach (Bellini et al., 2017; Hu & Hassink, 2017) or

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with a mixed-method approach (Bristow & Healy, 2015; Kakderi & Tasopoulou, 2017; van Grunsven & Hutchinson, 2016; Wink et al., 2016). In general, the studies used data available at the regional level, with rare studies based on data at the individual level (Doran & Fingleton, 2016; Obschonka et al., 2016). The European Union stands out as the most frequent locus of research, and the mainshock studied resulted from the 2008 crisis. In order to operationalize regional economic resilience, studies adopt variables related to employment (Di Caro, 2015; Eriksson & Hane-Weijman, 2017; Palaskas et al., 2015; Sedita et al., 2017), gross domestic product (GDP) (Eraydin, 2016b; Petrakos & Psycharis, 2016), or both (Brakman et al., 2015; Dokić et al., 2016; Sensier et al., 2016).

Some studies investigated the association between regional economic resilience and other variables. It is worth highlighting those studies that pointed out a positive association between regional economic resilience and diversification (Cainelli et al., 2019; Di Caro, 2017; Eraydin, 2016b; Eriksson & Hane-Weijman, 2017); sector specialization (Cuadrado-Roura & Maroto, 2016; Petrakos & Psycharis, 2016); commercial opening (Dokić et al., 2016); entrepreneurship (Eraydin, 2016b); human capital (Di Caro, 2017; Eraydin, 2016b; Giannakis & Bruggeman, 2017a); accessibility (related to infrastructure networks) (Östh et al., 2015); low financial constraints (Di Caro, 2017); government quality (Ezcurra & Rios, 2019); and dispersion of the immigrant workforce among occupations (Lester & Nguyen, 2016). Furthermore, concerning government actions in Turkey, Eraydin (2016a) showed how policies can be ineffective in increasing the capacity to respond to shocks.

Concerning urbanization, studies disagreed. Some studies presented a positive association between urbanization and regional economic resilience (Capello et al., 2015; Salvati, 2016), while others noted that there is not necessarily an association between these variables (Brakman et al., 2015; Giannakis & Bruggeman, 2017b). The study developed by Han and Goetz (2015) with counties in the United States of America found that counties adjacent to metropolitan areas suffered more severe impacts of shocks. Palaskas et al. (2015) showed an association between urbanization and unemployment in regions of Greece.

Despite theoretical-empirical advances, the findings on the determinants of regional economic resilience are still limited (Diodato & Weterings, 2015). Moreover, comprehending what determines regional economic resilience is complex, with several factors acting simultaneously (Boschma, 2015; Nyström, 2018). Nevertheless, it is worth highlighting one of the points on which the literature about the topic has converged, and that was adopted as a premise for carrying out the present study: economic resilience varies between regions (Di Caro, 2015; Hu & Hassink, 2017; Sedita et al., 2017; Tan et al., 2017; Ženka et al., 2017).

2.2 Resilience and COVID-19

Initially, to intersect regional economic resilience and COVID-19, we carried out a systematic search on WoS and Scopus. The survey was conducted in mid-September 2020 and repeated in early December of the same year by using the string: ("regional economic resilience" or "regional resilience") and ("COVID-19" or "SARS-CoV-2" or "2019-nCoV" or "n-CoV" or "coronavirus"). The use of the first section—the one that comes before the intersection connector—was justified in the previous subtopic. In turn, the second excerpt contains descriptors used in other systematic reviews on COVID-19 (Park et al., 2020; Wynants et al., 2020). The study by Gong et al. (2020) was the only one found and aimed to analyze characteristics of the COVID-19 crisis and its initial effects in China, enabling assessments of

short-term regional economic resilience. Hence, considering the present subtopic, we decided to carry out a narrative review.

COVID-19 constitutes a shock in the context of regional economic resilience due to the socioeconomic disturbances generated (Park et al., 2020; Wynants et al., 2020). According to Gong et al. (2020), the economic problems resulting from a pandemic arise for several reasons, such as (i) workforce absenteeism due to those who are sick and to those who need to take care of the sick, children, or the elderly; (ii) lockdown, aiming at contagion reduction; (iii) transfer of resources to the health sector, which may result in budget deficits in other sectors; and (iv) the interdependence and systemic nature of these crises, which may have negative cascade effects on part of the economy.

