INSTITUTIONS, HUMAN CAPITAL AND PRODUCTIVE STRUCTURE: ASSESSING REGIONAL INCOME PATTERNS IN BRAZIL

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Abstract

The present paper contributes to the literature by analyzing the different logical paths between latent factors such as institution, human capital and the productive composition of the economic base on the average income levels of Brazilian municipalities in 2015. This analysis was conducted by a Generalized Structural Equation Modeling (GSEM) to extract three confirmatory factors, which were associated with mean income by fuzzy-set Qualitative Comparative Analysis (fsQCA). The main findings revealed that cities should direct their efforts towards more than one of these dimensions and not just one of them.

Keywords: GDP *per capita*. Institutions. Human Capital. Productive Structure. fsQCA.

Área temática: 1. ECONOMIA.

1 Introduction

The literature devoted to assessing the determinants of economic development and regional disparities in average income across regions has branched out into several areas of study over the past four decades. While some authors were concerned with the analysis of the influence exerted by changes

in the institutional arrangement of regions on economic performance (*e.g.* North (1990), Acemoglu et al. (2005)), others focused the analysis on the mechanisms of impact of human capital and scientific accumulation (*e.g*. Romer (1990), Aghion and Howit (1990)) and the productive structures of the different economic bases (*e.g.* Hirschman (1961, 1985), Nelson and Winter (1982), Stiglitz (2013)). Although these determinants have gained focus in their respective fields of study, the endogeneity between them cannot be ruled out.

Certain activities located in cities provide incentives for wages, profits and price levels, in addition to constituting production possibilities and local technological, social and productive capacities (Constantine, 2017). The urban areas of these locations expand according to the need for production and demand, aggregating industries with different characteristics and culminating in the formation of urbanized regions, or metropolises, and in the complexity of the service sector (Monte-Mór, 2006; Pereira, 2012). The forces of agglomeration and urbanization that arise from this economic base generate the benefit of the formation of networks that connect regions, companies, productive sectors, universities, government agencies and society. However, diseconomies inherent to urban growth are also created, such as increased land income, environmental pollution, congestion, crime and others (Glaeser 1998; Glaeser et al. 1992; Jacobs 1970; Maia Pereira and Borges Lemos 2003; Marshall 1985; O'sullivan 2012; Pereira 2012). Thus, the relative economic importance of an urban center is provided by its ability to generate net savings from agglomeration and urbanization. Such capabilities are more evidently related to income inequality between regions in the long term (Dumais et al., 2002).

The attraction of private companies with productive capital, willing to invest in localities and with the potential to consolidate a stronger regional economic base, is, conditioned by the institutional framework in force in the municipalities (Constantine, 2017; Khan, 2010). That is, the creation and evolution of rules and norms make exchanges more reliable and predictable, which contributes to the development of economic bases (Acemoglu, Johnson, and Robinson 2005; Nelson 2006).

By generating guarantees and security, institutions enable the proper functioning of markets through price mechanisms, including labor, since they determine the rules for the return of education. Thus, given the workers' interest in receiving higher wages, having an institutional apparatus capable of more reliably determining the net gains from investment in education is related to the average increase in the quality and specialization of the workforce in organizations. This improvement in human capital, in turn, is associated with the creation and strengthening of the economic base of localities (Lipset 1960; Schultz 1971; Baumol 1996; Dias and Tebaldi 2012). In other words, if the process of industrialization and urbanization have always been articulated, cities expand in order to accommodate the needs of industries regarding the demands of production and reproduction of human capital that shape and diversify the economic base in urban space (Jacobs 1970; Lefebvre 2008; Mumford 2004).

In short, the consideration of the existing endogenous structural relationship between the economic-based productive design, the institutional arrangement and the stock of human capital are elements that contribute to regional disparities. In this variant, our goal is to understand how these dimensions (quality of human, institutional and structural capital formation) report to each other and to the economic performance of Brazilian cities in 2015. The choice of Brazilian municipalities for the applied study is due to the evident regional and local inequality present in Brazil. (Abrúcio and Sano 2013). According to information from 2021 from the Brazilian Institute of Geography and Statistics (IBGE 2021a), only 70 of the 5,570 municipalities concentrated around 50% of the Brazilian country's Gross Domestic Product (GDP). We believe that a better perception of the structural relationship between human capital, economic base and institutions, is relevant to the understanding of this scenario.

Most of the studies applied to this literature use econometric methods and do not take into account the non-linearity caused by the interrelation of these dimensions. There are studies that assess, in isolation, the influences of institutions (*e.g.* Dias and Tebaldi (2012), Acaravci and Erdogan (2017), Santana and Barreto (2016)), of human capital (*e.g.* Barro and Lee (1994), Fatima et al.(2020)) and production structure (*e.g.* Delgado et al. (2014)). To control for reverse causality problems, some studies have used instrumental variables (*e.g.* Dias and Tebaldi (2012), Leão et al. (2020), Silva and Teixeira (2011)), while others were only concerned with the causality between two of these phenomena (*e.g.*

Glaeser et al. (2004), Castelló-Climent (2008), Acemoglu et al. (2005a)). In general, in the applied literature there is a lack of quantitative works that evaluates the endogenous structural relationship of the three determinants of development specified for us.

