THE IMPACT OF INDUSTRIAL SPECIALIZATION OR DIVERSITY
ON EMPLOYMENT AND WAGE GROWTH:
AN ANALYSIS OF THE BRAZILIAN CASE IN THE 1990S

by

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The Impact of Industrial Specialization or Diversity on Employment and Wage Growth: an Analysis of the Brazilian case in the 1990s[1]

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Abstract   The objective of this paper was to verify if the specialization in a given industrial sector generated positive externalities in the Brazilian microregions. Analysis explored whether specialization had a greater impact on employment and wage variation in the microregions than industrial diversity, during the 1990s, when the focus upon specialized agglomerations was reinforced as the way to promote local economic development. The method utilized was adapted from the Glaeser *et al.* model, an externalities generation model applied to the USA case. The results showed that changes that occurred in the Brazilian industrial sector in the 1990s influenced the impact of specialization and diversity on employment and wages, and that there are many differences across the regions of the country. On the whole, the outcome showed that the specialized microregion was important to foster employment in a region where the clusters were consolidated. In a region where the clusters formation was initiated in the 1990s, the tendency was to decrease the employment and increase the wages, indicating a process of productivity augmentation. The implication is that mature industrial concentrations can foster growth more than other locations at least in Brazilian case, confirming the principal hypothesis about the presence of increasing returns in specialized locations.

1. Introduction

Recent growth theories attempt to explain the increase of disparities in development across the regions of the world in the last decades and, consequently, identify the main variables that affect economic growth. The common factor claimed to provide some explanation is notion of increasing returns generated when productive activities concentrate in some locations. Romer (1986), for example, attributes the occurrence of this phenomenon to knowledge spillovers,

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whereas Lucas (1988) promotes human capital and Grossman and Helpman (1994) suggest technology as the main factors responsible for generating increasing returns.

The main explanation for increasing returns in the concentration of activities is that geographical proximity generates externalities of a type that all firms enjoy. According to Romer (1986), for example, where there are many firms, the knowledge can spread to from one firm to another almost without cost. The investment in knowledge by each firm can improve the profit of others, generating a process of increasing returns. As a result of this process some locations, where the externalities are larger, grow faster than others.

In a recent study, Glaeser *et al*. (2001) addressed this issue by trying to answer the following questions: why and how do industries and consequently cities grow, concentrating productive activities; and what kind of productive arrangement is better to produce knowledge spillovers, thus creating the conditions responsible for faster growth. More specifically, they investigated whether this phenomenon occurs in more specialized cities, which produce the same product, or in more diversified cities, which have many different productive activities. Their work focuses on cities because they assumed that in cities the interaction among people is higher than in rural areas and, as a consequence, the externalities generated by transmission of information will also be higher.

The model was constructed based on three theories that deal with technological externalities. The first one also aggregates the ideas of three authors and is termed Marshall-Arrow-Romer (MAR) externalities.[2] The concentration of one kind of industry encourages the appearance of knowledge spillovers, through the intense competition among firms that try to spy and imitate and through information flow carried by qualified workers. The second theory in the model, addressed by Porter (1990), also argues that knowledge spillovers are more likely to appear in specialized locations; the difference is that he emphasizes local competition as important in the generation of innovation. The last theory incorporated into the model refers to the approach of Jacobs (1969), who claimed that diversification, rather than specialization, is important to foster fast growth in industry.

Glaeser *et al* (2001) focused on the largest industries of 170 cities in the USA[3] in order to check whether externalities are a permanent phenomenon. In this case, the externalities should

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[2] Marshall (1890), Arrow (1962) and Romer (1986).
[3] Cities were constructed taking the 170 largest standard metropolitan areas (SMAs) in 1956.

continue in the largest industries and not in the smallest industries, especially those that are still in formation. The main results of their work were: (1) the local competition and diversification were effective in explaining the employment growth in industry, but not specialization, from 1956 to 1987; and (2) the smaller size of firms, in comparison with the national average size of firms in the same industry, contributed to faster growth.

Based on this research, the objective of this paper is to apply the Glaeser *et al.* (2001) model to the analysis of Brazilian industrial growth after 1990, when many structural changes started to occur in the economy of the country. More specifically, the paper will evaluate which kind of geographical arrangement has been more effective in explaining the employment and income growth –, more specialized regions or more diversified ones. Since, historically, the southern half is more developed than the northern half of the country, the study analyzes separately each of five Brazilian regions (North, Northeast, Southeast, South and Center-West)[4].

