Global and local crises and regional disparities in Brazil in the XXI Century[1]

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Abstract

The paper deals with the effects of two crises in the Brazilian economy on regional concentration and income inequality. We consider the impact of The Great Recession of 2008 and a more intense national crisis starting in 2014. We calculate the yearly average latitude and longitude weighted by the regional share of the national GDP between 2002 and 2019 for agriculture, manufacturing, commerce & services, government, and the aggregate value added. We analyze the evolution of the average latitude and longitude over the period to check for changes in the average latitude and longitude after the occurrence of the highlighted events. We estimate per capita income convergence equations, introducing the effect of the two crises on the convergence process. Finally, we analyze the convergence pattern of skill intensity across regions, highlighting the impacts caused by the two shocks. We find that both shocks have affected the spatial distribution of productivity in terms of the level and the trend in the center of gravity. The crises also weakened the decreasing trend in regional inequality in per capita income and labor skill intensity.

Key-words: cycles and regional inequality; economic center of gravity; labor skill intensity

1. Introduction

Brazil is a country with a large territory and pronounced regional disparities (Azzoni and Haddad, 2018). The Northeast region is the poorest, hosting 28% of the population in the 2010 census. It per capita income was below half of the richest region, the Southeast, in the last two centuries (Barros, 2018). Regional disparities can manifest through concentration and inequality. The Southeast, which hosts the cities of São Paulo, Rio de Janeiro, and Belo Horizonte, produces over 55% of the national GDP. Figure 1 exhibits the share of the southeast region in national GDP. Although the regional concentration shows signs of diminution, the level is still worrying. The resource-oriented regions of the Center-West (grains) and the North (mining, and a free import zone in the city of Manaus) increased their shares in population and GDP in the last decades. As a result, there is a diminishing trend in regional disparities in the country in the XXI Century. This reduction has

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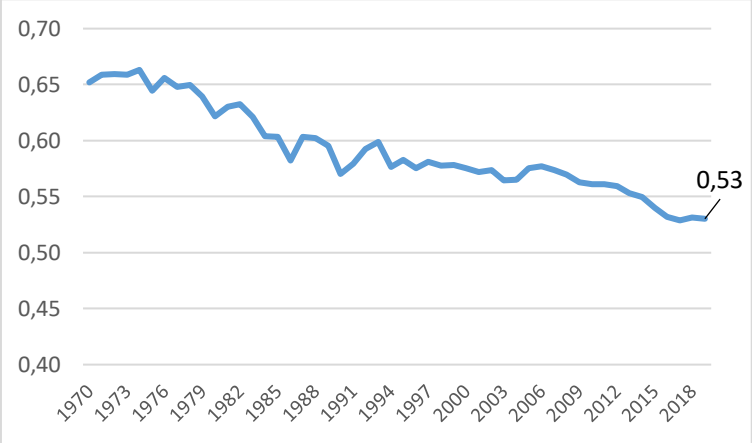
several possible explanations, including the establishment of a massive regional-blind policy of cash transferences to poor families (Silveira-Neto, 2010). As the country's economy received three successive shocks, namely the Great Recession (global), a political shock, and a public health shock, it is relevant to investigate how those shocks might have influenced these trends.

The relationship between macroeconomic performance and regional inequalities has interested authors for a long time. The classical works of Kuznets and Williamson indicate a possible U-shaped curve, with disparities increasing in the first phases of development, decreasing at intermediate levels, and increasing as the countries reach higher income levels (Azzoni, 2001). However, these approaches are not suitable for this investigation since the interest is on the effects of short-run movements of the national production on regional disparities. The Great Recession prompted interest in the topic, with several studies on its effects on particular economies. Cuadrado-Roura et al. (2016) analyze the impact of the economic crisis on the European economy, and how it has evidenced important disparities in economic weakness both between countries and between regions within countries. Royuela et al. (2019) find that the Great Recession is associated with an increase in inequality across OECD regions; Gbohoui et al. (2019) analyze European countries and find that regional inequality has intensified in the financial crisis; Odoardi and Muratore (2018) conclude that the regional economic gap between Italian regions has widened during the recession.