We use two approaches to fill this gap in the applied literature. The first is the Generalized Model of Structural Equations (GSEM), applied to qualify Brazilian cities in relation to the phenomena of interest. The method has the advantage of testing a preestablished theoretical structure, in addition to reducing the number of observable components (quality of elementary education, teacher qualification, presence of laws and codes, productive specialization and commercial openness) that form each of the variables (human capital, productive structure and institutions) (Hair et al. 2018). The second approach is the Fuzzy Set Qualitative Comparative Analysis (fsQCA), employed to assess whether the possible logical combinations of dimensions present sufficient and necessary links with a high relative average income. This method manages to capture the most likely combinations that are present together with the high GDP *per capita*, showing the possible interrelationships between the variables generated by the GSEM (Ragin, 2006).

We want to point out whether efforts to improve one of these dimensions would be enough to produce an increase in the regional average income to contribute to possible public policies. In fact, what is expected is that municipalities should try in joint measures that improve more than one of these aspects. Our contribution to this literature proposes an unprecedented application with the potential for a broader discussion of the determinants of Brazilian local inequalities.

In addition to the introduction, the article is organized into four more sections. The second presents approach that deal with the association of human capital, institutions and productive structure with average income. The third reports the empirical strategy and the database used. The fourth section discusses the main results found and, finally, the last section summarizes the main conclusions that we have drawn.

2 Institutions, human capital, and productive structure: review of approaches

The literature that investigates the determinants of economic development, as well as the elements that justify their regional disparities, is divided into several areas. These approaches go through geographic and climatic influences (*e.g.* Marshall (1890), Sachs (2000)), capital accumulation and technological changes (*e.g.* Solow (1956)), human capital accumulation and investment in Research and Development (R&D) (*e.g.* Romer (1990), Aghion and Howit (1990)), the institutional environment and its changes (*e.g.* North (1990), Acemoglu et al. (2005b)) and the productive structure of the regions (*e.g.* Hirschman (1961, 1985), Winter and Nelson (1982), Stiglitz (2013)). However, the focus of our review is on institutional, structural and human capital aspects.

Institutions are rules that govern social, political and economic interactions between agents in a society (North 1990). Institutions make human exchanges predictable and more reliable by creating rules. This leads to a process of economic growth since they are related to incentive systems, investment attraction and production organization. (Acemoglu, Johnson, and Robinson 2005; Nelson 2006).

So, part of the institutional literature has been evaluating its effects on various economic aspects. There are studies that have considered its effect on income growth between countries, such as Dias and Tebaldi (2012) and Acaravci and Erdogan (2017), using techniques linked to panel data. Other works have evaluated the relationship between institutions and labor productivity, like Alcalá and Ciccone (2004), using methods of instrumental variables. There are also analyzes regarding GDP *per capita*, such as Santana and Barreto (2016) and Leão et al. (2020), using simultaneous equations and spatial econometrics, respectively. All these works found evidence of a positive relationship between the variables. However, estimates differ due to sample, analysis period and method.

Human capital, on the other hand, can be interpreted as the set of intangible resources embedded in the labor factor and that increase its productivity (Goldin 2016). In this sense, the educational, ethical,

informational level, skills and tacit knowledge of workers, among others, are configured as influencing factors for regional economic development (Smith 1791; Marshall 1923; Becker 1964; Schultz 1971).

Thus, another consideration is the effect of this variable on several components related to economic development. Based on neoclassical growth models (*e.g.* Lucas (1988) and Romer (1990)), several studies have evaluated the relationship between human capital and growth, being Barro and Lee (1994), Temple (1999), Kroth and Dias (2006) and Ahmad and Khan (2018). The methods of apparently unrelated regressions (SUR) and instrumental variables, minus trimmed sum of squares (LTS), dynamic data panels and Generalized Method of Moments (GMM), respectively, were used. Other authors have also evaluated the relationship between human capital and GDP *per capita*, as is the case of studies by Gennaioli et al. (2013) and Cangussu et al. (2010), using linear regression and dynamic panel, in due order. These studies, in short, also found a positive relationship between the variables.

Another aspect considered by the literature is the productive structure of a given region and its relationship with dimensions related to the richness of the regions. It is considered a productive structure with increasing returns if it produces high value-added and sophisticated goods and is beneficial to the economy (Constantine 2017). These products are generated in market structures that provide a favorable environment for innovation (Winter and Nelson 1982).

In this aspect, several studies have shown a relationship between industry and various aspects, such as Delgado et al. (2014) who showed a positive association with industrial concentration and employment, patent filing and industry growth using panel data techniques. Silva and Teixeira (2011) showed that countries with structural changes towards innovation and technology industries grew more, even controlling human capital, using clustering techniques and dynamic panel.