One of the motivations in studying this issue derives from the fact that specialized areas in some productive activity have been a major part of the policy focus of Brazilian governments at all administrative levels. The governments have provided some type of support to firms in order to strengthen the agglomeration tendencies, in hopes of promoting regional development. It was hypothesized that clusters generate externalities that stimulate faster growth rates. In Brazil, the Federal government, for example, maintains, in the Ministry of Development, Industry and Trade, a group that it is responsible for studying productive agglomerations in order to help the government make decisions about how to provide support to selective specialized areas.

The other motivation is related to the increasing research about the interconnection between productive agglomerations and regional development. There are many studies based on different theoretical approaches, methodologies, foci of analysis, but most have a common goal, which is to try to understand what is the effect of the concentration of productive activities of some regions on their per capita income, productivity, growth rates of the production and so forth. Just to cite some of the studies in this specific topic, the Economics Institute from University of Rio de Janeiro analyzed many industrial agglomerations such as the telecommunication sector in Campinas, one of the largest municipalities of São Paulo State

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[4] This is the largest territorial geographic division of Brazil.

(Dória *et al.,* 2000) and the case of FIAT in the Minas Gerais State (Lemos *et al*, 2000).[5] In the case of Brazil, disparities of regional income constitute one of the major problems of the country, providing significant motivation for this type of research.

Following this introduction, the paper is organized as follows: section two identifies the principal changes in the Brazilian economy in the 1990s that had an impact upon the industrial structure of the country and cites some indicators of Brazilian regions performance; in section three, the methodology in the Glaser *et al* (2001) model will be presented and the variables and the data source used in this research will be defined. Section four presents the main results and their analyses; and, finally, section five provides a summary and some concluding comments.

2. Brazilian economy and Brazilian industry in 1990s

2.1 Stabilization plan, privatization and fiscal war

The Brazilian industry was not globally competitive at the beginning of the 1990s. On the one hand, the great problems faced by the Brazilian economy mainly in 1980s, such as foreign debt and inflation, reduced the level of private and public investments. On the other hand, the government policies were excessively protectionist, allowing many industries to survive without modernizing their production process. According to Coutinho and Ferraz (1993), at the end of 1980s the main characteristics of Brazilian industry were: old production process; many firms in each kind of industry with average size below the international average; firms producing the whole productive chain, and so on. This combination of characteristics resulted in an old-fashioned, expensive industrial structure that often produced products of inferior quality.

This was the landscape of Brazilian industry when the Brazilian economy started to change in the beginning of 1990s. One of the main causes of the transformation process was the greater exposure of the economy to international trade by imposition of World Trade Organization mandates and by changes in economic policy implemented by the newly elected president who was identified more with liberal ideas. The Collor Government implemented a plan named Industrial Policy and Foreign Trade, which had objectives such as to stimulate competition and to increase competitiveness in order to face the new worldwide economic environment. Foreign trade policy changed with the establishment of a schedule for reducing the

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[5] Many others papers can be cite such as Suzigan *et al.* (2001), Crocco *et. al.* (2003).

import tariff in the short term, thereby decreasing the protection of the national products (Castro, 2005).

There were many criticisms about the economic policy of this government and when the vice-president took office as the new president (President Collor was forced to resign at the end of 1992), the foreign trade policy changed in many aspects because the abrupt reduction of the import tariffs started a process of deindustrialization in the country. However the main point to emphasize here is the change in public sentiment about the large and increasing protection that was provided to industries since the acceleration of the industrialization process after 1930, which caused lack of innovation in productive sectors within Brazil. In the beginning of 1990s, Brazil was not in a condition to compete in the world market in most industrial sectors. In order to face the higher competition, the private entrepreneurs reacted to this new situation and the process of industrial restructuring began. After investment fell to a minimum level in the end of 1992 (13.4% of the GDP), it started to increase again. Most of the investments were accomplished through the importation of machinery and equipment. Capital goods imports increased by 48% in 1993, 43% in 1994 and 58% in 1995. At the same time, the foreign direct investment increased from US\$ 877 million in 1993 to more than US\$ 2,2 billion in 1994 (Pinheiro, 1995, pp.23-24; FGV, 1996 and Coutinho & Ferraz, 1993).

