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Economic growth in brazilian municipalities and the service sector and industry agglomerations: a spatial analysis[1]

Crescimento econômico dos municípios brasileiros e as aglomerações do setor de serviços e da indústria: uma análise espacial

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Abstract
This article aimed to analyze the impact of the agglomerations of certain segments in the service and industrial sectors on the economic growth of Brazilian municipalities. More specifically, it focused on companies that provide knowledge-intensive business services (KIBS) and companies that provide non-knowledge-intensive business services (NKIBS), using a spatial panel, with the inclusion of instrumental variables. As a corollary, industrial agglomerations were important in determining economic growth throughout Brazil; NKIBS and KIBS were not statistically significant, not affecting the dynamics of local economies. Regarding KIBS agglomerations, regionally, the group formed in the South, Southeast and Midwest was impacted, that is, regions with greater economic dynamism.
Keywords: Agglomerations. Service sector. Spatial panel.

Resumo
Este artigo teve como objetivo analisar o impacto das aglomerações de determinados segmentos do setor de serviços e do setor industrial no crescimento econômico dos municípios brasileiros. De forma específica, focou nas empresas de prestação de serviços de negócios intensivos em conhecimento (ECS) e nas empresas de prestação de serviços de negócios não intensivos em conhecimento (ENCS), utilizando painel espacial, com a inclusão de variáveis instrumentais. Como corolário, as aglomerações industriais se apresentaram importantes na determinação do crescimento econômico ao longo do Brasil; já as ENCS e ECS não foram estatisticamente significativas, não afetando a dinâmica das economias locais. No caso das aglomerações de ECS, regionalmente se teve impacto no grupo formando pelo Sul, Sudeste e Centro-Oeste, ou seja, nas regiões com maior dinamismo econômico.
Palavras-chave: Aglomerações. Setor de serviços. Painel Espacial.

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1 Introduction

The advancement of the economic development of a region results in the prominence of the service sector in the local dynamics (Rostow, 1961). This activity is not passive, on the contrary, in knowledge intensive areas and integrated to other productive activities, it has a direct action in the economic development.

Up to the 1970s, the service sector was seen as a low productivity segment, leveraged by the capital-intensive sectors. In such conception, salary increases in the service sector resulted mainly from the productivity growth in the economy more dynamic activities, affecting earnings in the service sector without necessarily increasing its productivity (Baumol, 1967).

However, with the advancements in the labor technical division, market expansion, information technology development, and incorporation of service activities in other productive chains, the perception of the importance of this sector in the economy also changed (Torres-Freire, 2006, Souza et al., 2011).

Oulton (2001) pointed out that the specialization of this sector allowed gains in economies of scale, influencing the dynamics of downstream activities in the production chain. This turned the service sector into a relevant intermediary segment in industrial activities, leading to increased productivity and, also, growth of the economy productivity. Lee and McKibbin (2018) observed such externalities of the service sector in the economic growth of Asian countries, leading to a direct interlink with the manufacture sector development, generating a more expressive and sustainable multiplier effect on the dynamics of the economy of each country. Also, Ayhan et al (2019), when analyzing the meaning of the causal relation between the service sector and economic growth in Turkey, confirmed the existence of a unilateral causality of the former over the second.

In fact, the service sector started to include some knowledge and technology intensive segments, becoming vectors of innovation for other economic activities. As highlighted by Muler and Doloreux (2009), knowledge-intensive businesses (KIBS) in the service sector combine several types of knowledge about technologies, aiming to solve their clients' problems, resulting from local specificities. Their action is directly related to rendering services to other companies, depending greatly on the existing knowledge (Tovoinen, 2006). In such context, Miles (2005) defined these companies as segments of the service sector that promote the creation, accumulation, and dissemination of knowledge.

Taking that into consideration, an important element rooted in those KIBS refers to innovation. At the same time, they strengthen the local innovation system because they buy technology, but they also produce it and transfer to other companies. This promotes a relationship between knowledge, innovation, and the spatial closeness of KIBS (Muler, & Doloreux, 2009).

Some authors, such as Koschatzky (1999), advocate that this proximity between KIBS does not occur by chance. The interaction with their partners, working in networks, makes the spatial distance relevant. Moreover, being close to the regional research institutes is vital in knowledge construction (Koschatzky, 1999; Muller, & Zenker, 2001), especially for better understanding local cognitive processes, for decodifying more easily scientific and technical information of tacit knowledge, which is improved via the close contacts strengthened by spatial proximity. Johnston and Huggins (2017) presented some evidence of this proximity when analyzing the United Kingdom and proved the existence of shorter spatial distances between KIBS and Universities, which usually shared common spaces.

Keeble and Nachum (2002) investigated why knowledge companies in the service sector in the United Kingdom grouped and found out two reasons for that. First, they seek to be close

to their clients, concentrating around their consumer market. Second, their spatial concentration is explained by the search for knowledge spillovers that are generated within agglomerates. Moreover, Graizbord and Santiago (2020), when analyzing Mexico, concluded that the KIBS concentration pattern resulted from the search for agglomeration economies added to the benefits of the availability of information and communication, mainly when these companies are agglomerated in large centers. In fact, basically, the main points defended by Krugman (1992) when determining the location of companies apply to the KIBS, with the particularity of knowledge externalities.

In Brazil, the development of KIBS occurred mainly from the 1990s onwards, with the intensification of outsourcing, as a result of the production restructuring at the time. Jacinto and Ribeiro (2015) demonstrated that productivity in services (excluding commerce) showed great growth between the mid-1990s and the late 2000s, influencing the aggregated productivity of the Brazilian economy.