Some studies were also concerned with the interrelationship between these variables. Institutions enable the proper behavior of the labor market and make clear the return of education, which encourages human capital. In addition, individuals with a higher level of education would be more likely to resolve conflicts through negotiation, agreements and voting, which is beneficial for the functioning of markets (Lipset 1960).

Thus, Glaeser et al. (2004) looked for this reverse causality using methods linked to instrumental variables, finding a positive relationship between human capital and political institutions and, in addition, indirect ones in economic development. However, that human capital is more important for growth than institutions. Castelló-Climent (2008) also found evidence that an improvement in educational indicators is related to democracy through its implementation and sustainability. The authors used a System GMM. Although, using the same sample as Glaeser et al. (2004) from 1965 to 2000, Acemoglu et al. (2005a) found that the effect of education disappears when taking into account the heterogeneity of countries and also that there is no significant effect of education on other measures of political institutions. The authors made use of panel data and dynamic panel techniques.

Another concern is the reverse causality between human capital and productive structure. This occurs because there are environments that are more favorable to innovation, higher wages and profits (Winter and Nelson 1982). In addition, the urban phenomenon itself causes different sectors to be close to each other, enabling gains, such as greater worker qualification and social densification, which also benefits the service sector (Pereira 2012). Furthermore, high levels of human capital can facilitate technology adoption (*e.g.* Acemoglu (2003); Caselli and Coleman (2006)). As technology can be beneficial for the productivity of skilled labor, the productivity of human capital-intensive industries is increased (Ciccone and Papaioannou 2009).

Teixeira and Queirós (2016) used a dynamic panel and found that both human capital and the dynamics of countries' productive specialization are crucial factors for economic growth. In addition, the interaction between these two variables proved to be an important determinant, but it varies between regions, in which richer countries have a positive effect, but the effect of human capital via specialization in high-technology and knowledge-intensive activities is negative.

Similarly, the relationship of these factors (human capital, institutions, and productive structure) with the average income of Brazilian cities was analyzed. As well as the econometric works with instrumental variables (*e.g.* Dias and Tebaldi (2012), Leão et al. (2020), Silva and Teixeira (2011)), the

method used is concerned with the endogeneity inherent to these dimensions . However, unlike the works found in the literature, these three factors are incorporated into the same model, in which possible complementarities between them and non-linearities that lead to a high *per capita* income are sought, as partially done by Teixeira and Queirós (2016) with the use of an interaction variable in an econometric model.

3 Empirical strategy

The present empirical strategy consists of two steps. First, we used the Confirmatory Factor Analysis (CFA) to generate the latent variables related to the phenomena of interest. Subsequently, the sufficient and necessary configurations of "Institutions", "Human Capital" and "Production Structure" were evaluated for a high GDP *per capita* using Qualitative Comparative Analysis and fuzzy sets (fsQCA) of cities in Brazil, in 2015. CFA is a method belonging to Structural Equation Modeling (SEM) and the GSEM model. GSEM allows for a wide variety of specifications, in which some factor loadings are constrained, and other assumptions can be examined. Therefore, an advantage of the method is that it allows causal relationships to be tested, evaluating the fit between observed data and an idealized model derived from a theoretical relationship (Hair et al. 2018).

The use of QCA, against a formal regression model, has the advantage of being able to obtain interactive combinations that are related to the variable of interest. Thus, if in econometric methods there is a linear, distinct and independent path (result) (symmetric causality), the QCA provides several other specific and/or distinct patterns, bringing a notion of "conjunctural causality", in which different paths may be present (absent) in the same phenomenon of interest. However, this does not mean that the method is superior to the traditional ones, quite the contrary, since, for example, longitudinal data (only transversal) are not included here.

The GSEM model is composed of two parts, a measurement model and a structural model. The measurement model must be defined in advance. The second model specifies how latent variables are related. In this aspect, CFA is used to test the validity of the formation of latent variables. In fact, a final GSEM is not analyzed here, but through the CFA it is possible to remove indicators for "Human Capital", "Institutions" and "Production Structure". Furthermore, it should be noted that the scales of the latent variables were fixed, and intercepts for each relationship were not yet estimated so that the model could be identified. The model can be written as follows:

$$\begin{aligned} a_{10x1} &= \Lambda_{10x4}\xi_{4x1} + \varepsilon_{10x1} \\ h_{5x1} &= \Lambda_{5x4}\xi_{4x1} + \varepsilon_{5x1} \\ e_{5x1} &= \Lambda_{5x4}\xi_{4x1} + \varepsilon_{5x1} \\ s_{4x1} &= \Lambda_{4x4}\xi_{4x1} + \varepsilon_{4x1} \end{aligned} \qquad (1)$$

where a_{10x1} refers to a vector of 10 variables referring to the presence of observed space organization laws, h_{5x1} a vector of 5 observed educational quality variables, e_{5x1} a vector of 5 variables related to observed productive structure and s_{4x1} a vector of 4 observed social variables. ξ_{4x1} is a vector of 4 latent variables (human capital, institutions, productive structure and social deficit), Λ are factor loading matrices linked to the i-th observed variable and the j-th latent variable and, finally, ε are single-valued vectors.

