Understanding Regional Development Traps and the Role of Local Capabilities: Evidence from Brazilian Regions

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Abstract

One of the central topics in economic geography is understanding why some regions grow faster while others struggle to sustain economic prosperity and well-being. Studies on regional performance indicate persistent variations in economic growth, productivity, employment, and innovation. In Europe, research has identified "development clubs", where regions experience divergent growth trajectories, with middle-income regions often facing stagnation. A similar pattern is observed in developing countries, where some regions achieve sustained growth while others remain trapped in low or middle-income stagnation. The notion of middle-income traps at the national level describes economies that transition from low- to middle-income but fail to progress further. When applied to subnational regions, this concept requires adaptations, as developing regions are often trapped at lower GDP per capita levels than their European counterparts. These traps manifest through long-term income decline, weak productivity gains, and employment stagnation. Moreover, policy efforts tend to focus on dynamic regions, neglecting those at risk.

This paper introduces the Regional Development Trap Index (RDT) for Brazil, adapting the development trap framework to subnational regions. Following Diemer et al. (2022), we construct a synthetic indicator of regional economic dynamism, considering productivity, employment, and income trends over time. Our findings reveal significant regional disparities, shaped by historical, structural, and institutional factors. The study covers a period of economic growth (2002–2014) followed by crisis and stagnation (2014–2020), demonstrating uneven regional impacts.

Results show that highly industrialized regions are at high risk of falling into development traps, while low-income areas also face significant risks. The geographic concentration of these risks suggests spatial dependence on regional economic stagnation. Between 2014 and 2022, shifts in regions most vulnerable to development traps indicate a procyclical behavior influenced by economic downturns. Notably, central Brazilian regions, major agricultural exporters, showed resilience due to their integration into global commodity markets. Their economic performance remained stable despite national economic slowdowns, reducing their exposure to development traps. In conclusion, the risk of regional development traps in Brazil is driven by economic, social, and institutional factors, deeply tied to historical path dependencies. Addressing these challenges requires a comprehensive understanding of the structural determinants shaping regional trajectories, paving the way for targeted policies to mitigate long-term stagnation risks.

Keywords: geography of innovation; economic geography; regional development trap; regional growth

JEL code: R11; R12; O18

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Introduction and brief theoretical remarks

A central theme of economic geography is understanding the varying growth trajectories of regions. Scholars have long sought to explain why some regions grow faster than others, why some struggle to achieve higher growth rates, and why significant disparities persist in their levels of economic prosperity and well-being (Diemer et al. 2022; Crescenzi et al. 2023; Dunford e Smith 2000). A growing body of literature on regional performance indicators highlights persistent variation, not only in the levels of performance, but also in the trajectory and frequency of changes in such indicators.

Previous studies, primarily applied to European regions, suggest the existence of "development clubs", wherein regions exhibit deep disparities in income, employment, industrial composition, education, productivity, innovation, urbanization, and demography. These disparities are often attributed to long-term economic stagnation processes that have detrimental effects on regional dynamics. For example, in Europe, many middle-income regions experienced prolonged periods of low growth, weak productivity gains, low job creation, or even job losses, some of which involved previously wealthy regions, pushing them into the middle-income category (Diemer et al. 2022).

In the case of Brazil, the second half of the twentieth century saw the country transition from a low-income to a middle-income nation in the global context. However, this growth was interrupted by the crisis of the late 1970s, during which Brazil, alongside other emerging economies, faced severe macroeconomic imbalances that persisted for the following two decades (Canuto, Dinh, and Ayn here 2024). This national trajectory, both during the growth phase and the subsequent crisis, did not unfold uniformly across space. Instead, it exacerbated regional disparities, with the North and Northeast lagging behind the rest of the country, especially in relation to São Paulo and the Southeast as a whole.

Carrying the burden of its historical challenges, Brazil's economy regained growth capacity from the 2000s onwards. Economic expansion, coupled with conditional cash transfer policies, contributed to reducing poverty and inequality, both within individuals and across regions (Fernandes and Pereira 2024). However, these advancements proved insufficient to elevate the country to high-income status or substantially reduce regional inequalities. This stagnation can largely be attributed to the persistence of structural issues within the Brazilian economy, which have kept it trapped in what is widely known as the "Middle-Income Trap".