Despite such importance, the literature relating the formation of KIBS agglomerates and their impact on regional productivity and growth is still scarce. The very few national studies found investigated points such as the determinants of innovation in that sector or presented specific analysis of third sector segments (e.g., Pinheiro et al, 2015) without focusing on the spatial concentration of this activity. At the international level, a focus on the evidence of agglomerations in the service sector is also scarce, since the focus of those studies are mainly on the factors that determine such concentration (e.g., Krenz, 2010; Jennequin, 2008; Midelfart-Knarvik et al., 2000) rather than on deepening the analysis of the regional impact of this concentration on the dynamics of the local economy. Zhang (2016) is one of the few authors that analyzed the impact of the service sector agglomerations when investigating the Chinese economy. However, he does not present spatial inferences.

This is the context approached by this paper, it seeks to analyze the importance of KIBS agglomerations in the economy of Brazilian municipalities. Moreover, it evaluates the impact of the service rendered by NKIBS on this process. This group included the companies that render service to the productive activity, but that the literature describes as users of knowledge rather than actors that introduce knowledge (Zhang, 2016). Thus, both the KIBS and NKIBS form the group that Kon (2013) called development inducer segments[2]. However, that author reclassified them according to the theoretical expectation of their action in the construction of knowledge, following the methodology introduced by Zhang (2016).

It seems relevant to point out that in international studies, such as Miles et al (1995), all the other segments that are not included in the "*Knowledge Intensive Business Services* (KIBS)", including public administration, sheltering, health, education, etc., form the "non-KIBS", and this is the main difference from this paper, for focusing only on services directed to the productive activity of each municipality, and disregarding the segments directed to families.

Therefore, our focus is on the construction of KIBS and NKIBS agglomerates and their impact on the municipal economic growth. In addition, we also evaluated the importance of

[2]This group is formed, according to Kon (2013), by: Land transport; Water transport; Air transport; Activities related and supporting transports and travel agencies; Real Estate activities; Mail and telecommunications; Financial intermediation; Insurance and complementary social security; Financial intermediation supporting activities; insurance and complementary social security; Car, machine, and equipment rental services without drivers or operators, and personal and household objects; Computing activities and related services; Research and development; Services rendered mainly to companies; Education; Health, and Social Work. The first five items in this list were considered NKIBS in this research, while the remaining ones were considered KIBS, except for education, health, and social work, which were not included in neither of the groups for being more directed to families rather than to businesses.

industrial agglomerations in this process. Regarding the latter, there is a consensus in the literature about their relevance (Glaeser et al., 1992; USAI, & PACI, 2003; HENDERSON, 1999; Nakamura,1985). However, their role was reevaluated by applying a theoretical model that subdivides the productive activity between the industry and the segments related to the service sector.

Thus, this paper aimed to analyze the impact of agglomerations of certain service segments (KIBS and NKIBS) and the industrial sector on the economic growth of Brazilian municipalities between 2007 and 2017. More specifically, we analyzed the spatial distribution of these agglomerates over time, via spatial panel, their effects on the municipal GDP per capital dynamics, with specific inferences per region.

The paper is divided into five sections, organized as follows: The first section introduces the topic. In the second section, theoretical aspects of productive agglomerations are approached. Next, the theoretical model used to obtain the estimates and the empirical strategy used are presented. Section four presents the analyses related to agglomerate distribution and its importance for the economic growth of a region. The last section contains our final considerations.

2 Productive agglomerations: theoretical and empirical aspects

The spatial concentration of productive activities basically results from three distinct forces, namely, the production economies of scale; the local market size; and the transportation cost. If the last factor is relatively low, the local market becomes important, and the productive activity tends to concentrate on a single spot, aiming to obtain maximum gains from internal economies of scale. However, when the cost of transportation is high, companies tend to be located in specific points in space, generally closer to the raw-material source, aiming to reduce such expenses. In addition, attracting workers can also benefit the spatial concentration of companies, which on the one hand provides workforce to all companies and, on the other hand, creates a consumer market, reinforcing the firms' geographical concentration. (Krugman, 1992).

This agglomeration might generate different competitive advantages for the region. Marshall (1890) pointed out that, by specializing, the concentration of companies produces externalities with economies internal to the firms, mainly via increased production scale. The proximity of these firms of the same industry generates flows of technology and efficiency, producing positive impacts on the regional productivity.

In fact, the process of concentration of companies of the same industry (called productive specialization) intensifies the joint efficiency resulting from lower global costs, causing competitive advantages and higher growth rates. Such advantages are known as pecuniary economies Marshall (1890). Also, the proximity between firms of the same industry can generate transactional economies by intensifying personal relationships and favoring the execution of contracts.

Another source of externality originates in the formation of a specialized workforce market, with the accumulation of specific human capital, fostering collective apprenticeship processes, which optimize productivity. It seems relevant to emphasize that centralizing the workforce promotes a simultaneous market for qualified workers. For these workers, gains would be associated with higher availability of new jobs resulting from the concentration of more companies; and for the firms, the reduction in downtime would also result in benefits, since they would have a greater offer of specialized resources. Thus, the composition of highly qualified workforce formed by individuals with similar technical knowledge, favors a

satisfactory relationship between employer and employees. The entrepreneurs obtain qualified workforce when they need it, and individuals find greater job offer whenever they decide to leave certain company (Krugman, 1992).

In addition, Marshall (1890) also discusses the existence of a series of services locally concentrated, intensifying the valuation of the local production, with chain effects. Moreover, the creation of an industrial atmosphere that guides more efficient technological and organizational combinations is observed, which results in technological spillovers to firms that are spatially concentrated.