Shocks caused by pandemics are marked by public health actions to reduce contagion, especially in the absence of vaccines and viral drugs (Aquino et al., 2020). These actions include isolation, quarantine, spatial distancing, and community containment (Abel & McQueen, 2020; Wilder-Smith & Freedman, 2020). Isolation refers to the separation between sick people and uninfected people to protect the latter; quarantine aims to reduce potential transmission, involving restriction of people who may have been exposed to a contagious disease but have no symptoms, either because they have not been infected or because they are in the incubation period or because they are asymptomatic; spatial distancing aims to reduce interactions between people in a community, which may include infected people who have not been identified yet, and hence, have not been isolated; and last, an extreme case of spatial distancing is community containment, designed to reduce personal interactions in a community, city, or region, allowing only minimal interactions to guarantee vital supplies (Wilder-Smith & Freedman, 2020).

According to Massaro et al. (2018), public health actions based on restriction or limitation of social mobility effectively reduce the risk of contagion during a disease outbreak, but they can yield damaging effects on essential social functions. The review carried out by Aquino et al. (2020) suggests that spatial distancing is effective, especially when combined with the isolation of confirmed cases and quarantine of those who had contact with suspects or who were contaminated, and all this must be accompanied by social protection measures that guarantee action sustainability. Effective government support and regional industrial characteristics are expected to influence the long-term recovery of regions affected by the COVID-19 shock (Gong et al., 2020).

Gong et al. (2020) argue that (i) the proportion of infected people is directly correlated with the regional economic effects of COVID-19; and (ii) factors, such as population density, dependence on foreign trade, and disease severity (measured by the infection rate per million people) are negatively correlated with the short-term economic resilience of surveyed regions. Nevertheless, few studies have been developed on regional economic resilience with respect to the shock resulting from the COVID-19 pandemic (Appel & Hardaker, 2021; Gong et al., 2020).

3 Method

Descriptive research with a quantitative approach was developed, under a functionalist paradigm, based on secondary data. As a data collection strategy, database research was adopted through data systematization and analysis. The following subtopics present the unit of analysis, data source, and procedures adopted for collecting and analyzing data.

3.1 Unit of analysis

One of the challenges in regional economic resilience research is establishing the spatial scale of analysis (Sensier et al., 2016). Data series were collected for each of the Brazilian states (including the Federal District, a federative unit of Brazil, where the country's capital, Brasilia, is located). Although there is a discussion about the appropriateness of using regional limits like this for studying resilience, data availability justifies the scale adopted (Martin, 2012).

3.2 Data source and collection

The only variable used was the spatial distancing index, calculated by Inloco (2020), measuring the percentage of mobile devices that remained, in a given period, within a radius of 450 meters from a geographic point identified as a residence. The referred company reports having data from more than 60 million devices in Brazil, and, according to Peixoto et al. (2020), Inloco (2020) collects data through anonymous tracking, location, and movement of these devices. On the company's website, data on the samples by Brazilian states are not available.

We collected daily data from February 1, 2020, to July 31, 2020. Once these data came from third parties and were made available only through an interactive graph, data were tabulated individually by two researchers who then proceeded with verification of tabulation discrepancies and with corrections by consulting the Inloco (2020) website.

3.3 Data analysis

Univariate data analysis was performed with support from the R language, the integrated development environment RStudio, and the packages tseries (Trapletti & Hornik, 2019), ggplot2 (Wickham, 2016), and corrplot (Wei & Simko, 2017). After tabulating the data, missing values were initially checked out. Then, to view data in an exploratory way, graphs of the series were elaborated for the 26 states and the Federal District.

To allow comparison among the series and to avoid spurious correlations, data were transformed to ensure stationarity. In stationary time series, its properties do not depend on the time when the series is observed (Hyndman & Athanasopoulos, 2019). So, after being converted to a logarithmic scale, the series underwent differentiation and standardization (Hyndman & Athanasopoulos, 2019; Johansen, 2008).