The concept of middle-income traps in developing countries refers to economies that have transitioned successfully from low- to middle-income status but subsequently experienced a prolonged stagnation in growth. These traps have been linked to the inability to drive continuous productivity increases and to shift workers into more knowledge- and technology-intensive (i.e., more complex) sectors (Bianchi et al. 2024; Hidalgo 2021).

For regions within developing countries, this problem is more complex. As a populous, continental middle-income country with marked regional inequalities, Brazil presents a particularly challenging case. Some regions have demonstrated a strong capacity for income growth, job creation, productivity improvement, and even innovation. However, other regions have faced stagnation, with low-income growth and significant job losses, particularly in manufacturing. National-level studies

suggest that such regions may be trapped in long-term economic stagnation, potentially experiencing both low- and middle-income traps (Im e Rosenblatt 2013; Radosevic e Yoruk 2018).

Despite these insights, the application of country-level analyses and indicators to subnational areas requires substantial conceptual and methodological adjustments. Even studies focused on European regions demand modifications to address the specific characteristics of developing countries. For instance, European regions tend to be caught at considerably higher levels of gross domestic product (GDP) per capita than their counterparts in developing countries (Diemer et al., 2022).

In this context, the aim of this paper is to introduce a Regional Development Trap index for a developing country like Brazil, addressing a significant gap in the literature through a more nuanced regional analysis. First, we define the concept of the regional development trap, highlighting how some regions have reached middle-income status but remain stagnant, while others continue to be trapped in low-income conditions. Building on this, and following Diemer et al. (2022), we apply a synthetic indicator to assess regional dynamism in terms of economic, productivity, and employment performance relative to recent trends. This approach allows us to pinpoint regions in Brazil at significant risk of entrapment between 2005 and 2020 and to examine the key factors that differentiate them.

Therefore, this paper contributes to the literature on regional economic dynamics by developing an index tailored to identifying regional development traps in a developing country context. While previous studies have largely focused on European regions, our approach adapts and refines these frameworks to account for the structural and institutional specificities of Brazil. By constructing a synthetic indicator that captures regional economic, productivity, and employment trends, we provide a systematic method for assessing the risk of entrapment in both low- and middle-income situations. This allows for a more granular understanding of the persistence of regional disparities and the factors driving stagnation, offering insights that are critical for designing targeted policy interventions

The paper proceeds as follows. The next section reviews the related literature on regional development traps and the dynamics of economic growth. Section 3 describes the data, and the measures used to construct the Regional Development Trap index. In Section 4, we present and discuss our findings, highlighting the regional variations and the factors contributing to the trap. The final section offers a conclusion.

Methodology

The aim of this study is to identify Brazilian regions that are either already in a development trap or at significant short-term risk of falling into one. This requires distinguishing between a level indicator and a flow (growth) indicator and analytically separating the structure from the performance of the regions. Although these two categories are historically interconnected, it is only through a persistent difference in growth rates that the trajectory of one region diverges from others.

With this distinction in mind, it is essential to define the objective parameters that classify a region as being “caught in a trap”. Im and Rosenblatt (2013) note that this definition can be made in either absolute or relative terms, with each approach yielding different conclusions at the country level.

A *relative* approach implies that the “target” or wealthier region is on the move. In other words, for a poorer region to catch up to the per capita output level of a wealthier region, it must consistently grow at a rate higher than that of the wealthier region. Even if, over the course of a decade, it reaches the same per capita level that the wealthier region had at the start, the poorer region would still not have overcome its poverty status if it grew at the same rate or slower than the wealthier region. Conversely, an absolute threshold or “fixed target” would disregard growth rate differentials, which could lead to greater regional disparities. In this case, a poorer region could surpass the income threshold that classifies it as poor but remain significantly distant from the wealthier region.

In this work, we opted for an intermediate method of classification based on a hierarchical cluster algorithm of the per capita product levels. This allows consistent and robust limits to intertemporal changes.