All these externalities, originated in the agglomeration of different companies of the same industry, are called specialization economies. Glaeser et al (1992) emphasized that these benefits mainly result from the concentration of qualified workforce and technological spillovers that are generated locally.

It seems relevant to highlight that agglomerations do not have to include companies of the same industry only. When it refers to firms of different industries, these are specially attracted by economies of agglomeration – also known as diversification economies – which result from the availability of public goods and services, an enlarged consumer market, and the existence of an incubator of productive factors with an extensive and qualified job market that provides higher education and entrepreneurial institutions, as well as research centers. Another factor favoring these economies is the production resource market, which refers to a wide range of specialized services in fields such as organizational, technological, financial, transportation, and entrepreneurial qualification, among others (Camagni, 2005).

Jacobs (1969) explained that the availability of diversified goods and services generates new types of jobs, enabling new products to be included, expanding the variety of activities, and leading to an increase in the regional competitiveness. Also, the possibility of knowledge spillovers between companies of different industries is observed, which optimizes the diversity of ideas, contributing to an increase in the productivity of the whole region.

Regarding the service sector, its spatial concentration is mainly observed in central regions, with high populational concentrations (Perobelli et al, 2016) allied to the availability of qualified workforce, infrastructure, and accessibility, among other factors (Beckmann, 1999). It seems relevant to reinforce that, in studies focusing on developed countries such as Camagni and Capello (2005), the lack of concentration or reallocation of certain services to small municipalities occurs mainly around large centers, for the benefits provided by the economies of agglomeration in those spaces.

Meliciani and Savona (2015) analyzed determinant factors of specialization in technology more intense service sector in the European Union countries and identified a positive effect of economies of agglomeration, technology, and the intermediary demand. They also observed a spillover process of this specialization to neighboring regions. In addition, a positive and significant impact of the innovation environment and the knowledge infrastructure on the innovation process of specialized service conglomerates was observed.

Finally, the importance of agglomerations of the service sector must be emphasized mainly in technology more intensive sub-sectors for the process of economic growth of a region. Cermeño (2015) evaluated the North American economy and concluded that places specialized in this sector obtained a more intense economic dynamism. Similar results were reported by other authors such as Kubota (2006), Lee and McKibbin (2018) and Suzigan (2006), who also evidenced that certain sub-sectors showed innovative characteristics, with innovation capability, were knowledge intensive, and contributed directly to the spillover of technologies to other sectors, becoming transmitters and developers of technology. Moreover, Kon (2013) observed the existence of a chain of these service sub-sectors leading to development with the industrial activity, which stimulates their location pattern, offering fundamental knowledge for

productive and innovative processes, outstanding in the managerial and/or organizational qualification process in companies.

3 Methodology

3.1 Theoretical Model

The theoretical model employed in this paper followed Zhang's construction (2016), which started from a Production Function of the Cobb-Douglas type:

$$Y_{ij} = A_{ij}\, K_{ij}^{\alpha} H_{ij}^{\beta} L_{ij}^{1-\alpha-\beta} \qquad (1)$$

Where: Y_{ij} refers to the production in municipality *i* within a larger region *j*. A_{ij} is a technology parameter, K refers to the physical capital, H is the human capital, and L is labor. In this composition, the production function presents constant returns of scale ($\alpha + \beta$) equal to one.

That author assumed that economies of agglomeration are related to the size of the municipality and the industry, inferring that the populational density is fundamental for the generation of externalities between companies, resulting, consequently, in product increase:

$$A_{ij} = \pi_0\, D_{ij}^{\pi 1} I_{ij}^{\pi 2} \qquad (2)$$

Where: D is populational density; I is industrial agglomeration, $\pi 0$ refers to other technology factors that do not depend on populational density or industrial agglomeration; $\pi 1$ is the elasticity related to the populational density, and $\pi 2$ is the elasticity resulting from the industrial agglomeration.

Zhang (2016) hypothesized that the capital rental price (r) is the same in all municipalities under analysis in the same region (due to the difficulty of measuring physical capital at a local level). With this assumption, the capital marginal product for the region is:

$$r_j = A_{ij}\, \alpha K_{ij}^{\alpha-1} H_{ij}^{\beta} L_{ij}^{1-\alpha-\beta} \qquad (3)$$

When substituting (1) in (3), the demand-capital function in municipality *i* in the region j is obtained:

$$K_{ij} = \frac{\alpha}{r_j} Y_{ij} \qquad (4)$$

That author substituted physical capital (1) with the capital demand function (4), and then inserted (2), obtaining the labor mean productivity:

$$\frac{Y_{ij}}{L_{ij}} = \varphi_j \frac{H_{ij}^{\frac{\beta}{1-\alpha}}}{L_{ij}} \left(D_{ij}^{\pi 1} I_{ij}^{\pi 2}\right)^{\frac{1}{1-\alpha}} \qquad (5)$$

Where φ_j is a constant that depends on the capital rent price in the region j; $\frac{\pi 1}{1-\alpha}$ and $\frac{\pi 2}{1-\alpha}$ refer to the effects of the municipality populational density and the industrial agglomeration, respectively. The logarithm application in (5) produces:

$$Log\frac{Y_{ij}}{L_{ij}} = Log\varphi_j + \frac{\beta}{1-\alpha}Log\frac{H_{ij}}{L_{ij}} + \frac{\pi 1}{1-\alpha}LogD_{ij} + \frac{\pi 2}{1-\alpha}LogI_{ij} \qquad (6)$$

Since the focus is to analyze the effect of the service sector agglomerations – knowledge intensive and non-knowledge intensive businesses – linked to the productive activity, the agglomeration found in (6) was subdivided into three types, according to the application proposed by Zhang (2016): industrial agglomerations (IAG), agglomerations of knowledge intensive service businesses (KIBS) and agglomerations of non-knowledge intensive service businesses (NKIBS).