In the second step, the fsQCA, approached by Ragin (2006), was applied to identify the relationships between the latent variables, coming from the CFA, with the GDP *per capita* of Brazilian cities in the year 2015. The results provide several patterns of configurations and support of the possible factors that have a relationship of belonging with the average income (Longest and Vaisey 2008). The method uses notions of Boolean logic, algebraic structures that capture the essential properties of logical operators and sets, evaluating the most likely combinations of "Productive Structure", "Institutions" and "Human Capital" that are present with high-level sets GDP *per capita* (Betarelli Junior and Ferreira

2018). It should be clear that the procedure does not provide support for cause and effect relationships, but may represent synchrony between the phenomena of interest (Schneider and Wagemann 2010). In fact, these relations must be understood as associations between sets. In this case, the objective is to obtain combinations of conditions of "Human Capital" (C), "Productive Structure" (E) and "Institutions" (I) that adjust to the high GDP *per capita* (P) in terms of need and sufficiency. In addition to the three phenomena of interest, a fourth latent factor was generated to control the "Social Deficit" (S) of a given municipality.

3.1 Data base

The variables selected for us cover 3 characteristics (Institutions, Human Capital and Productive Structure) for 5349 municipalities in 2015. The *per capita* GDP of the municipalities was obtained from the Brazilian Institute of Geography and Statistics (IBGE, 2021a). The variables to characterize the other aspects of the municipalities were collected from the Municipal Basic Information Survey (MUNIC), also from IBGE (2021b), to the National Institute of Educational Studies and Research Anísio Teixeira (INPEP) (2016), to DATASUS, from the Ministry of Health (2016), to the Institute of Applied Economic Research (IPEA) (2016). Furthermore, data were collected from the Annual Social Information Report (RAIS), made available by the Brazilian Ministry of Labor.

At MUNIC it is possible to collect information about the structure and functioning of municipal public institutions. The research evaluated several aspects in the years 2013, 2014 and 2015. These three years were used, as the research has changed over time. Nonetheless, the data collected refer to the same municipal management and, thus, it is hypothesized that such factors have not changed substantially over time. The data from INEP, on the other hand, include several educational factors in elementary school. From RAIS it was possible to obtain data on employment in the cities. Finally, from DATASUS it is possible to collect information on social aspects of the municipalities. Table 1 reports the selected random variables and their descriptive statistics.

It is expected that Human Capital can be represented by several variables observed here, linked to the quality of elementary education. The Basic Education Assessment System (SAEB) is an education assessment system, and its installation was an attempt to measure the quality of education to meet the needs of the labor market. The improvement in this indicator indicates an increase in educational quality. There is the Basic Education Development Index (IDEB) together with the approval rate. The first would be responsible for measuring the performance (performance) and the second proficiency (flow) of students in the assessments (INEP 2014). Thus, a positive association is expected between these two measures and the latent variable Human Capital.

On the other hand, age-grade disorder refers to students who did not have the years of study compatible with their age at the beginning of each school year. According to Ribeiro and Cacciamali (2012), the main causes of this variable include late entry into school, dropout and school repetition. In this variant, school dropout itself may represent this educational deficit of individuals and, thus, low Human Capital. Therefore, if a city has low rates of disturbance and abandonment, the greater the tendency to be Human Capital. It is also expected that the percentage of teachers with higher education has a positive relationship with Human Capital, as it represents the training of professionals directly involved in the educational training of the inhabitants.

Table 1 – Variables selected from Brazilian municipalities - 2015

Cod.	Description	Average	S. D.	Min.	Max.	%
p1	GDP per capita.	19471	20198	3089	513142	
h1	SAEB average score.	5.34	0.65	3.32	8.06	
h2	Age-grade distortion rate.	19.95	10.49	0.50	66.00	
h3	School approval rate.	89.59	6.58	54.90	100.00	
h4	School abandonment rate.	2.10	2.08	0.00	17.50	
h5	Percentage of teachers with higher education.	78.13	18.62	2.90	100.00	
e1	Trade opening - (Exp+Imp)/GDP.	0.08	0.26	0.00	4.70	
e2	QL of knowledge-intensive services.	0.40	0.53	0.00	15.61	
e3	QL of Weberian industries.	0.91	1.74	0.00	19.97	
e4	QL of dynamic industries.	0.51	1.39	0.00	17.92	
e5	QL of industries with emphasis on work.	1.16	1.66	0.00	10.57	
s1	Infant deaths (under 5 years) preventable.	20.06	18.40	0.00	284.37	
s2	Homicide rate per 100,000 inhabitants.	20.44	21.55	0.00	166.51	
s3	CO2 emission.	11.30	1.47	4.58	16.94	
s4	Population growth.	0.50	1.00	-13.34	11.23	
a1	Soil legislation created or granted to build.					64.45%
a2	Existence of Master Plan.					49.23%
a3	Area legislation and/or area of social interest.					54.77%
a4	Area legislation and/or area of special interest.					62.22%
a5	Land parcelling legislation.					43.87%
a6	Zoning legislation or land use and occupation.					45.53%
a7	Legislation on soil created.					76.32%
a8	Legislation on consortium urban operation.					80.92%
a9	Legislation on neighborhood impact study.					72.65%
a10	Existence of Code of Works.					37.12%