Whatever the parameters for classifying regions into income categories (poor, middle-income, high-income, etc.), what defines a trap position is the dynamic capacity of the regional context. Therefore, the central object of this work is the reproduction of an indicator based on the growth of variables selected to reflect in terms of "risk" the potential of a region to be or be trapped in a development trap. In turn, the indicator was also transformed into a categorical variable through the same hierarchical cluster algorithm. These procedures are detailed in the following subsections.

Data

The dataset used in this study was constructed using data from three sources: the Annual Report of Social Information (RAIS), the Brazilian Institute of Geography and Statistics (IBGE), and the Institute of Applied Economic Research (IPEA).

First, we used data from RAIS compiled by the Ministry of Labor and Employment (MTE) to derive variables related to formal employment, including the number of employment and the employment per capita. These variables are essential for understanding labor market dynamics and regional variations in formal employment over time. Second, we used data from IBGE, which provided socioeconomic data such as gross domestic product (GDP) per capita at constant 2010 prices and demographic data. These indicators are crucial for assessing economic performance and income levels across different regions, enabling a comparative analysis of regional development trajectories.

Lastly, we incorporated data from IPEA to complement our analysis, focusing on regional economic complexity, infrastructure, and other macroeconomic indicators. These additional data helped contextualize the growth patterns and structural changes within Brazil’s regions.

The dataset spans the period from 1999 to 2020. The calculation of growth rates with a 5-year lag resulted in the loss of the first five observations, while one additional observation was lost due to the calculation of acceleration indicators. As a result, the Development Trap Index (DTI) was measured for the period between 2005 and 2020.

The regional analysis is conducted at the level of Brazilian mesoregions, which are intermediate spatial units defined by IBGE. These mesoregions, similar to NUTS-2 regions in the European Union, serve as an ideal level of analysis for regional development dynamics in Brazil. By using mesoregions, this study captures significant variation in economic performance and

employment patterns across the country, allowing for the identification of regional disparities and the potential for regions to fall into or remain in development traps.

The Regional Development Trap – RDT Index

Following Diemer et al. (2022) and Cinar (2024), adapting it to the regional context of the Brazilian economy, we employ an index that captures economic, productivity, and employment performance. This index is constructed based on a combination of growth rates, accelerations, and deviations of three key variables: 1) gross domestic product (GDP) per capita at constant 2010 prices, which serves as the standard economic indicator in the literature; 2) labour productivity, measured as the total gross value added at constant 2010 prices per formal employment relationship; and 3) the formal employment rate, defined as the proportion of formal employment relationships relative to the total population, serving as an indicator of employability.

The procedure for measuring the index consists of four stages. First, the compound average growth rate of each variable (y) is calculated using a five-year time lag (as shown in Equation 1). Consequently, each observation of the growth rate captures the short-term dynamics of the variables over the preceding five years.

$$g_{it,t-5} = \frac{1}{5} \times ln\left(\frac{y_{it}}{y_{it,t-5}}\right) \qquad \textit{Equation 1}$$

Secondly, to capture structural changes in the dynamics of the variables, we calculate the acceleration, which is measured as the difference between the observed growth rate and the growth rate from the previous period (as shown in Equation 2). This calculation incorporates a time window spanning the last 10 years, allowing for the identification of shifts in the growth trajectory over a longer period.

$$a_{it} = g_{i,t,t-5} - g_{i,t-5,t-10} \qquad \textit{Equation 2}$$

The third step is to quantify the deviation in growth observed in the regions both state to which it belongs (equation 3) and of Brazil as a whole (equation 4)[1].

$$d_{it}(e) = g_{it} - g_{et-1} \qquad \textit{Equation 3}$$

$$d_{it}(c) = g_{it} - g_{ct-1} \qquad \textit{Equation 4}$$

For the last step, following Diemer et al (2022), two distinct approaches are used to measure developmental pitfalls. The first (equation 5) is based on an average of dummies, defined by the

[1] This is the main difference between the original proposal, in which the deviations are calculated in relation to the countries and in relation to the European Union as a whole. We considered the country as the aggregate dimension and the states of the federation as the intermediate, while our regional cut is the Brazilian mesoregions, which are similar to the EU NUTS2.

accelerations and deviations of the variables, assuming the value 1 when they present a positive value, or 0 otherwise. The second is based on a standardized average of the observations (equation 6)[2].