In order to verify whether the series had become stationary, the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test was adopted by using the tseries package (Trapletti & Hornik, 2019). This test adopts the null hypothesis of data stationarity (Kwiatkowski et al., 1992). Once the transformation had already been carried out, the test sought not to reject the null hypothesis. For all series, p-values of 0.1 were obtained, resulting in weak stationarity, a condition sufficient to perform Pearson linear correlation. Hence, a Pearson correlation matrix was elaborated to the transformed series.
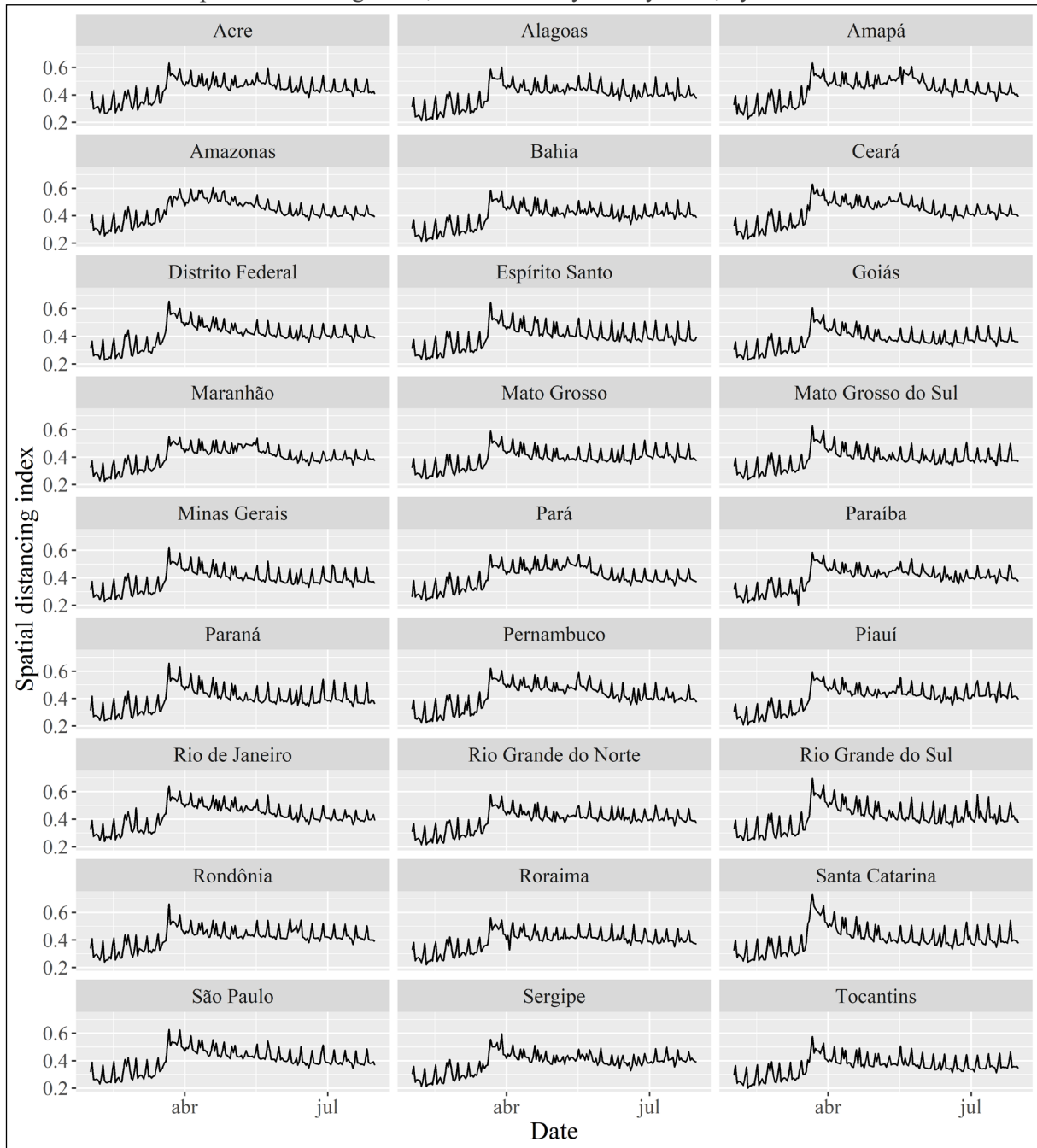
4 Results