Source: INEP (2016), IBGE (2021a), Ministry of Health (2021), Ministry of Labor (2021) and IPEA (2016). Note: QL – Location Quotient; SAEB – Basic Education Assessment System. Exp – Exports; Imp – Imports; S.D. – Standard Deviation.

It was also hypothesized that variables a1 - a10 synthesize institutional-urban aspects of a given city. These variables deal with legislation on urban and regional planning. Therefore, it is expected that the presence of such aspects represents Institutional Quality, since it incorporates rules and norms that deal with the organization of the territory and property rights in the municipalities. Such legislative aspects would aim to shape the behavior of agents. Leão et al. (2020) point out that this latent factor will incorporate a large part of the administrative limitations of the municipalities which, according to Senem and Teza (2015), are responsible for norms and laws such as the Master Plan, Code of Works and Buildings, Code of Postures, among others, also including specific laws.

Finally, it is expected that the Productive Structure of a given city can be represented by its Location Quotient. These ratios compare the percentage share of a region in a particular sector with the percentage share of the same region in total employment (in this case, cities) (Haddad 1989). Weberian industries (e3) are capital intensive and oriented to be located close to raw materials. Dynamic industries (e4) tend to be in consumer centers with a high supply of productive services and demand a qualified workforce. The labor-intensive industries (e5) demand low qualification of the workforce, and are directed to places with low wages (Betarelli Junior and Simões 2011).

Knowledge-intensive business services (KIBS) (e2) contribute to increasing the competitiveness of companies in other sectors, especially industrial ones, and these sectors are expected to be composed of activities that drive innovative processes (Silva and Teixeira 2011). Trade liberalization (e1), in turn, captures part of the gain arising from the need for exporting companies to compete in the international market in a period of lower tariff barriers and subsidies.

4 Results

The CFA result (based on the GSEM method) can be seen in Table 2. The latent factors generated; "Human Capital", "Institutions", "Productive Structure" and "Social Deficit" followed the desired structure. The discussions by Senem and Teza (2015) are valid in the case of "Institutions", in which this latent variable incorporated part of the administrative institutional limitations of Brazilian cities. They are also in agreement with the results obtained by Leão et al. (2020). The authors observed that these same variables are related to an institutional factor insofar as it incorporates elements of municipal planning in relation to laws on territorial organization and, thus, on property rights. It was observed that the latent variable Institutions has a positive relationship with factors linked to institutional and urban aspects, having a positive association with the presence of legislation referring to land use, areas of social and special interest, subdivision, creation, and zoning of the land soil and the presence of consortia and, also, if there is a Master Plan and Works Code. In other words, cities that have incorporated these aspects into their legislation have a better institutional indicator and would be better able to foster behavior patterns to shape the agents' political, social, or economic interactions.

In turn, we noticed that the coefficients of "Human Capital" follow the expected, positively relating to observed variables that capture the performance and flow in teaching (INEP 2014) and the training of professionals involved in education. It also corroborates the approach suggested by Ribeiro and Cacciamali (2012), in which both age-grade distortion and school dropout are variables that reflect the low quality of education. In this aspect, Human Capital would have a positive (negative) association with aspects related to the performance, flow and training of teachers (distortion and school dropout). Therefore, this factor is associated with a better quality of education and, therefore, with the educational training of workers.

Finally, the last factor of interest refers to the "Production Structure" of the municipalities. Both Location Quotients and commercial openness are positively related to it. In this factor, commercial openness stands out, followed by the Location Quotients of Weberian Industries, Knowledge-Intensive Services, Dynamic Industries and, finally, the Labor Intensives in the production process. Furthermore, for this latent variable, it is not just any productive structure that matters, but, to a greater extent, the concentration in sectors intensive in knowledge and technology and with high contact with the foreign market. In this aspect, cities more open to the foreign market and with greater technological content have a better indicator of Productive Structure.

Removing the latent variables through the CFA, it is worth answering the present research problem, that is, analyzing the configurations of "Human Capital" (H), "Institutions" (I) and "Productive Structure" (E) that have a relationship of sufficiency and need with high GDP *per capita* (P), in addition to the Social Deficit (S). [1] Independently, the frequency of municipalities contained in each of the two conditions that coincide with the average income was observed, thus providing the relations of sufficiency and need. The total proportion of overlap between the pairs of sets was counted in Table 3, and the coincidence scores were standardized by the respective sizes of the sets.

[1] Each set is represented by a letter. If uppercase (lowercase) it represents a high (low) conditional probability of belonging to the cases in each set.