Figure 1 – Share of the Southeast region on the national GDP



Source: IBGE, Contas Regionais

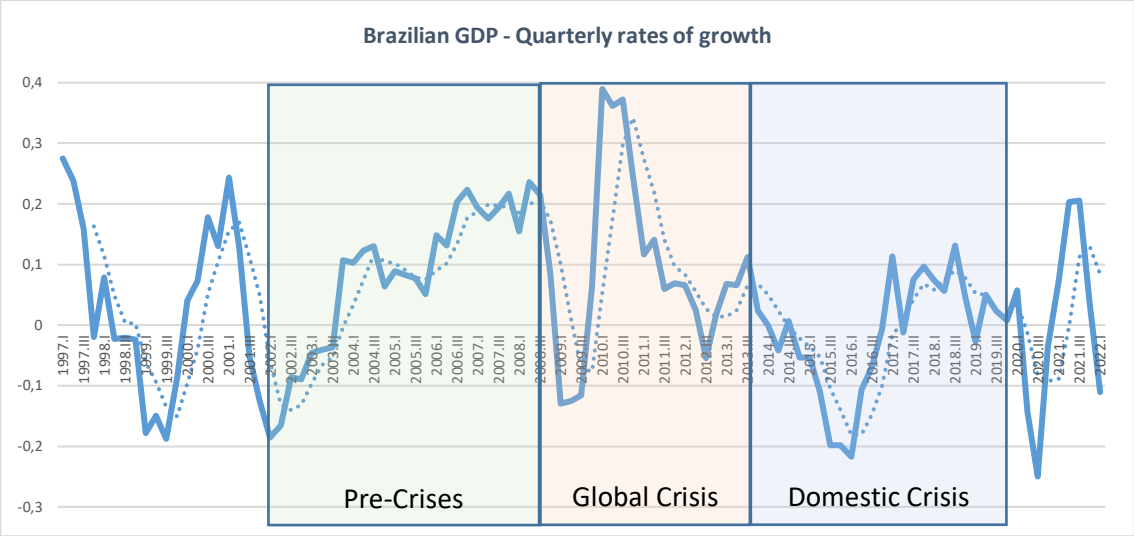
he Great Recession's effect on Brazil's regional inequality has not attracted researchers' attention so far. On the contrary, the synchronization of regional cycles has received more interest. Mejía-Reyes et al. (2019) use data on Mexican states to analyze the co-movements from 2000 to 2017. (Mejía-Reyes, 2019). Artis and Okubo (2010) identified regional business cycles for 12 UK regions and foundnd that the UK is cohesive with regional cycles for Japan, the USA, and Europe. The literature on the impact of national cycles on regional disparities is scarce. Azzoni (2001) presents the first analysis of the effects of national economic cycles on regional disparities in Brazil. He finds that periods with fast national economic growth are associated with increases in regional inequality, but the effects vanish some years later.

2. Data

Given the restrictions on data availability at a fine geographical scale, our period of study is 2002-2019. Based on the quarterly rates of growth of national GDP (Figure 1), we have defined three periods for the analysis: pre-crises, 2002-2008; global crisis, 2009-2013; and domestic crisis, 2014-2019. The Pre-Crises

period presented favorable growth rates of national GDP, associated with a booming global economy demanding commodities from Brazil (grains and mining products). However, the exports of manufactured products also experienced growth. The second period is associated with the Great Recession, whose effects hit the Brazilian economy with some delay, produced an immediate rebound, but left secondary shocks that affected the economy in the following quarters. A modest recovery showed up in late 2013, but then the weakening of the global economy, associated with a local political crisis[2], caused a more profound shock to the economy, one that lasted for almost two years and caused the economy to suffer. The Covid-19 pandemic landed on an already weak economy and had devastating effects probably worse than in other countries. Unfortunately, there is no available information at the regional level to extend our analysis to capture the impacts of this third shock.

Figure 1 – National rates of GDP growth



Source: IBGE, Contas Nacionais Trimestrais, Tab_Compl_CNT_1T22_cei_fin_2021, Prices of 1995.
https://www.ibge.gov.br/estatisticas/economicas/contas-nacionais/9300-contas-nacionais-trimestrais.html?=&t=downloads

We work with yearly data on the Per Capita GDP and labor skills of 510 functional regions, between 2002 and 2019, as displayed in Figure 2. These are functional regions defined by IBGE, the Brazilian official statistical office, based on access to consumption, job opportunities, health, education, and public services. [3]

3. Regional concentration – Economic Center of Gravity

To evaluate the concentration trend from a geographical perspective, we calculated the economic Center of Gravity, using data on the 539 geographical unities. This is simply the average of latitude and longitude, weighted by the shares of each region in the national GDP in each year. Let $k_{r,t}$ be the share of region *r* on national GDP in year *t*. The average latitude and longitude in each year are given by