The time series of the spatial distancing index for Brazilian states are illustrated in Figure 1. It is noted that the index's increase in mid-March 2020 is due to the implemented distancing measures. From April 2020 on, the index declined in all states but remained above the measurements of February and early March 2020.

Figure 1
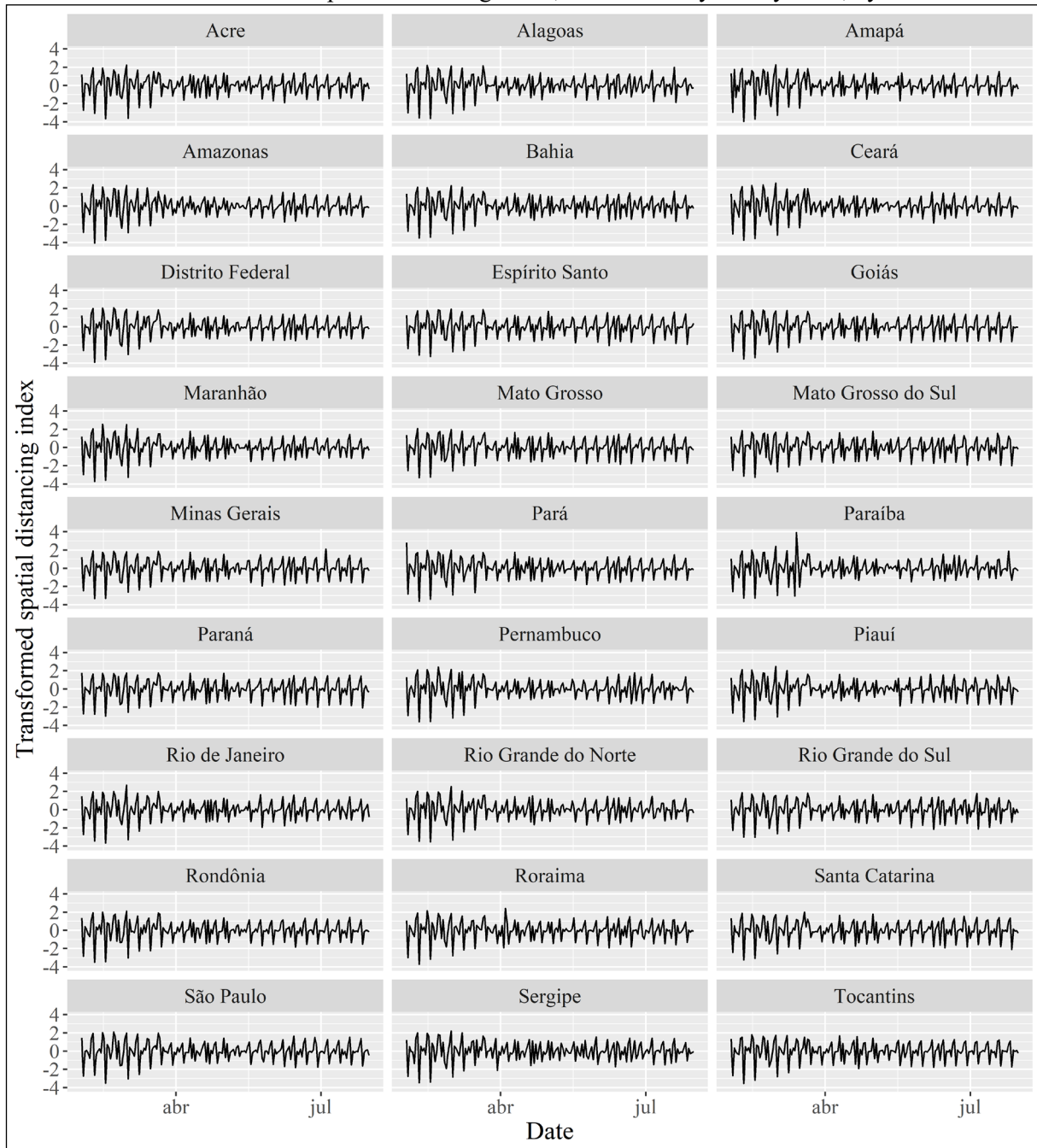Time series of the spatial distancing index, from February to July 2020, by state.