Table 2 – Results of the GSEM model

Latent	Observed	Description	Coeff.	S. D.
Institutions	a1	Soil created or granted to build.	2.85***	-0.11
	a2	Master Plan.	2.51***	-0.10
	a3	Area of social interest.	3.13***	-0.13
	a4	Area of special interest.	3.39***	-0.14
	a5	Land parcelling.	2.05***	-0.09
	a6	Zoning legislation.	2.34***	-0.10
	a7	Soil created.	2.67***	-0.13
	a8	Consortium urban operation.	2.09***	-0.10
	a9	Neighborhood impact study.	3.63***	-0.19
	a10	Code of Works.	0.97***	-0.05
Human Capital	h1	SAEB.	0.66***	-0.01
	h2	Age-grade distortion rate.	-0.94***	-0.01
	h3	School approval rate.	0.90***	-0.01
	h4	School abandonment rate.	-0.78***	-0.02
	h5	Teachers with higher education.	0.60***	-0.01
Production Structure	e1	Trade opening.	0.49***	-0.05
	e2	QL knowledge-intensive services.	0.28***	-0.04
	e3	QL Weberian industries.	0.36***	-0.04
	e4	QL dynamic industries.	0.25***	-0.03
	e5	QL with emphasis on work.	0.11***	-0.02
Social Deficit	s1	Infant deaths.	0.21***	-0.03
	s2	Homicide.	0.29***	-0.03
	s3	CO2 emission.	0.47***	-0.04
	s4	Population growth.	0.40***	-0.04
Wald Test	Institutions		3504.27***	
	Human capital		4044.40***	
	Production Structure		1277.21***	
	Social Deficit		816.47***	

Source: Search result. *** sig. with 99% confidence.

Table 3 – Sufficiency and need matrix

	P	I	H	E	S
P	1	0.72	0.77	0.8	0.72
I	0.75	1	0.69	0.74	0.72
H	0.77	0.66	1	0.73	0.66
E	0.82	0.72	0.76	1	0.73
S	0.72	0.69	0.66	0.7	1

Source: Search result.

The Productive Structure (E) shows the greatest sufficiency in terms of GDP *per capita* (P), since the shared areas correspond to 82%, which indicates that a higher structural quality is associated with a

high level of GDP *per capita*, followed by Human Capital (H), 77%, and Institutions, 75%. These three latent variables also have a high sufficiency relationship with each other. The smallest shared area is between Institutions and Human Capital. Although important, this analysis does not reveal the relations of need and sufficiency and cannot infer which of the sets is contained in the other. Then, the sufficiency relationships were tested and the logical combinations that are associated with a high GDP *per capita* were derived. As there are 4 sets, Institutions, Human Capital, Productive Structure and Social Deficit, there are 16 possible logical combinations, but there were 8 possible configurations associated with a high GDP *per capita* or about 48% of the cases. Table 4 indicates only those logical combinations that have a sufficiency and need relationship with meddle income, in which consistencies are greater than 0.8, as suggested by Ragin (2006). All of these settings are significant at 5% significance.

Table 4 – Consistency with high middle income

Config.	Consistency		F	No.
	D	1-D		
iHEs	0.90	0.81	141.44***	345
iHES	0.93	0.79	289.62***	225
IhEs	0.91	0.84	85.80***	131
IhES	0.90	0.77	221.69***	428
IHes	0.89	0.86	16.44***	199
IHeS	0.91	0.85	50.52***	141
IHEs	0.94	0.73	781.44***	408
IHES	0.95	0.63	1467.75***	731

Source: Search result. *** sig. with 99% confidence.

As an example, 345 cities, representing 6.45% of the total number of municipalities, have a combination of the iHEs type, that is, they are regions with relatively low institutional quality (i), without laws and guidelines related to territorial organization, high levels of human capital (H), with high flow rates and performance in elementary education and teacher training and low rates of delay and school dropout, and productive structure (E), with high commercial openness and locational ratios, mainly in sectors knowledge-intensive and dynamic and, finally, low social deficit (s) with good rates of health, violence, population growth and pollution.

While important, this analysis presents all possible logical paths, that is, multiple configurations of logical conditions that are sufficient for high GDP *per capita*. These configurations are identified by the primitive expression of high GDP *per capita*. Nevertheless, as a way of simplifying the different paths presented in Table 4, this study resorted to the application of the Quine–McCluskey minimization algorithm, in which the presence of a certain causal condition in a combination is compared and the absence of it in another condition of way to reduce them. This result is reported in Table 5 or in the following equation:

$$HE + IE + IH \rightarrow P \qquad (3)$$

These combinations, HE, IE and IH, are alternative paths of conditions that lead to the result of high average income (P) among Brazilian municipalities. Cities that have a combination of high relative human capital with high trade openness and productive structure (HE) are more likely to have a high GDP *per capita* (P). The same is true for municipalities with a good institutional environment and a high indicator of productive structure (IE). Another alternative path is with good institutional indicators and

the presence of good indicators that refer to the quality of the training of the workforce (HI). If a municipality presents one of these three combinations, it will likely have a high relative average income.