$$DTI_1 = \begin{cases} 1 - (\sum Da_{it} + \sum Dd_{it}(e) + \sum Dd_{it}(c))9^{-1} \\ \\ Brasília: 1 - (\sum Da_{it} + \sum Dd_{it}(c))6^{-1} \end{cases} \qquad \textit{Equation 5}$$

$$DTI_2 = \begin{cases} \frac{[-1[(\sum a_{it} + \sum d_{it}(e) + \sum d_{it}(c))9^{-1}] - \mu^{uns.Idt_2}]}{\sigma^{uns.Idt_2}} \\ \\ Brasília: \frac{-1\left[[(\sum a_{it} + \sum d_{it}(c))6^{-1}] - \mu^{uns.Idt_2}\right]}{\sigma^{uns.Idt_2}} \end{cases} \qquad \textit{Equation 5}$$

In the standardized version, it is the mean and standard deviation before the standardization process referring to the first annual result of the indicator (2005). As highlighted by Diemer et al. (2022), the second measure is more sensitive to outliers and is often harder to interpret, unlike the first approach, which relies on dummy variables. However, the first method does not consider the size of the variations in the variables, potentially leading to an underestimation or overestimation of the risk of falling into or remaining in a development trap in the region (see Figure 2).

Building Groups

To identify development traps in Brazilian regions, it is essential to construct groups that allow for comparison over time. To achieve this, we employed a hierarchical clustering algorithm as the foundation for categorizing the regional development trap index (DTI) and per capita gross domestic product (GDP), which serves as a proxy for income levels

Hierarchical clustering is a set of techniques aimed at organizing data into a hierarchy of groups, without requiring the pre-definition of the number of clusters. This method can be performed in two main ways: bottom-up, where each data point begins as an individual cluster and clusters are successively merged, and top-down, where all data points start as one cluster and are progressively divided. The objective is to group observations in such a way that elements within each group are more similar to each other than to elements in other groups (Hair et al. 2019).

Among the various algorithms available, we used Ward's agglomerative method. It seeks to minimize the sum of squares of distances (WSS) within the clusters at each merger, that is, it seeks to combine the clusters in such a way that the variance within the resulting groups is as small as possible. At each step, Ward's method joins the two clusters whose mergers cause the smallest increase in the total sum of variance. This tends to form clusters of relatively similar size. Because it is based on the minimization of variance, the Ward method is particularly effective when one wants to obtain compact and homogeneous clusters (Hair et al. 2019).

[2] Note that both methods were adapted to obtain results for the Federal District of Brasília, which does not belong to any state

Among the available algorithms, we employed Ward's agglomerative method. This method minimizes the sum of squared distances (WSS) within clusters at each merging step, ensuring that the variance within the resulting groups is as small as possible. At each step, Ward's method merges the two clusters whose combination results in the smallest increase in the total variance. This characteristic often leads to clusters of relatively similar size, making it particularly effective when aiming for compact and homogeneous groups (Hair et al., 2019).

To define the optimal number of clusters, we applied the elbow method, which identifies the point where the reduction in WSS slows down, forming an "elbow" on the graph. The location of this *elbow* marks the optimal number of clusters, striking a balance between the complexity of the model (with a higher number of clusters) and the improvement in cluster cohesion (reflected by a lower WSS). The procedure involved standardizing the data and applying Ward's clustering algorithm by year for each variable (DTI_1, DTI_2, and GDP per capita). The results of the cluster hierarchy and thresholds for each variable are presented in Figure A1 and Table A1 in the annex A.

As a result, we considered three groups for the development trap index and four groups for GDP per capita. This choice reflects a significant reduction in WSS, while maintaining an analytically consistent number of categories across variables. The clusters reveal regional development patterns captured by the DTI_1 and DTI_2 indicators and income disparities through GDP per capita.

This categorization forms the basis for subsequent analyses, enabling temporal and spatial comparisons of regional development and income. Grouping the observations reveals persistent patterns, structural changes, and regions at risk of falling into development traps.