The changes were deepened with the privatization process of state firms, which started at the end of 1980s and accelerated with the implementation of the stabilization plan, *Plano Real* in 1994. The major share of international money that entered in this process to invest in government firms helped to diminish the trade balance. The industrial restructuring has continued with the entry of new capital and new technology, modernizing the production process, improving the quality of goods, producing new products and increasing productivity (Pinheiro and Fukasaku, 2000; Castro, 2005).

Another change that can be mentioned is the fiscal war[6] phenomenon that started in 1989, after the new Constitution from 1988 that gave more autonomy to Brazilian states. The state governors have provided different combinations of fiscal and credit subsidies in order to attract investments and, consequently, to promote the development of their states.[7] Private firms, in

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[6] The fiscal war constitutes a concession of fiscal and credit subsidies in order to attract investments to the regions.
[7] Eight states out 27 were highlighted by the government development bank (BNDES) as the more aggressive in fiscal war: Rio Grande do Sul e Paraná (South Region), Espírito Santo (Southeast Region), Goiás (Center-West Region) e Bahia, Pernambuco e Ceará (Northeast Region).

turn, have chosen the municipalities according specific criteria such as the presence of infrastructure in transportation, in energy and others; the presence of qualified or cheap manpower and so on. In many cases the investments have gone to cities in some specific industry, which has established or enhanced the specialization of these industries.

Summing up, after 1990s Brazilian industry has presented many structural transformations. Vermulm (1999) pointed out five key changes that occurred in this decade. The first change was the reduction of the participation of industrial value-added in the GDP. In fact, as Vermulm emphasized, the industrial value-added in the Brazilian GDP has decreased during the 1990s, from 32.3% in 1989 to 20.7% in1998. However, after this year the industrial value-added has increased again to 24.2% in 2005. This result may have been influenced by the favorable performance of the export of agro industry products.

The second tendency was the change in the industrial structure in terms of participation of each industrial category according to their use, in which durable goods increased more than any other category, from 1980 to 1997. The data obtained from IBGE (2006) from 1991 to 2003[8] confirm this tendency and durable goods increased by about 71%. The production of both capital goods and intermediate goods increased 37.4% and 37.3% respectively. Finally, semi-durable and non-durable goods showed very low rates of growth, only 4.2% in this period.

The other tendency was the change in the import and export structure. The import coefficient (imports divided by total consumption) in high-tech products, from a technological, economic and foreign trade point of view, registered higher growth in 1990s than traditional products. On the export side, the opposite situation occurred – the export coefficient of products derived from natural resources presented a higher rate of growth.

The fourth change may be considered the reverse of import substitution whereby there was an increase in the use of foreign parts products in Brazil production; this occurred because locally produced components were not competitive. Finally, according Vermulm (1999), the industrial restructuring process has increased labor productivity. Changes such as firms' de-verticalization (or what Jones and Kierzkowski 2005 would refer to as the fragmentation of production, in which production would be broken into components spread across many establishments), higher import of parts, and the introduction of technical and organizational innovations, increased the product per worker.

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[8]IBGE – Monthly Industrial Research, 2006.

This restructuring process has made industry more efficient and competitive and has also transformed the industrial landscape in terms of participation of each kind of industry in the total industrial production value, geographical relocation of industries, productivity, as well as other changes.

Sousa (2002) verified that there was a decentralization process of Brazilian industry across the country after the 1970s. Two states in the Southeast Region which concentrated almost 75% of gross product – São Paulo (58%) and Rio de Janeiro (15.6%) – in 1970, showed a greater decrease in their share; on the other hand, most other states increased their participation, especially those in the South Region. This process was more evident before 1985. After this year, the rate of decentralization decreased among the states. In the case of São Paulo, this phenomenon can be explained by the strong migration of industries from the capital of the state to its interior.