In Zhang' estimates (2016) for 280 cities in China, he identified that the KIBS agglomerations are important for the urban productivity and outnumber the NKIBS agglomerates. Moreover, he found evidence that KIBS agglomerations favor greater urban productivity than industrial agglomerations and NKIBS in more developed cities.

3.2 Empirical model, data source, and parameter estimation strategy

Aiming at analyzing the impact of agglomerations of certain segments in the service sectors (KIBS and NKIBS) and the industrial sector on the economic growth of Brazilian municipalities between 2007 and 2017, equation (6) was estimated for the 5,565 Brazilian municipalities, and also for the most developed regions in the country (South/Southeast/Midwest) and for the least developed ones (North/Northeast) to investigate regional differences.

To estimate equation (6), the following data was used: *economic growth*, measured through the GDP (Gross Domestic Product) per capita (source: IBGE); *populational density*, corresponding to the population divided by the municipality area (in kilometers, source: Ipeadata); *human capital*, whose *proxy* was the percentage of workers that completed higher education (source: Rais); *industrial agglomeration*, composed of the percentage of workers in the industry of each municipality (Source: Rais); *agglomeration of knowledge intensive businesses in the service sector (BIKS)*, referring to the percentage of workers in KIBS in each municipality (Source: Rais); *agglomeration of non-knowledge intensive businesses in the service sector (NBIKS)*, measured by the percentage of workers in NKIBS in each municipality (Source: Rais).

In the composition of NKIBS, the following segments were considered: real estate activities, land transport, water transport, air transport, transport related and ancillary activities, and travel agencies. The KIBS composition included the following segments: mail and telecommunications; financial intermediation; financial intermediation ancillary activities, insurance and complementary social security; car, machine, and equipment rental without drivers or operators, objects, people, and domestic service; computing activity and related services; research and development; and service rendered to companies. It seems relevant to point out that regarding KIBS, the companies listed, in general, transmitted knowledge to other economic actors, while NKIBS were basically users of pre-defined knowledge (Zhang, 2016), which was also related to the productive activity. Equation (6) was estimated as follows:

$$Log\ y_{ij} = \frac{\beta}{1-\alpha}Log\ \ h_{ij} + \frac{\pi 1}{1-\alpha}LogD_{ij} + \frac{\pi 2.1}{1-\alpha}LogAGL_{ij} + \frac{\pi 2.2}{1-\alpha}LogKIBS_{ij} + \frac{\pi 2.3}{1-\alpha}LogNKIBS_{ij} + u_{ij} \qquad (7)$$

Where: *y* is the economic growth; h is the human capital, *D* is the populational density; *AGL* are industrial agglomerations; *KIBS* are agglomerations of knowledge intensive business in the service sector; NKIBS are agglomerations of non-knowledge intensive business in the service sector; and *u* is the residue.

Theoretically, some endogeneity is observed between agglomerates and economic growth, and between the latter and urban density. Wooldridge (2002) highlighted the existence of three possible sources for the existence of endogeneity in data, namely, measure error, omission of variables correlated to at least one of the explaining variables, and simultaneity. In this paper, endogeneity resulted theoretically from the simultaneity bias, so that the explaining variable affects the dependent variable, and vice-versa. To solve such problem, the two-stage least squares method (2SLS) with instrumental variables was used. Following the methodology put forward by Combes et al. (2008) and Zhang (2016), the instrumental variable used was the time lag corresponding to five years of urban density, industrial agglomerates, KIBS, and NKIBS.

For this instrument to remain valid, it is important that two hypotheses are satisfied. The first refers to the relevance of the instrument, so that it must be correlated to the endogenous variable (D, AGL, KIBS and NKIBS). However, in addition, the estimator cannot be weakly identified. For this reason, the Hausman test[3] was employed to validate the instruments used. The second hypothesis needed to ensure that the validity of the instrument refers to its exogeneity, this hypothesis is theoretically validated by the instruments used as referred by Combes et al. (2008), and Zhang (2016).

Thus, the endogeneity in (7) was solved by applying the two-stage least squares method, with the use of instrumental variables. Moreover, theoretically, space is important in the formation of urban productivity, in addition to being relevant in the formation of agglomerates. Therefore, as an empirical strategy for (7), a spatial panel was built, considering all Brazilian municipalities in the period 2007, 2012, 2017[4]. The use of a spatial panel aims to control the unobservable spatial heterogeneity that manifests in the regression parameters, mainly in the intercept. The spatial heterogeneity must be controlled by means of using either fixed effect models or random effect models, whose choice was based on the *Hausman* test, which led to the option for the fixed effect model[5].

The general specification of the spatial fixed effect model can be represented by (8).

$$y_t = \alpha + \rho W_1 y_t + X_t \beta + W_1 X_t \tau + \xi_t \qquad (8)$$
$$\xi_t = \lambda W_2 \xi_t + \varepsilon_t$$

Where: α is the unobserved heterogeneity; ρ and λ are scalar spatial parameters; τ is a spatial coefficient vector; W is the spatial weight matrix[6]; $W_1 y_t$ corresponds to the dependent variable spatial lag; $W_1 X_t$ are the spatially lagged explaining variables; $W_2 \xi_t$ represents the spatially lagged error term. Starting from these general models and imposing some restrictions regarding the behavior of parameters ρ, τ and λ, different forms of spatial fixed effect models can be specified.