$$Lat_{+,t} = \sum_r k_{r,t} * Lat_r \quad \text{and}$$

$$Long_{+,t} = \sum_r k_{r,t} * Long_r$$

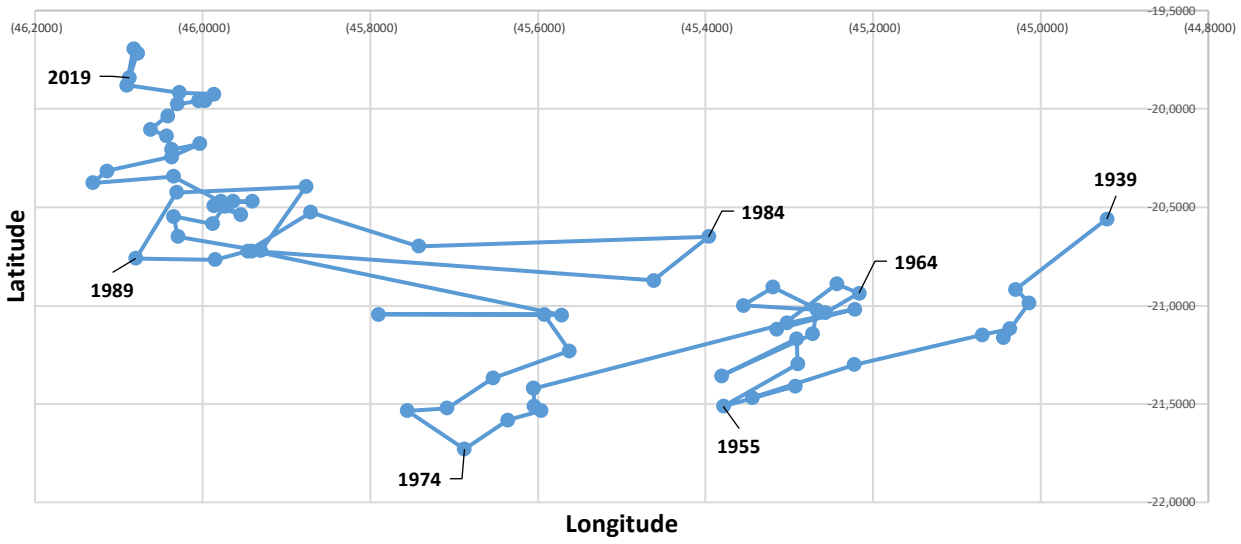
[2] Including the impeachment of the elected President

[3] IBGE (2021) Divisão Urbano-Regional do Brasil, 2nd Edition, https://biblioteca.ibge.gov.br/visualizacao/livros/liv101862.pdf

As Lat_r and $Long_r$ are constant, the average latitude and longitude are solely produced by the changes in $k_{r,t}$. Therefore, changes in $Lat_{+,t}$ reflect the combined changes in the shares of the regions in the national GDP over time. Of course, this measure for one specific year lacks any economic meaning. However, its change over time summarizes the joint movement of the regional economies. Any movement to the north of the original point, for example, indicates that the set of economies to the north of that point grew faster than the economies south of it. The movement of the point is the resultant of the growth of all regions simultaneously.

Figure 4 provides a long-term view of the movement of the center of gravity of the Brazilian economy. In this case, the geographical unities are the 27 states[4] since no information is available at a finer spatial disaggregation. The movement of the center of gravity of GDP reflects the spatial dynamics of the sectors that compose the national production. The transition westbound is a result of the explosive growth of agricultural activities in the center-west region, which is now a breadbasket of grains to feed the world, and by mining activities in the northern region. These two regions increased their share of population and GDP impressively in the last seven decades or so. At the same time, Brazil is facing strong deindustrialization negatively affecting the Southeast's traditional manufacturing centers southeast Finally, as with any other economy in the world, there is a tertiarization process in place, as commerce and services become the predominant activity in the country, reaching 72.7% in 2021[5]. This third aspect tends to favor the advanced economies in the southeast. In summary, over this 80-year period, there was a "march towards the west," with a slight north-bound component.

Figure 4 – Economic Center of Gravity, 1939-2019 (state-level information)



We repeated the exercise with data for 510 functional regions to have a finer view of more recent trends. Figure 5 shows the estimated centers of gravity of the national economy between 2002- and 2019, which are also displayed in the maps in Figure 6. The latter gives an idea of the geographical location, although, as mentioned before, the movement of the point is important, not its location. Their location within the Southeast region, in the state of Minas Gerais, is a consequence of the concentration already mentioned. The movement has a clear northwest orientation, but with nuances in different periods. From 2002 through

[4] Until 1970 there were only 20 states.
[5] https://sidra.ibge.gov.br/home/cnt

2005, it oscillated east-west, followed by a northbound movement up to 2014. From this point on, it clearly moved west, with a slight change northwards.