Source: Elaborated by the authors based on Inloco (2020).

In all states, the daily spatial distancing index was below 0.5 during at least 75% of the collection period. It is noteworthy that, in Brazil, the health and economic crisis is added to a political crisis and that the country is marked by 40% of its workers in the informal sector (IBGE, 2022), people in poverty, and homeless people, which can jeopardize the effectiveness of spatial distancing (Aquino et al., 2020).

Figure 2 shows the series after transformation to ensure stationarity.

Figure 2
Transformed time series of the spatial distancing index, from February to July 2020, by state.
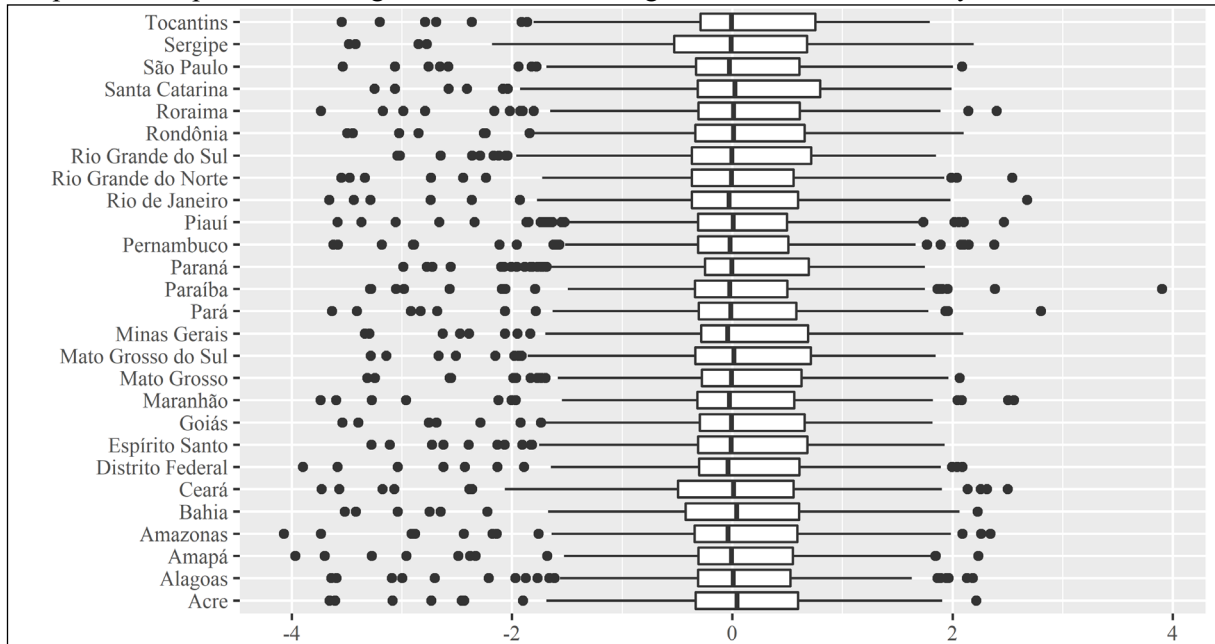

Source: Elaborated by the authors based on Inloco (2020).

Figure 3 illustrates the distribution of this index after transformation by using a boxplot. It is observed that all states behave similarly concerning spatial distancing.