Table 5 – Minimization of paths consistent with high regional average income

Classification	Configuration	Cover		Consistency
		Brute	Single	
High Middle Income	HE	0.66	0.13	0.90
	IE	0.62	0.09	0.89
	IH	0.59	0.06	0.89
Coverage rate = 0.81				
Consistency solution = 0.84				

Source: Search result.

All these configurations that lead to a high GDP *per capita* are statistically significant. There are 1709 municipalities that have a combination formed with high levels of Human Capital and Productive Structure (HE), 1506 with relative institutional development and good structural conditions (IE) and 1479 with good institutions and levels of educational quality. These types of cities account for about 90% of high GDP *per capita* cases.

The presence of the condition of high Institutional Development or high Human Capital or Productive Structure are necessary conditions for high GDP *per capita*, but they are not sufficient in isolation since it is necessary to combine these conditions two by two to lead to the result of interest. Figure 1 illustrates the spatial distribution of configurations consistent with high GDP *per capita*. According to the maps in Figure 1, there is a spatial pattern. Cities with a high degree of belonging to the HE, IE and IH conditions also have high income. Still, it is observed that the North and Northeast regions are the ones that have a smaller number of municipalities that present a configuration consistent with high GDP *per capita*. In this case, it is suggested that municipalities should focus their efforts on improving indicators related to the training of their population's workforce; how to increase school performance and flow, teachers' schooling and reduce student dropout and tardiness rates.

In the institutional aspect, municipalities should seek to improve their institutional matrix, by legislating on institutional-urban aspects, such as applying laws related to the Master Plan, Works and Buildings Code, Code of Posture, and laws on land occupation and zoning. Also, they must seek industrial policies to promote dynamic industries and services and with high commercial opening. However, isolated measures to meet one of these factors will possibly not reproduce the necessary and sufficient conditions for a high GDP *per capita*, but a combination of these measures.

In empirical terms, the results showed that, possibly, there are associations between the latent variables that are necessary and sufficient for a high GDP *per capita*. As a combination and interaction of these factors is necessary, the results provided by the fsQCA make it difficult to compare with econometric studies that related these factors to income, such as the studies by Dias and Tebaldi (2012), Acaravci and Erdogan (2017), Alcalá and Ciccone (2004), Gennaioli et al. (2013), among others. This is justified by the fact that these studies did not control all these factors or only used controls. However, it is in line with the work of Glaeser et al. (2004), Castelló-Climent (2008), Acemoglu et al. (2005a) and Silva and Teixeira (2011) who evaluated a relationship in part of these variables. In this aspect, econometric models must insert interaction variables between these terms to capture these phenomena in an asymmetrical way, as partially done by Teixeira and Queirós (2016), since the author did not consider institutional aspects.