Figure 5 – Movement of the center of gravity – Aggregated Value Added

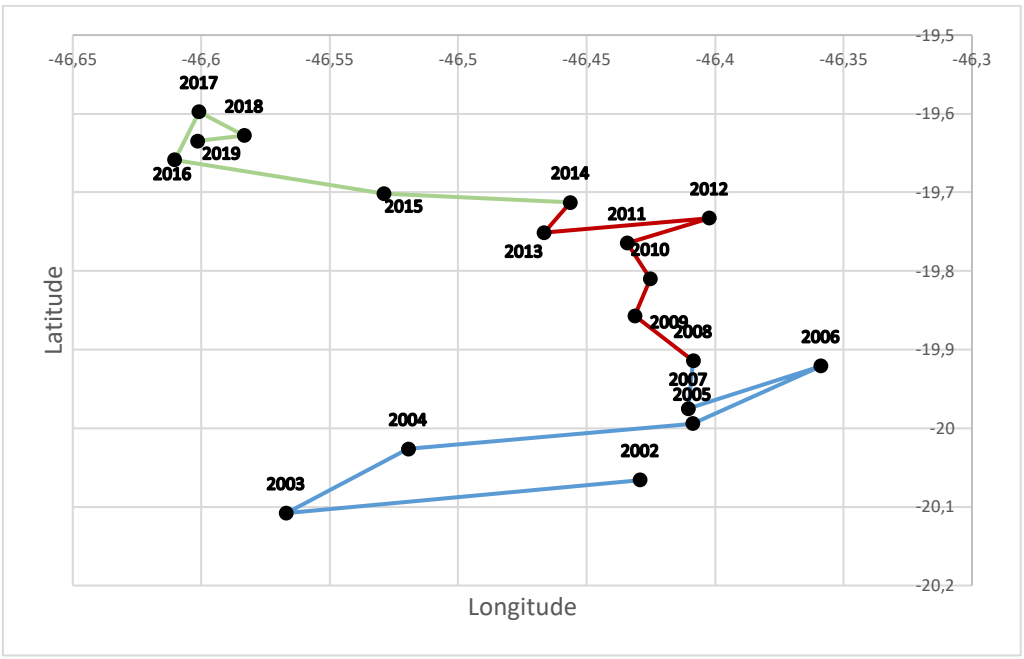
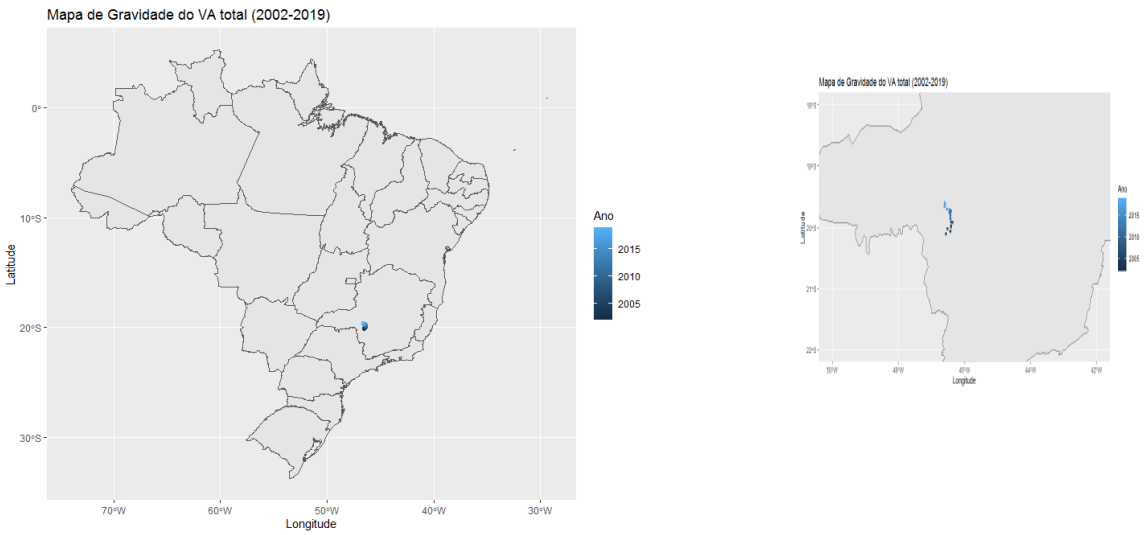
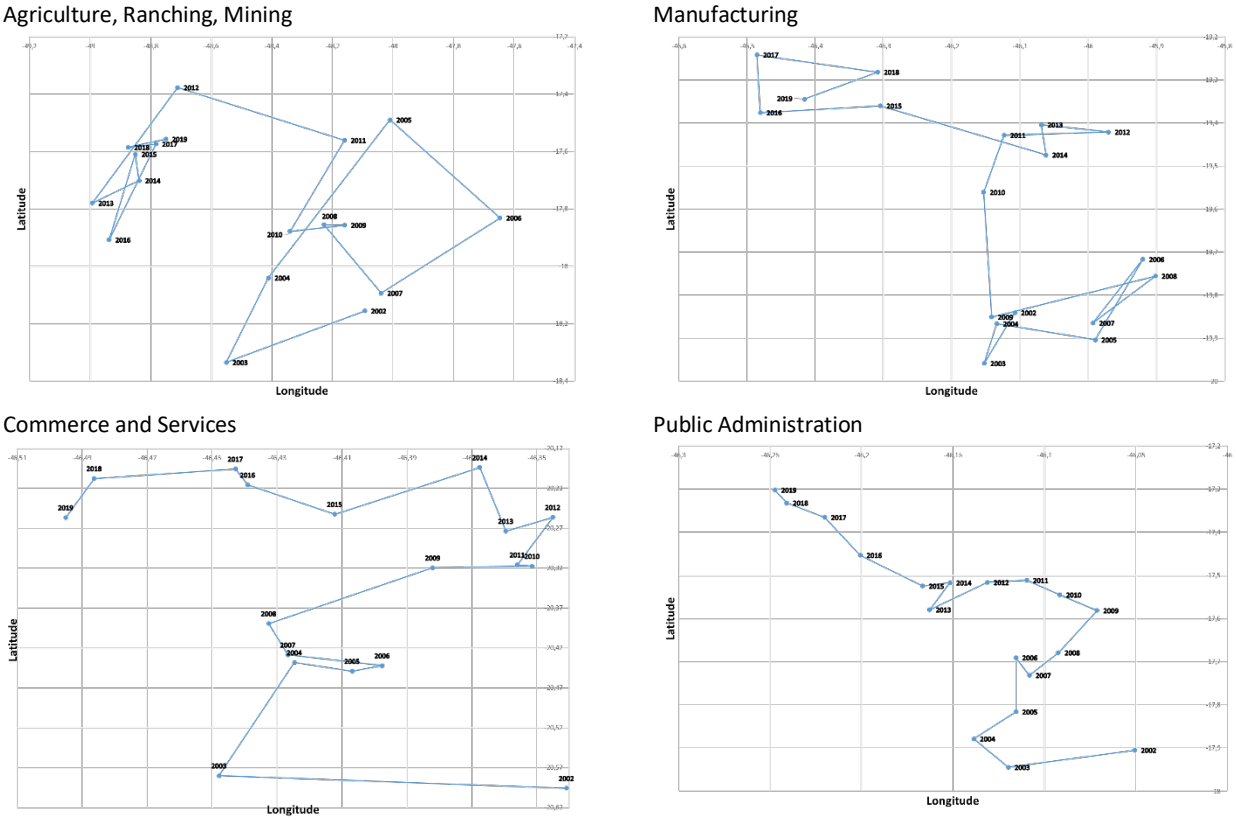