[3] For D2003, 23.4 was obtained; for AGL2004, the test resulted in 13.6; for KIBS, the result was 22.8; the NKIBS result was 13.4

[4] The Pesaran CD test value was equal 73, indicating the spatial dependence of stacked data.

[5] The value obtained in the *Hausman* test corresponded to 2088, indicating the fixed effect model as the most suitable.

[6] The matrix chosen was the ten neighbors for obtaining the highest Moran I of residues in the estimate before the application of spatial econometry.

In this study, three specifications were tested: spatial gap (SAR), spatial error model (SEM), and spatial Durbin (SDM). Regarding SAR, it indicates that changes in the explaining variable of a region affect not only the region itself due to the direct effect but can also affect the dependent variable value in all regions due to indirect effects (Almeida, 2012). Such indirect effects are interpreted as spatial spillovers, represented by ρ. In models of the SEM type, the spatial dependence manifests in the error term, considering that the errors associated with any observation are the average of errors in the neighboring regions, added to a random component. This model informs that the effects on the dependent variable do not result only from the shock (represented by the error term) of a region, but from the spillover of shocks coming from neighboring regions, which are captured by λ. Finally, the SDM model incorporates the idea of spillover through the explaining variables (WX) lag, along with the dependent variable (ρ) lag.

To choose the model that best fits the data, the information criteria Akaike and Schwarz were used, considering the best model the one that presented the lowest information criterion value. In this case, the SDM model was the one presenting the best adjustment (according to the results in Appendix A). After model (8) was estimated, the spatial randomness of its residues was confirmed, as described in Appendix B.

4. Agglomerations and their Importance in Urban Productivity

The aim of this paper was to analyze the impact of agglomerations of certain segments of the service sector (KIBS and NKIBS) and the industrial sector on the economic growth of Brazilian municipalities between 2007 and 2017. The evolution of the industrial density and the KIBS and NKIBS density between 2007 and 2017 (Table 1) showed that over time, both segments the KIBS and NKIBS increased their participation in the Brazilian employment rates, in opposition to the industrial sector dynamics that reduced its participation.

Table 1: Average of the GDP per capita (thousand BRL - 2007=100[7]), industrial density (AGL - %), BIKS (%) and NBIKS (%) density in Brazilian municipalities and their regions - 2007 and 2017

	GDP per capita		AGL		BIKS		NBIKS	
Region	2017	2007	2017	2007	2017	2007	2017	2007
Southeast	12.1	11.0	15.81	16.76	4.52	3.98	3.31	2.66
South	15.6	12.4	23.74	25.13	4.57	3.46	4.41	2.66
Midwest	15.3	11.3	12.90	13.53	3.87	2.87	2.60	1.79
North	7.9	5.8	5.52	7.30	3.04	2.63	1.47	1.18
Northeast	5.4	4.3	6.63	7.03	2.49	2.12	1.16	0.79
Brazil	10.6	8.8	13.47	14.38	3.70	3.07	2.64	1.86

Source: Research results

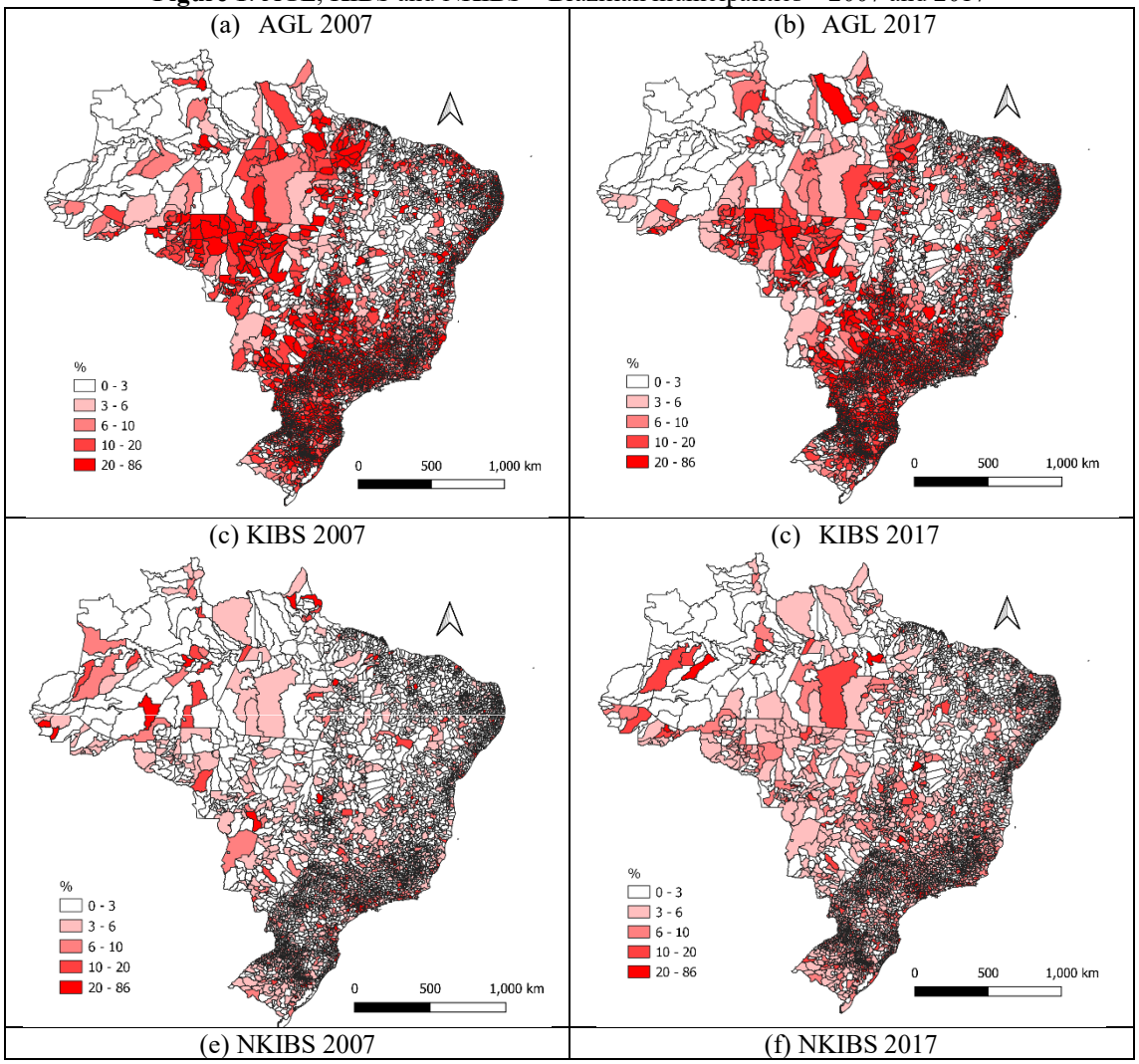
Regionally, greater participation of the industrial, KIBS, and NKIBS activities was observed in the Southern, Southeastern, and Midwestern regions. As highlighted by Cano (2008), the regional distribution of these activities has been historically unequal, concentrating mainly in the Southeastern region up to the 1970s, with some decentralization to the South mainly from the 1990s onwards (resulting from the proximity of this region with the Mercosur, the development of agro-industrial activities, etc), and more recently to the Midwestern region with the expansion of the Brazilian agricultural border.