Figure 3
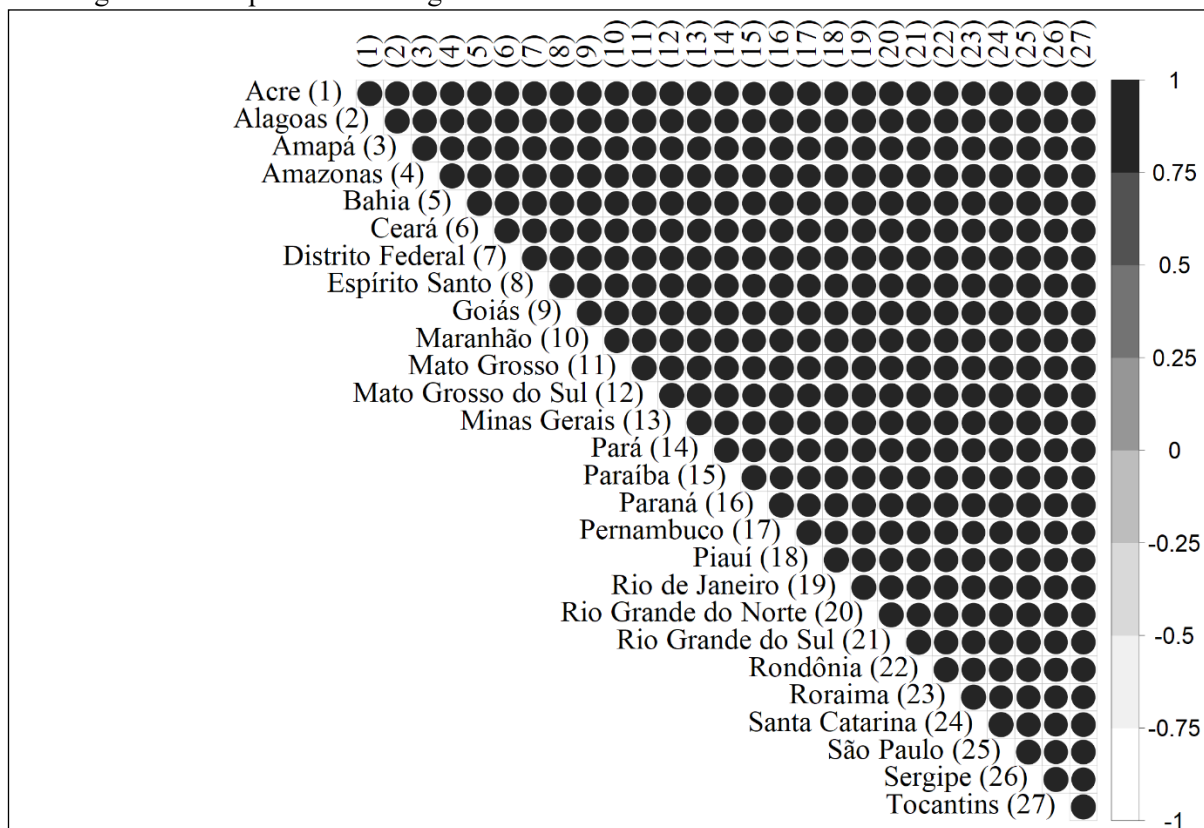Boxplot of the spatial distancing index transformed to guarantee series stationarity.

Source: Elaborated by the authors based on Inloco (2020).

The correlogram (Figure 4) shows the correlation matrix of the spatial distancing index, also after transformation. The lowest Pearson correlation coefficient was 0.85, indicating a strong positive correlation among the data (see Hyndman & Athanasopoulos, 2019).

Figure 4
Correlogram of the spatial distancing index for transformed series.

Source: Elaborated by the authors based on Inloco (2020).

Hence, it is observed that as spatial distancing in one state increases, it also tends to increase in the others. In sum, both graphs (Figures 3 and 4) point in the same direction: there are no considerable variations in the spatial distancing index, considering the regional level.