Figure 6 – Maps showing the location of the centers of gravity



To give an idea of the spatial movement of the sectors that compose the GDP, we have calculated the center of gravity for four macro sectors: agriculture and mining, manufacturing + electricity + construction, commerce + services, and government. The results presented in Figure 6 indicate that the northwest-bound movement is pervasive.

Figure 7 – Sectoral centers of gravity, 2002-2019



To check if the crises affected the observed trends in the center of gravity, we perform a simple econometric exercise, estimating the following equation:

$$Lat_t = \alpha + \beta Time + \gamma Long_t + \delta C + \theta(Time * C) \quad \text{and}$$

$$Long_t = \alpha + \beta Time + \gamma Lat_t + \delta C + \theta(Time * C)$$

The coefficients β indicate the trend in the movement of latitude (longitude). The dummy variable indicating the periods are $C = 0$ for the period before the crises, and $C = 1$ for the crises. Therefore, coefficient δ indicates the effect of the crisis on the latitude (longitude) level, and coefficient θ measures the effect of the crisis on the trend of these variables. In the latitude (longitude) equation, the longitude (latitude) is included. The idea is to capture the movement of one of the variables, given the level of the other.

Tables 1 and 2 exhibit the results. As the information in the figures presented above indicates, the latitude trend for the aggregate value added (Table 1) is positive and significant, meaning that the center of mass is moving north. The same conclusion holds for agriculture, and commerce & services. Manufacturing and public administration show no significant trend. For the aggregate value added, the crises had no significant impact either on the center of gravity level (δ) or on its trend (θ). Agriculture, ranching, and mining had the level affected with a negative sign, showing that the crises contributed to moving it south, although they affected the trend otherwise. The opposite happened for industry and commerce & services, and the public administration was not affected. As for the longitude, the trend for the aggregate value added is negative, showing a westbound movement of the center of gravity, replicated commerce & services and agriculture (in this case, only at the 10% significance level). The crises had no effect on levels and trend at the aggregate value-added level, but some sectors presented significant impacts, especially agriculture.

Table 1 – Latitude trends

Dependent Variable: Latitude

	All Sectors		Agriculture		Industry		Com & Services		Public Adm	
Longitude	0,28702	***	0,1570651	***	0,170013		0,2646139	***	0,019819	***
	0,0001		*0,037*		*0,023*		*0,036*		*0,015*	
Trend	0,0001918	***	0,0003969	***	0,000122		0,0001542	**	-0,0000496	
	0,0001		*0,0001*		*0,0002*		*0,00005*		*0,00009*	
Trend x Crisis (10-14)	-0,0011202		0,0012922	*	-0,002004	***	-0,0009275		-0,0017801	
	0,0008		*0,001*		*0,0014*		*0,0005*		*0,0004*	
Trend x Crisis (15-19)	-0,0006418		0,0028896	***	-0,0002372		-0,0014132	***	0,0000992	
	0,0004		*0,0009*		*0,002*		*0,0004*		*0,0005*	
Crisis (10-14)	0,0026394		-0,0027797	*	0,0043551	***	0,0020964		0,0040257	
	0,0019		*0,002*		*0,003*		*0,001*		*0,001*	
Crisis (15-19)	0,0016725		-0,0076638	***	-7,84E-06		0,0035511	***	-0,0007964	
	0,0012		*0,0026*		*0,0061*		*0,001*		*0,0015*	
Constant	-0,0039014		-0,0205348	**	-0,0139936	***	-0,0050178	***	-0,022567	***
	0,003		*0,004*		*0,001*		*0,002*		*0,0011*	
FE ind.	Yes		Sim		Sim		Sim		Sim	
# Obsv	9056		9056		9056		9056		9056	
R2	0,7433		0,7022		0,8868		0,7359		0,6644	
LogLik	38282,39		32588,32		29703,16		42452,52		39208,91	
AIC	-76552,79		-65164,64		-59394,33		-84893,04		-78405,83	
BIC	-76510,12		-65121,89		-59351,66		-84850,38		-78363,12	