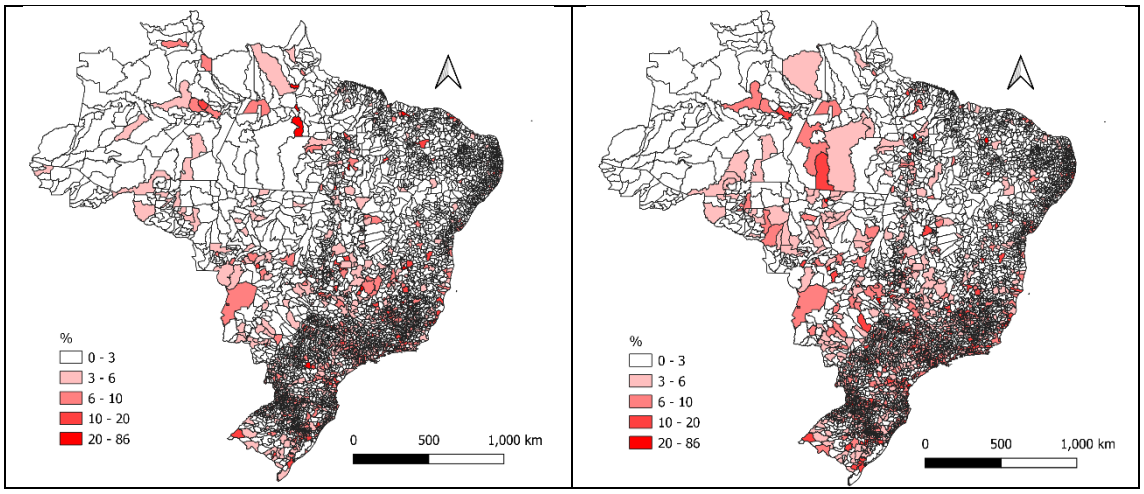
[7] The GDP deflator was used and 2007 was the base year.

The most recent evolution of the location of these productive activities (AGL, KIBS and NKIBS) was also verified (Figure 1). When the industrial density was investigated, 60% of the municipalities decreased their participation in this sector regarding employment generation between 2007 and 2017, mainly in the municipalities of the Northern and Northeastern regions, evidencing a process of reduction in their industry participation in the Brazilian economy.

At the same time, the participation of KIBS and NKIBS of the service segment was increased, so that 82% of the municipalities showed an increase in the percentage of jobs in NKIBS and 71% in KIBS, evidencing greater intensification of the NKIBS dynamics all over the country. Although this increase was observed in almost all Brazilian municipalities, the percentage of workers in this activity is still low, that is, below 4% in average. Therefore, both KIBS and NKIBS are activities presenting relevant growth, but still in phase of construction.

Figure 1: AGL, KIBS and NKIBS – Brazilian municipalities – 2007 and 2017





Source: Research results

As pointed out by Krugman (1991), the spatial distribution of productive activities is decisive in the process of increasing the productivity of certain region. When a company sets up business on a certain point in space, positive feedbacks might be generated, reinforcing local externalities, and attracting new investments. This positive evolution of the segments selected in the service sector is a positive point for the local dynamics of each region, presenting a spatial concentration pattern of these agglomerates (as demonstrated by the Moran I in Table 2), possibly resulting from the externalities generated (such as the concentration of workforce and consumers, availability of infrastructure, concentration of related services, technological spillovers, etc.) according to the spatial concentration.