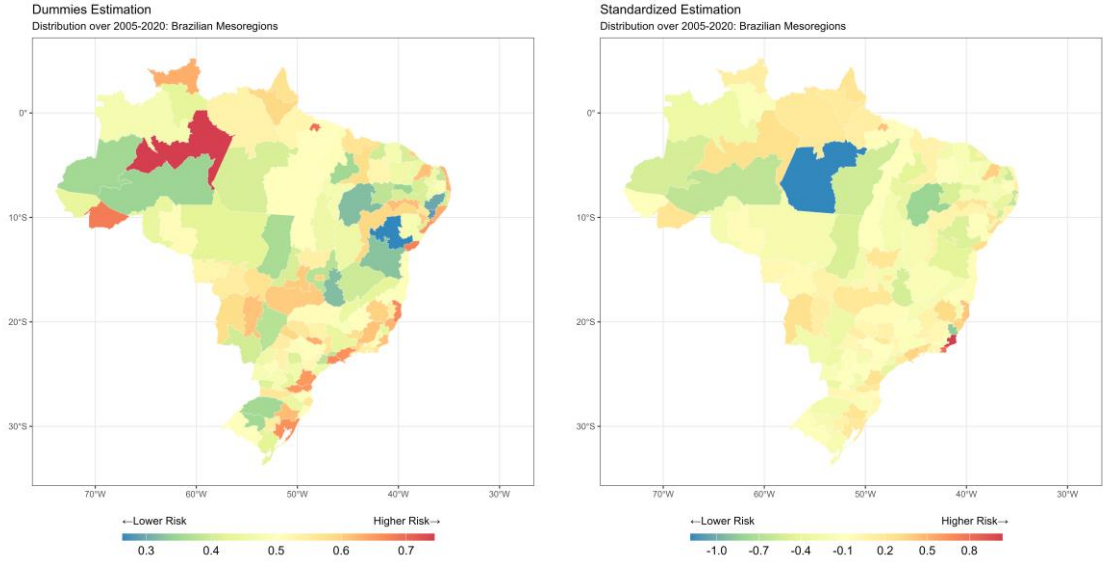
Results and Discussion

Figure 2 presents the average distribution of the indicators (DTI_1 *and* DTI_2) over the entire period, with higher indicator values corresponding to an increased likelihood of a region falling into or remaining trapped in middle- or low-income strata.

Notably, the indicator based on the dummy variable DTI_1 exhibits fewer extreme results, constrained between 0 and 1, whereas its standardised counterpart, DTI_2, displays continuous values approximately centred around zero. While the DTI_1 facilitates a clearer comparison between regions, it may obscure the intensity of regional dynamics and their critical inflection points. This suggests that both measurement approaches offer complementary insights.

The average risk level varies across the country, revealing spatial patterns with clusters of high- and low-risk areas. Regions with higher average risk are concentrated in densely populated areas, including state capitals and major economic hubs, as well as specific interior regions across all macro-regions. Conversely, regions with the lowest risk levels are predominantly located in the country's interior, particularly in areas characterised by agricultural and mineral production.

Figure 2. Average development trap risk



Source: Prepared by the authors based on the results of the research

In other contexts, these findings have been interpreted as evidence of absolute and conditional convergence, where poorer regions tend to grow at faster rates than wealthier ones (Almeida and Moreira 2019). However, examining regions beyond these average trends reveals a more nuanced reality. The results capture a spectrum of development trajectories, ranging from regions that benefited most from Brazil's economic growth regime in the 21st century to those marginalised and constrained by structural challenges (Fernandes and Pereira 2024).

The period under analysis is not a homogeneous unit without disruptions. Between 2004 and 2014, Brazil experienced the upward phase of a significant growth cycle, followed by a deep recession in 2015–2016 and subsequent stagnation until 2019. The COVID-19 pandemic in 2020 introduced yet another major economic shock. For a middle-income country marked by profound regional inequalities, the cumulative effects of a decade of crises and stagnation present complex challenges with potential long-term repercussions.