Table 2 – Longitude trends

Dependent Variable: Longitude

	All Sectors		Agriculture		Industry		Com & Services		Public Adm	
Latitude	2,697128	***	3,74406	***	4,073933	***	2,876915	***	4,583951	***
	0,103		*0,505*		*0,409*		*0,208*		*1,066*	
Trend	-0,00075	***	-0,0012686	*	-0,0006767		-0,0006964	***	-0,000162	
	0,0002		*0,0006*		*0,0009*		*0,0002*		*0,0005*	
Trend x Crisis (10-14)	0,002186		-0,0093826	***	0,009263		0,0006433		-0,0156274	
	0,002		*0,003*		*0,005*		*0,001*		*0,0158*	
Trend x Crisis (15-19)	0,001286		-0,016494	**	0,0052311		0,0034401	**	0,0018153	
	0,0016		*0,007*		*0,012*		*0,0016*		*0,0052554*	
Crisis (10-14)	-0,00508		0,0209327	**	-0,02043		-0,0012071		0,0367698	
	0,005		*0,008*		*0,0148*		*0,003*		*0,037*	
Crisis (15-19)	-0,00326		0,0432149	**	-0,0127148		-0,0088074	**	-0,0063866	
	0,004		*0,0216*		*0,0344*		*0,003*		*0,015*	
Constant	-0,0039		0,0323549	*	0,0336017	***	0,0013976		0,0342166	
	0,002		*0,019*		*0,011*		*0,004*		*0,025*	
FE ind.	Sim		Sim		Sim		Sim		Sim	
# Obsv	9056		9056		9056		9056		9056	
R2	0,7433		0,7022		0,8868		0,7359		0,6643	

LogLik	28137,91	18032,21	15324,79	31650,18	14385,75
AIC	-56263,8	-36052,42	-30637,57	-63288,37	-28759,49

4. Geographical economic center of mass – GDP per capita convergence

The analysis of the center of gravity provides information on the regional concentration of economic activity and its trend. Another aspect of regional disparities is per capita income inequality. We have estimated equations to check if the regional convergence pattern has suffered any alterations after the crises. The first estimated equations is

$$\log Y_{r,t} - \log Y_{r,t-1} = \alpha + \beta Y_{r,t-1} + \gamma [Y_{r,t-1} * \mathrm{C}]$$

In which $Y_{r,t}$ is the per capita income of region *r* in year *t* and *C* is a crisis dummy variable (*C* = 1 for years pertaining to a crisis period, and *C* = 0 otherwise). The convergence coefficient in a non-crisis time is β, and in a crisis time (that is, when *C* = 1) is $(\beta + \gamma)$. It indicates if the convergence process was affect by the crisis, and how.

Table 3 presents the results. Figure 8 displays the estimated coefficients $(\beta + \gamma)$ in a visual way, to facilitate interpretation. The negative convergence coefficients indicate that regions with lower initial per capita income levels experienced faster growth over the period, therefore signalizing the existence of regional income convergence. This result coincides with several other studies on regional income convergence in Brazil, at different geographical scales (states, macro, meso, and micro-regions, and municipalities). In the second column, we introduce the effect of the Great Recession (Global crisis) and, in the third, the effect of the domestic crisis. As the estimated γ coefficients are positive and statistically significant, the results indicate that both crises reduced the convergence coefficient, with a slightly stronger effect for the global crisis.

Figure 8 – Convergence coefficients for different periods

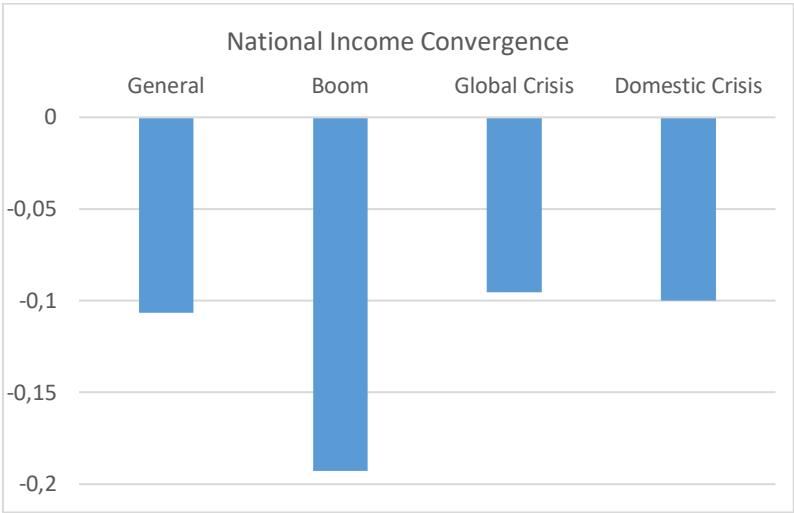


Table 3 – Income convergence

Var.	Per Capita GDP			
Initial Level (B)	-0,10671	***	-0,19293	***
	0,005		*0,013*	
B x Time(10-14)			0,020286	***
			0,001	

B x Time(15-19)		0,012333 ***
		0,001
FE ind	Yes	Yes
Phi	0,009	0,016
MV	34,680	18,257
Obsv	8670	8670
R2	0,055	0,0999
LogLik	8305,08	8514,88
AIC	-16608,16	-17023,8
BIC	-16601,09	-17002,6

5. Future disparities: labor skill intensity in manufacturing

The analyses above provide a good description of the events in recent years but are of less interest in providing insights on future movements. To provide an idea of future trends, we analyze the intensity of labor skills involved in production. Skill intensity is an indicator of competitiveness. Therefore, by analyzing the trend in this variable one grasps insights into the future of inequality. The analysis is restricted to manufacturing. Although this sector is not quantitatively relevant, its role in regional development is still crucial (Attiah, 2019; Moyo and Jeke, 2019).