5 Discussion and conclusion

Many studies have investigated the association between factors and regional economic resilience. Part of these studies operationalized regional economic resilience through data regarding employment or production—usually through GDP (Brakman et al., 2015; Di Caro, 2015; Dokić et al., 2016; Eraydin, 2016b; Eriksson & Hane-Weijman, 2017; Palaskas et al., 2015; Petrakos & Psycharis, 2016; Sedita et al., 2017; Sensier et al., 2016). Sensier et al. (2016) point out that the operationalization of economic resilience through GDP or employment data shows moderately different results. Nevertheless, regardless of the variable used, the literature on the topic notes that regions are unevenly resilient to shocks (Brakman et al., 2015; Cuadrado-Roura & Maroto, 2016; Dokić et al., 2016; Sensier et al., 2016; Wink et al., 2016).

The transformed series of the spatial distancing index present a strong positive correlation, pointing out that the Brazilian federative units behave similarly concerning the spatial distancing index. These findings suggest that it may not be helpful to use such data in an analysis of association with a dependent variable, such as employment or GDP. The fact that a possible predictor varies does not make it sufficient to determine short-term regional economic resilience. Nevertheless, given the similar behavior among Brazilian regions, the

adopted index conflicts with the understanding that different regions respond differently to a shock. In this sense, the present paper contributes to the study of short-term regional economic resilience, related mainly to the dimensions of resistance and recovery and to the bounce-back perspective.

Tupy et al. (2021) presented how the Brazilian regions were distinctly affected by the financial crisis of 2008-2010 and the political-economic crisis of 2014-2015. Furthermore, in reaction to COVID-19, different actions and actors were mobilized in the country, again indicating a heterogeneous impact at the subnational level (Miranda et al., 2022). These findings are reinforced by the diverse unemployment levels presented by Brazil's states in 2020 (IBGE, 2020). Nonetheless, our results show equivalent behavior for the analyzed variable, which allows us to question this variable as a proxy for a determinant of regional economic resilience. Thus, we suggest the following for future studies:

Proposition: the restriction or limitation of mobility is not directly correlated with employment levels or GDP during a pandemic shock.

The perception of short-term regional economic resilience depends on how it is assessed (Sensier et al., 2016) and, from a theoretical point of view, the knowledge about the effectiveness of spatial isolation regarding containment of the pandemic is well established (Aquino et al., 2020; Malta et al., 2020; Massaro et al., 2018; Wilder-Smith & Freedman, 2020). Also, it is noteworthy that the gap explored in the present research refers to the discussion of a spatial distancing index as a possible determinant of the resilience capacity of regions regarding the side effects of the COVID-19 pandemic in the economic sphere and the short term.

Part of the studies on regional economic resilience dealt with the 2008-2010 economic crisis (e.g., Dokić et al., 2016; Giannakis & Bruggeman, 2017a; Hoffmann et al., 2017), and many methods and techniques used assume data availability in a wide time range (Miranda & Hoffmann, 2021). In the coming years, studies should focus on the global economic crisis resulting from the impacts of COVID-19 and other types of shocks. Also, for future studies, data regarding employment should be intersected with other data provided by government agencies, which may provide information on the regional economic resilience of Brazilian federative units. Moreover, qualitative analyses focused on the dimensions of reorientation will elucidate whether the process of regional economic resilience will be associated more with a return to the previous situation (bounce back) or with transformative resilience.

The main limitation of the present study is the impossibility of verifying the relationship between the spatial distancing index and other indicators due to methodological differences in database construction and strong correlations among series of the adopted spatial distancing index. However, this can be explored in future studies by using different databases or considering other regions/countries.

The present study contributes to the literature on regional economic resilience by (i) addressing a poorly researched locus, (ii) dealing with a recent crisis whose consequences are not yet fully understood, and (iii) yielding a proposition about the use of spatial distancing indices as a predictor for short-term regional economic resilience to the shock resulting from the COVID-19 pandemic. In practical terms, based on the yielded proposition, it is argued that the index does not constitute an effective substrate for elaborating short-term socio-economic policies aimed at increasing the economic resilience of regions most affected by the pandemic crisis. However, this argument does not minimize the role of the index as a guide for public health actions aimed at viral contagion reduction.

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