Table 2: Moran I – AGL, BIKS, NBIKS – Brazilian municipalities – 2007 and 2017

	Queen	Tower	4 neighbors	5 neighbors	10 neighbors
Agl 07	0.45*	0.44*	0.45*	0.44*	0.41*
Agl 17	0.45*	0.45*	0.46*	0.44*	0.43*
BIKS 07	0.17*	0.16*	0.17*	0.15*	0.16*
BIKS17	0.18*	0.17*	0.18*	0.16*	0.16*
NBIKS07	0.26*	0.26*	0.26*	0.26*	0.27*
NBIKS17	0.31*	0.30*	0.32*	0.30*	0.30*

Source: Research results
Note: 99999 permutations; * statistically significant at the 1% level of significance.

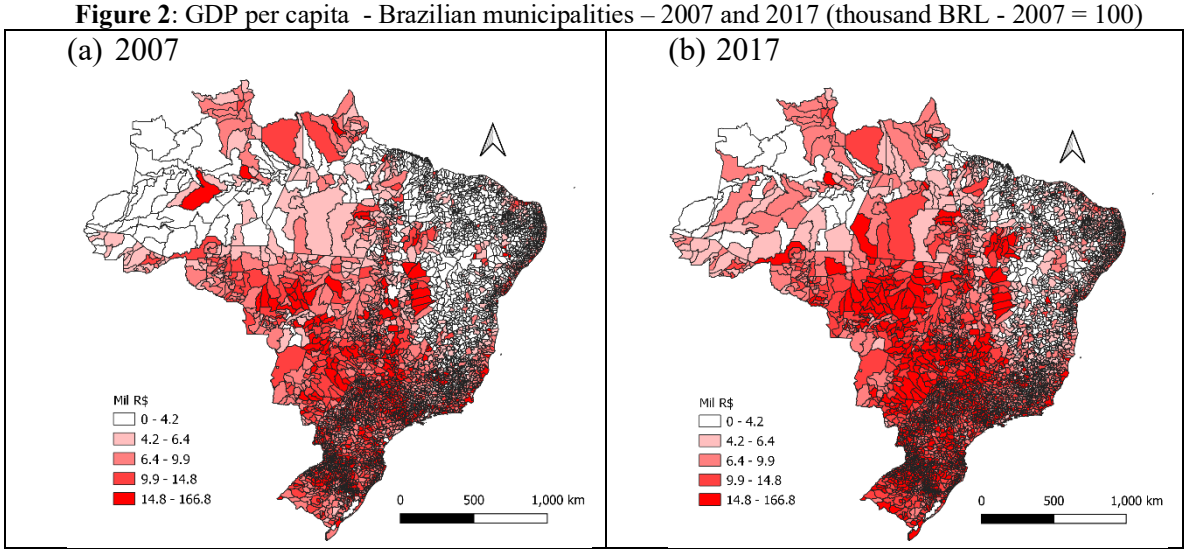
Therefore, an advancement of the agglomerations of the segments selected in the service sector with the formation and intensification of spatial densification was observed over time.

Considering this scenario, the impacts of these agglomerations on the economic growth of Brazilian municipalities was investigated. The evolution of the GDP per capital in Brazil and its regions was observed (Table 1) and although a big economic crisis occurred in the period under analysis (in 2015, which was the biggest crisis in the last thirty years), the average GDP per capita between 2007 and 2017 grew 14%. Moreover, 84% of the Brazilian municipalities managed to increase their economic dynamics. This can be verified when comparing Figures 2a and 2b, with intensification of the economic dynamics mainly in the Midwestern region. However,the North and mainly Northeast are regions that still present great gaps in economic growth.

As for the spatial distribution, the GDP per capita showed a concentration pattern (Table 3), so that municipalities with high GDP per capital tended to have neighbors with similar

characteristics (and vice-versa). In addition, the Moran I value increased over time, signaling and enlargement of the GDP per capita spatial concentration pattern all over the country.

Figure 2: GDP per capita - Brazilian municipalities – 2007 and 2017 (thousand BRL - 2007 = 100)



Source: Research results

Table 3: Moran I – PIB per capita – Brazilian municipalities – 2007 and 2017

	Queen	Tower	4 neighbors	5 neighbors	10 neighbors
2007	0.30*	0.29*	0.31*	0.28*	0.28*
2017	0.36*	0.35*	0.37*	0.32*	0.33*

Source: Research results

Note: 99999 permutations; * statistically significant at the 1% level of significance.

As observed, most of the municipalities advanced economically over the years, and tended to be close to each other, with spatial externality trends. Therefore, the importance of AGL, BIKS and NBIKS agglomerations in the process requires some discussion (Table 4).

When analyzing Brazil as a whole, we could observe that the BIKS and NBIKS agglomerates did not affect, on average, the municipal economic dynamics. In fact, industrial agglomerations were seen to be important in this process. That is, when considering all municipalities in the country, the service sector dynamics related to the productive activity was not a key element for the economic growth, which is still dependent on the industrial concentration.

In fact, the industry appears as the engine of the economic growth as already pointed out by Raiher (2019). In that work, the author evidenced a positive effect of the productive specialization in Brazilian municipalities, mainly referring to the low technology industry, without significant effects for more technologically advanced industries. This might somehow justify the lack of statistical significance of BIKS agglomerates, considering that the most relevant productive structure for most municipalities in the country still relies on low technology, which is not in the most advanced stages of development, not making the segments related to the productive activity in the service sector relevant to promote development.

Regionally, due to the existing heterogeneity in the country, the effects of agglomerations of knowledge intensive businesses in the service sector was seen to be different, so that in the group of more advanced economic development regions (South, Southeast, and Midwest) the effect was positive and statistically significant. Similar result was also reported

by Zhang (2016), inferring that BIKS agglomerations favored more strongly the urban productivity in more developed municipalities in China.