The future depends on how competitive the region has been and, most importantly, how it will evolve in the future. Complex production processes involve hiring personnel for occupations requiring greater workers' skills. A given region may have an extensive set of people with a high level of education. Still, the companies located there might demand low-skilled workers, not taking advantage of existing resources. A relevant aspect of the region's future competitiveness, therefore, is the complexity of the activities it hosts, as revealed by the skills requirements of its workers. The basic assumption is that the more complex the occupations of their workers, the more competitive firms tend to be. Extending the idea to the regional level, the more complex the activities developed by the workers employed there, the greater the regional competitiveness.

The basic source of information is the RAIS - Annual Social Information Ratio of the Ministry of Economy, which indicates the occupation each employed worker is allocated, following the codification of the International Classification of Occupations. The complexity of each of the 2,708 occupations was defined by Maciente (2013), which adapted a study developed by the American Department of Labor (ONet) to the Brazilian reality. We have the list of skills and the intensity with which these skills are required in each occupation. Neves (2018) selected a subset of the 263 skills available and classified them into three groups: cognitive, social, and motor. Cognitive skills indicate logical reasoning, learning capacity, and oral and verbal mastery of the language; social skills focus on interpersonal relationships in the workplace; Motor skills reflect manual dexterity and various types of skills linked to strength and ability to perform strenuous work. The skill intensity of an occupation is an indicator of its complexity. Although competitiveness is more clearly related to cognitive and, to a lesser extent, social skills, motor skills are also relevant. Both the work of a floor cleaner and of an aircraft mechanic, for example, require motor skills, but the second is much more complex than the first, which is reflected in the indicator generated for the occupations.

As described in Neves et al. (2021), each occupation receives a value in the 0 – 1 numeric interval. Therefore, each occupied employee receives three scores, one for each type of skill. We average the numeric values of all regional workers to produce an indicator of the regional average skill level. Therefore, each region has three indicators per year (for cognitive, social, and motor skills. The analysis of the levels and the evolution of these indicators composes a comparative picture of the complexity of the activities developed and how this complexity varies over time. Regions with higher levels of complexity are, by assumption, in a better

competitive position. Regions with positive (negative) evolution of the complexity of occupations increase (decrease) this competitiveness compared to the other regions.

We have estimated convergence equations similar to the ones estimated with per capita GDP with the average skill-intensity indicators of the 510 regions. Table 4 displays the results. As the negative coefficients for the initial level of complexity indicate (first column in each skill group), there is absolute convergence of skill levels across regions in the period 2006-2019. Comparing the absolute value of the coefficients, the convergence process is more intense for the cognitive skills, while social and motor skills present similar convergence speeds. To facilitate the analysis, Figure 9 displays the resulting coefficient (sum of the pre-crises coefficient with the respective crisis coefficient). As the crises dummy coefficients are positive, the convergence process suffered with the shocks. Only the domestic crisis produced significant reduction in the speed of convergence in social skills. The cognitive and motor skills were affected more intensively by both crises, especially by the domestic crisis. In relative terms, the convergence process of motor skills was the most affected.

Considering these results on skill intensity convergence, it seems that the two crises that affected the Brazilian economy significantly hindered the convergence process of skill intensity across the country's regions. Thus, the regional equalization process of regional competitiveness seem to have suffered with the shocks, compromising the overall regional income convergence process. As complexity is a proxy for competitiveness, the two successive shocks might have hurt not only the present convergence process but also generated negative aspects for the future.