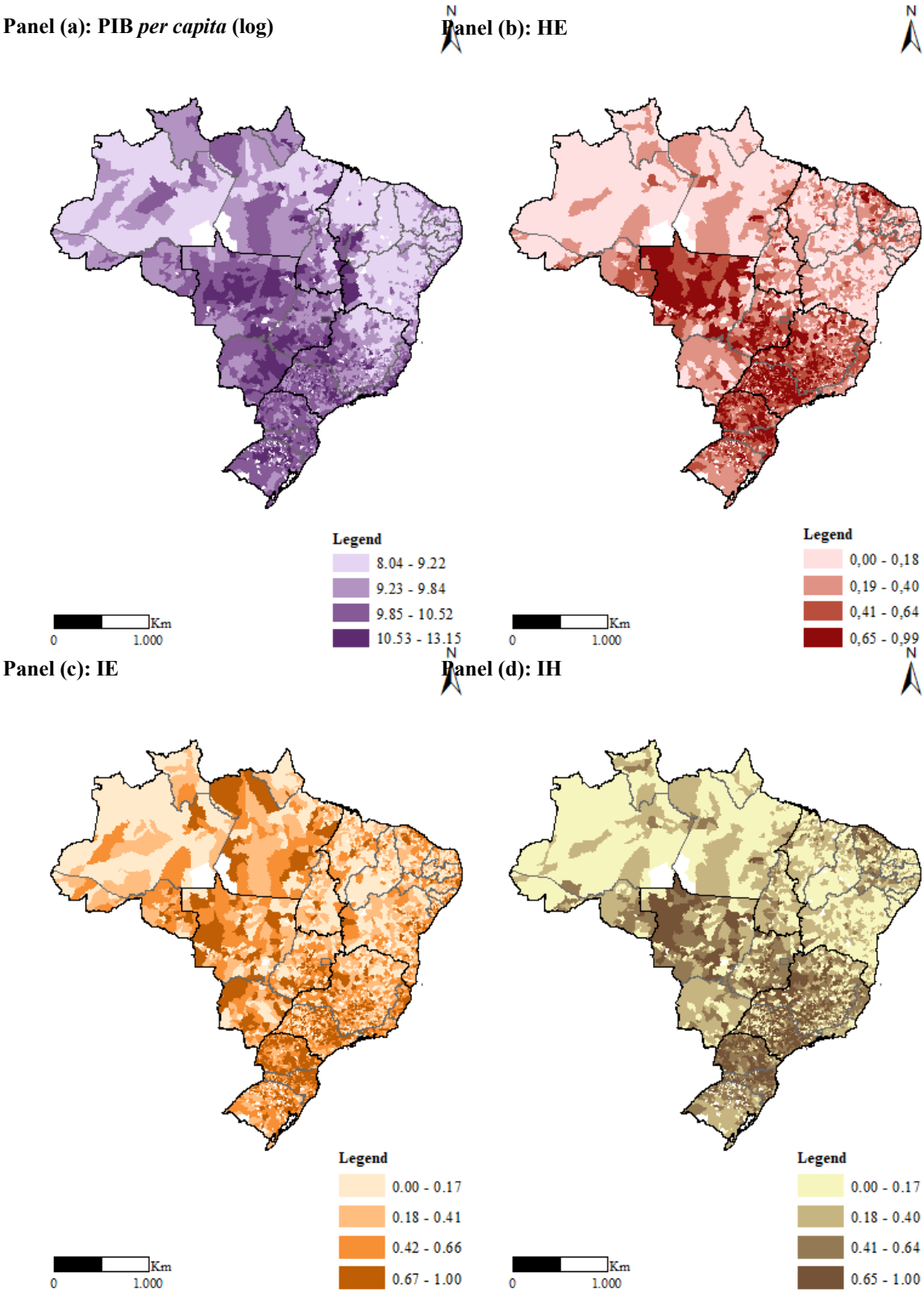
5 Final considerations

The concern about regional differences and the inequality of the urban-industrial hierarchy has been recurrent in the applied literature. In general, the breadth and diversification of the economic base, the transformations and social practices, the institutional structure and the endowment of human capital and other resources that accommodate the production needs in urban centers, determine competitive trends, different levels of average income and different degrees of economic development of the centralities in the urban system. There are, therefore, several conditions that, if combined, define multiple configurations that are present and absent for an upper-middle (lower) income pattern among the municipalities. This study contributes to the debate on the unequal structure in the Brazilian territory and evaluates the complex relationship between the "productive structure" of the economic base, the "institutional arrangement" and the provision of "human capital" on income disparities. between the centralities of the urban fabric (network), whether hypercenters or hinterlands. Our underlying hypothesis is that these three conditions alone are not enough for the existence of a high average income level in the municipalities, but the multiple combinations between them are.

We propose a methodological strategy in two successive stages differently from the studies applied in the Brazilian literature. First, the Generalized Structural Equation Modeling (GSEM) was applied to extract the constructs more broadly from an institutional, productive, and human capital perspective, which are conceptually unobservable. Then, from the fuzzy-set Qualitative Comparative Analysis (fsQCA) these three latent constructs became the logical conditions of each urban centrality in the country to identify the multiple configurations that are sufficiently related to the high average income. region in 2015.

The conclusive results of this study indicate that only the combinations of a pair of logical conditions are sufficient for high average income in Brazilian municipalities, which confirms the hypothesis of this research. The high level of human capital (H) in Brazilian centralities, if combined with high institutional quality (I) or with a high level of productive structure (E), are configured as the two alternative paths, "HI" or "HE", that are sufficient to result in high GDP *per capita*. The "HI" combination means that Brazilian municipalities with a higher income standard may have a low productive structure, provided that they jointly present high scores in the logical conditions of institutional scope and human capital. On the other hand, the low endowment of human capital is possible in municipalities with upper middle income that have a logical configuration between the high institutional and the productive arrangement (IE).

Figure 1 – GDP *per capita* and the necessary and sufficient settings



Source: Search result.

Therefore, the policy implications of these results are straightforward. As the condition of human capital appears in two of the three alternative paths, Brazilian municipalities that have been directing or absorbing policies for educational improvements, be they inclusion in teaching, social quotas, expansion of supply and demand for vacancies in educational institutions, or training and professional qualification of teachers, even in higher public spheres, can increase the population's income standard. These human capital improvement policies articulated with institutional improvements in terms of laws, norms, and guidelines or with instruments that allow expanding localization and urbanization economies for local productive activities, especially for companies in sectors with greater technological, dynamic and knowledge-intensive (e.g. Weberian Industries and Knowledge-Intensive Business Services (KIBS)) and with greater participation in the international market. Industrial and tax policies can be planned to stimulate the internationalization of companies, such as training programs for small and medium-sized companies with export potential and generate research and development (R&D) through programs to access credit for companies belonging to sectors intensive in capital and in skilled labor. There would probably be a reduction in regional inequality if municipalities with a lower level of wealth directed their efforts in a combined way towards these three dimensions.

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