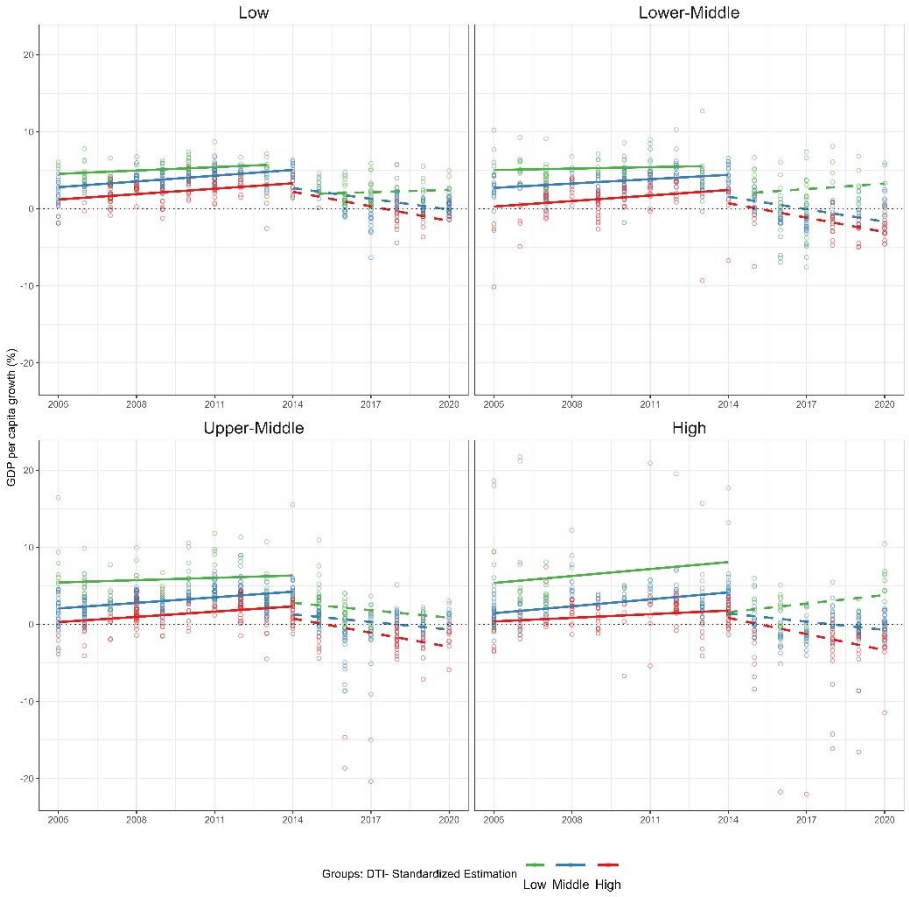
Figure 3 illustrates the economic growth performance of regions, categorized by GDP per capita groups and risk groups of falling into an economic development trap. The disparities in growth dynamics across regions and risk groups are evident.

The figure points out some interesting patterns. First, regions in higher-income groups (higher GDP per capita) showed more volatile growth rates and greater dispersion, contrasting with more stable trajectories of low-income regions (lower GDP per capita), both in periods of growth and in periods of crisis. Second, low-risk regions showed higher growth rates, although in all risk and income groups an accelerating growth trend was observed until 2014. After this year, the trend reversed, with many regions entering deep recessions. While low-risk regions were also affected, these were the only ones that recovered some growth trend, except for the middle-upper-income regions, contrasting with the sharp decline of high-risk ones. Third and last, the difference in growth levels among risk groups was higher in high-income regions.

A significant observation from this analysis is the emergence of regions within the high-income group that demonstrate strong economic growth and a minimal risk of encountering development traps. The concentration of several such regions in the Centro-Oeste suggests that their economic performance is closely linked to Brazil's successful integration into global markets as a

leading exporter of agricultural and mineral commodities. This pattern also provides insight into the recovering observed in low-risk regions after 2014, which stands in contrast to other trajectories over the same period.

Figure 3.