Thus, the actual impact of BIKS agglomerations is only perceived by advancing the municipal economic dynamics. Since, especially in the North and Northeast, the rhythm of economic growth is still very low – due to the smaller existing productive structure in those regions (Perobelli, & Hadad, 2006) – BIKS agglomerations are not relevant yet for the economic growth. Veríssimo and Saiani (2019) confirmed the results found in this study when they analyzed Brazilian municipalities. Those authors identified that the service sector cannot optimize its effects on the product when the municipality has a lower income.

Table 4: Spatial determinants of GDP per capita – spatial panel***

Variables	Brazil EF	Brazil SDM – EF	North/Northeast SDM - EF	South/Southeast/Midwest SDM – EF
AGL	0.003*	0.002*	0.0002**	0.03*
BIKS	0.0005*	0.0009	0.00009	0.002*
NBIKS	0.005	0.0008	0.001	0.0005
Density	-0.56*	-0.79*	-0.82*	-0.65*
KH	0.003	0.004	0.0005	0.05*
WY	-	0.84*	0.98*	0.43*
WAGL	-	-0.002	-0.001	-0.005**
WBIKS	-	0.002	-0.0004	0.003
WNBIKS	-	0.0002	-0.003	0.002
WDensity	-	0.59*	0.82*	0.60*

Source: Research results

Note: (*) statistically significant at the 5% significance level. (**) statistically significant at the 10% significance level. (***) spatial panel estimated using the Instrumental Variables or Generalized Method of Moments (GMM), in which in addition to the usual instrument of spatial econometry, the AGL, KIBS, and NKIBS endogeneity was also controlled, using proper instruments for each one, as presented in the methodology.

Regarding NBIKS agglomerations, even when subdividing the country according to the existing economic development, they were not seen as important elements in this process, without regional differences. In fact, even being activities linked to the productive structure, they tended to be induced by the local development rather than being the engine of economy.

Industrial agglomerations, in turn, showed positive and statistically significant coefficients in both North/Northeast and South/Southeast/Midwest groups. Therefore, fostering the Brazilian industrialization is one of the main ways to generate effects on the municipal GDP per capita, regardless of the Brazilian region. Raiher (2019) observed a positive effect of industrial agglomerations on the productivity all over the country, evidencing the significant relevance of the secondary sector as the engine of economic growth.

As regards spatial effects, the spatial lag of industrial agglomerations in the South/Southeast/Midwest group was negative and statistically significant. This means that the increased industrial concentration in a municipality tends to affect, on average, negatively the GDP per capita in neighboring municipalities. Hirschman (1958) emphasized that when an agglomerate exists, its effects might go beyond borders, affecting the neighborhood. This impact usually tends to be positive, due to the installation of satellite industries in the surrounding area, the purchase of raw materials, etc. However, it might be also negative, mainly for the transfer of human capital to neighboring municipalities, which is attracted to the agglomeration center, or due to the leakage of income, among others.

When the demographic density was analyzed, both in Brazil and each group of regions, it was seen to be statistically significant, with negative effect. Therefore, pointing out

agglomeration diseconomies, suggesting that the higher the populational concentration is, the lower the economic growth pace is.

Finally, the importance of the spatial effect on the GDP per capita was evidenced, showing a spillover effect of the GDP per capita to neighboring regions all over the country.

5 Final Considerations

This study sought to analyze the impact of agglomerations of certain segments in the service sector and the industrial sector on the economic growth of Brazilian municipalities. More specifically, we focused on knowledge intensive businesses in the service sector (BIKS) and non-knowledge intensive businesses in the service sector (NBIKS).

Our results showed an advancement in the BIKS and NBIKS segments, with increased mean percentage of the participation of these companies in the job market, although it is still under 4%, and a spatial distribution pattern of these agglomerations was observed. Regarding the GDP per capita impact, neither BIKS nor NBIKS showed any effect when all municipalities were considered, and in the regional analysis, some impact was only seen in the most developed regions of the country.

Two hypotheses were considered to explain such results: 1. The impact of these segments of the service sector only appears when more mature development of the productive structure is observed, and/or; 2. The participation of these segments in the Brazilian productive activity is still very low, and it lacks enough mechanics to generate externalities in the economic growth. The literature, mainly international, addresses the importance of the service sector – mainly that of the BIKS segments – for the economic growth process; in this sense, the absence of significant effects does not invalidate the pursuit of development of this sector, but rather indicates that chains and more robust investments must be implemented so that these segments can evolve and favor economic growth. In fact, the participation of these segments in the country productive activity is still low and concentrated in few spaces.

As for industrial agglomerations, they were seen to be important in the formation of the municipal economic dynamics, being the main tool to obtain economic growth all over the country. Therefore, industrial externalities were seen to be stronger in promoting economic growth than those of the service sector. It seems relevant to emphasize once more that this does not mean that the development of these sectors should be neglected, but that it is necessary to form a more solid industry, allied to a more dynamic service sector, mainly in the least developed regions of the country.

Further studies should analyze the effect of links created between the technology intensive industry and BIKS segments on the productivity and economic growth of Brazilian municipalities.

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APPENDICES

APPENDIX A: Akaike Information Criterion

	SAR	SEM	SDM
Brazil	-1778	-1643	-1780
North/Northeast	-1334	-1331	-1387
South/Southeast/Midwest	-1891	-1876	-1894

Source: Research results

APPENDIX B: Moran I residues –EF spatial panel

	2007	2012	2017
Brazil	0.02	0.03	0.002
North/Northeast	0.01	0.01	0.02
South/Southeast/Midwest	0.001	0.01	0.01

Source: Research results