Figure 9 – Skill-intensity convergence - Manufacturing

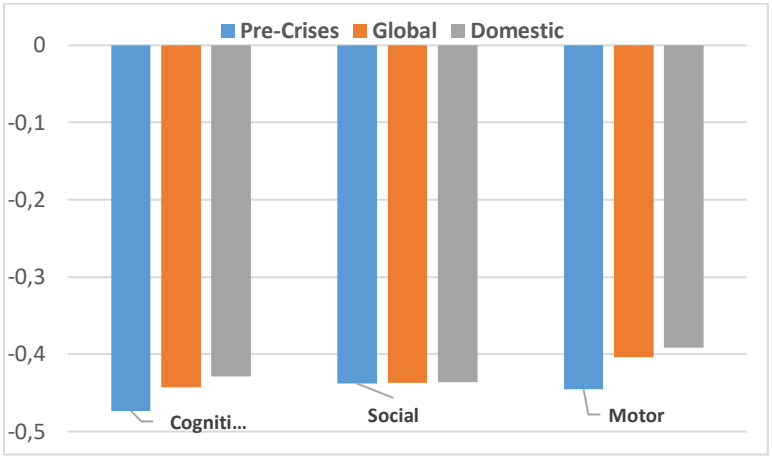


Table 4 – Skill-intensity convergence - Manufacturing

Var.	Cognitive Skills		Social Skills		Motor Skills	
Initial Level (B)	-0,35776 ***	-0,4730237 ***	-0,43698 ***	-0,4379 ***	-0,36683 ***	-0,44546 ***
	0,024	*0,03*	*0,0369*	*0,036*	*0,022*	*0,026*
B x Time(10-14)		0,0302532 ***		0,001369		0,042088 ***
		0,002		*0,0008*		*0,004*
B x Time(15-19)		0,0446541 ***		0,001978 ***		0,053719 ***
		0,003		*0,001*		*0,005*
FE ind	Sim	Sim	Sim	Sim	Sim	Sim
Phi	0,034	0,049	0,044	0,044	0,035	0,045
MV	8,838	6,109	6,813	6,793	8,563	6,637

Obsv	6565	6565	6565	6565	6565	6565
R2	0,197	0,2462	0,240	0,2404	0,203	0,2343
LogLik	15442,87	15649,2	20155,80	20159,47	12959,65	13092,75
AIC	-30883,74	-31292,41	-40309,61	-40322	-25917,31	-26179,5
BIC	-30876,95	-31272,04	-40302,82	-40292,6	-25910,52	-26159,1

6. Conclusions

In this paper, we analyzed the effects of the Great Recession and a national crisis on the regional income concentration and inequality in Brazil in the first two decades of the XXI Century.

We analyzed the evolution of the geographical center of mass of the national GDP and verified that the crises had no significant impact neither on the level of the geographical center of mass nor on its trend for the aggregate value added. Agriculture, ranching, and mining had the level affected with a negative sign, showing that the crises contributed to moving it south, although they affected the trend otherwise. The opposite happened for industry and commerce & services, and the public administration was not affected. As for the longitude, the crises had no effect on levels and trend at the aggregate value-added level, but some sectors presented significant impacts, especially agriculture. Thus, looking from this point of view, the crises produced minor effects.

The analysis of convergence was performed for the per capita GDP and for the labor skill intensity. In the case of per capita GDP, the results indicate that both crises reduced the convergence coefficient, with a slightly stronger effect for the global crisis. As for skill intensity, the two crises restricted the convergence process of skill intensity across the country's regions.

In summary, our results indicate that the convergence process that was in march in Brazil has suffered from the crises. The results on skill intensity are more worrying, as it indicates that the regional competitiveness equalization process has stalled. As complexity is a proxy for competitiveness, the two successive shocks might have hurt not only the present convergence process but also generated negative aspects for the future.

Looking at the future, words of concern are called for. Each crisis had its impact estimated individually, regardless of the other. Unfortunately, data limitations precluded the incorporation of the Covid-19 pandemic shock. The conclusion that the domestic crises that succeeded in time the Great Recession had larger impacts, in general, might be caused by the residual effect of the former. As the Covid-19 shock resulted in a third successive massive blow on an already feeble economy, the combined effects might be much stronger.

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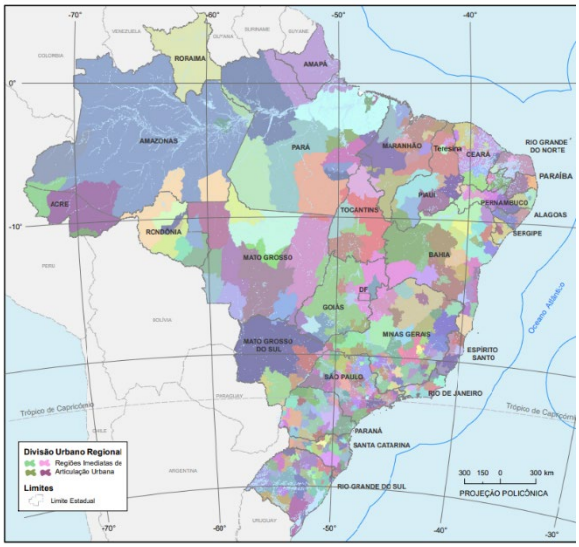
Appendix

Regions considered in the study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ARGENTINA
URUGUAY
RORAIMA
AMAPÁ
AMAZONAS
PARÁ
MARANHÃO
Teresina
CEARÁ
RIO GRANDE DO NORTE
PARAÍBA
PIAUÍ
PERNAMBUCO
ALAGOAS
SERGIPE
ACRE
TOCANTINS
RONDÔNIA
MATO GROSSO
BAHIA
DF
GOIÁS
MINAS GERAIS
MATO GROSSO DO SUL
ESPÍRITO SANTO
SÃO PAULO
RIO DE JANEIRO
PARANÁ
SANTA CATARINA
RIO GRANDE DO SUL
Oceano Atlântico
Trópico de Capricórnio
Trópico de Capricórnio
Divisão Urbano Regional
Regiões Imediatas de
Articulação Urbana
Limites
Limite Estadual
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PROJEÇÃO POLICÔNICA