Source: Prepared by the authors based on the results of the research

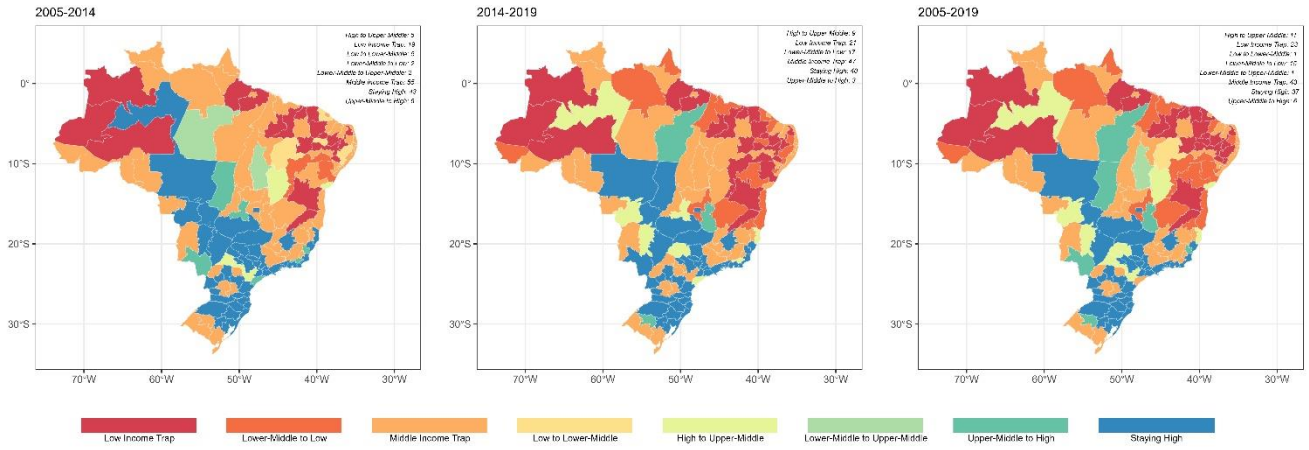
Between 2005 and 2004, many high-income regions and others that rose to this status or to upper-middle-income status were concentrated in central Brazil, forming what we could describe as "new rich regions" (**Figure 4**). This rise contrasts sharply with the near stagnation observed in some “old rich regions” during the same period, particularly in the Southeast, including parts of São Paulo and Rio de Janeiro. This complex landscape reflects an interplay of structural and macroeconomic trends alongside endogenous factors like institutional arrangements and localized policies.

The stagnated “old rich regions” had historically driven Brazil’s economic growth during the 20th century through industrialization and the integration of the national market. However, these regions now face a persistent decline in industrial complexity and competitive capacity, resulting in premature deindustrialization (Sugimoto and Diegues 2022; Rodrik 2016). This trajectory places some of the country’s most industrialized mesoregions at high risk of falling into an economic development trap, increasing the likelihood of regressing to middle-income status.

These findings underscore that the crisis following 2014 cannot be dismissed as a short-term fluctuation. Instead, it is deeply rooted in the structural challenges of the Brazilian economy, which manifest regionally through varying types of development traps.

Despite the growth observed in the period from 2005 to 2014, the results show that transitions between income groups were exceptions. Most regions maintained their status, with regions trapped in middle-income traps and low-income trap pockets remaining untouched (**Figure 4**). In the post-2014 period, a few mesoregions demonstrated upward trajectories, while the vast majority, despite differing income levels and challenges, remained caught in a middle-income trap. The economic crisis had a marked impact, with regions regressing from high-income to middle-income status, and many others from middle to low-income.

Figure 4.



Source: Prepared by the authors based on the results of the research. Note: The **low-income trap** refers to regions that remain classified within the low GDP per capita group in both years. The **middle-income trap** applies to regions that were classified as lower-middle or upper-middle in both years.

Interestingly, although no perfect linear relationship exists between development trap risk levels and income status, an increase in the proportion of mesoregions classified as high risk preceded the 2015–2016 crisis. This growth in high-risk classification began in 2010 and peaked during the initial year of the crisis (2015). From the second year of the series onward, middle risk became the predominant classification among mesoregions.

This middle-risk profile represents stability, but its implications vary depending on income status. For high-income mesoregions, stability may not pose an immediate threat unless prolonged, as it increases the likelihood of transitioning to high risk and, subsequently, a regression to middle-income status. Conversely, for middle- and low-income regions, medium risk often signals an inability to achieve the structural transformation necessary to escape poverty or progress to high-income levels.

Final Remarks and implication

The analysis of regional economic trajectories in Brazil from 2005 to 2019 underscores the persistent and complex nature of regional inequality. While the period until 2014 marked a significant improvement in growth and income levels for several regions, the post-2014 economic crisis revealed structural vulnerabilities that have hindered sustained progress. The rise of "new rich" regions in the Center-West, driven by the export-oriented growth model, contrasts sharply with the stagnation of "old rich" regions in the Southeast, where premature deindustrialization and structural challenges have led to higher development trap risks.

The interplay between income levels and risk profiles reveals critical insights. Regions with lower income but lower risk demonstrate potential for breaking poverty barriers, while middle-income regions, particularly those trapped in a middle-income status, face greater challenges due to higher risks and structural limitations. These findings highlight the need for targeted regional policies that address the specific constraints faced by different income groups.

Ultimately, the patterns observed during this period reflect broader structural challenges in the Brazilian economy, including the limits of the primary export model, the uneven impacts of macroeconomic trends, and the lack of structural transformation in several regions. Addressing these issues requires a comprehensive approach that combines regional development strategies with national economic policies to foster innovation, industrial diversification, and equitable growth across the country.

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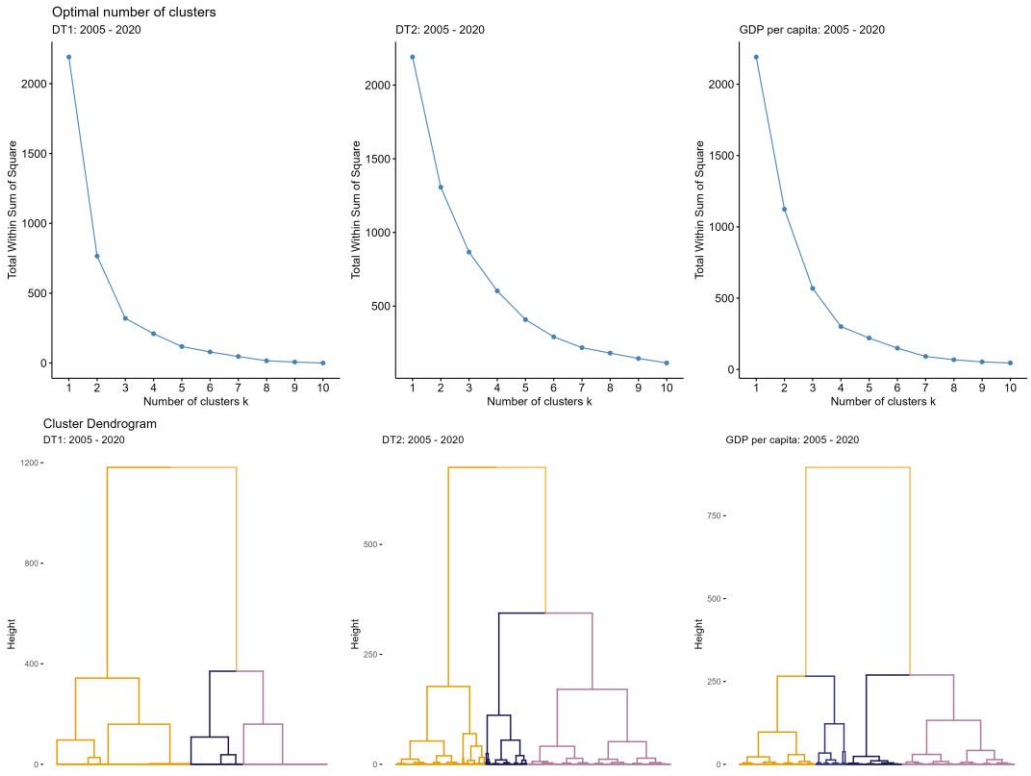
Appendix

Figure A1. Cluster Classification Procedure



Source: Prepared by the authors based on the results of the research

Table A1. Mean of annual groups thresholds

Thresholds	Development Trap Index: Dummies Estimation	Development Trap Index: Standardized Estimation	Gross Domestic Product Per Capita*	
Low	[0.028, 0.319)	[-3.510, -0.895)	[4.00, 8.04)	
Middle	[0.431, 0.569)	[-0.660, 0.426)	lower	[8.52, 13. 20)
			upper	[13.90, 20.40)
High	[0.674, 1.000]	[0.845, 3.190]	[21.40, 70.3]	

Source: Prepared by the authors based on the results of the research. *Thousands of Brazilian reais constant at 2010 prices.