Azevedo and Toneto (2001) confirmed this tendency, showing that employment in the 1990s migrated across regions of the country, implying a decentralization process. Employment in intensive labor sectors moved to regions that paid lower wages; employment in intensive natural resource sectors migrated to locations that were abundant in this factor; and finally, employment in intensive capital sectors moved to states near São Paulo, such as Paraná and Minas Gerais. There was also migration of employment inside São Paulo State. Sabóia (2001) verified the same movement of jobs, observing that some newer regions such as the Center-West as well as some states of Northeast and South Regions increased their participation in national employment as well. Public policies were very important in influencing regional relocation because they provided firms with the incentives and subsidies to move to particular states. Many policies sought to attract firms that produced similar goods, such as footwear, garments and so on. Summing up, the alterations, which occurred in Brazilian industry during the 1990s contributed to changes in productive structure and location.

2.2 Performance of Brazilian Regions

Brazil is usually divided into five major regions which aggregate a different number of states[9], as can be seen in figure 1. The Northeast and North Regions are the poorest parts of the

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[9] There are 26 Brazilian states distributed as follow: seven in the North Region; nine in the Northeast; four in the Southeast; three in the South; and three in the Center West Region. There is also a Federal District, the capital of Brazil.

country, concentrating more than 35% of the Brazilian population but employing only 15% of the country's industrial employment. Most of these employees work in traditional sectors such as food, garments, textile, furniture, footwear, and so on, that constitute about 65% of the total industrial jobs in both regions. On the other hand, in high-tech industries such as machine and equipment, computers, telecommunications, electric, electronic, automobile and others, the participation is very low, 2.5% in the North and 7% in the Northeast Region (IBGE, 2006).
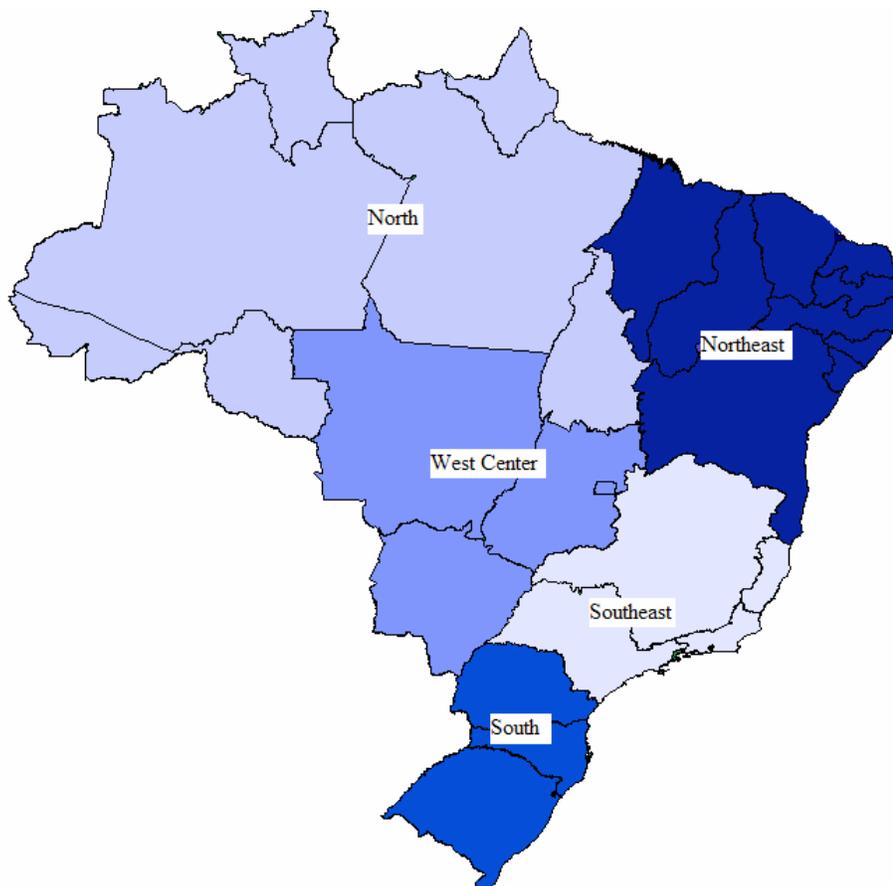
Figure 1: Brazilian Regions

The Center-West Region has been increasing its agribusiness sector due to abundant and fertile land and favorable climatic conditions. It concentrates almost 7% of the Brazilian population but only 3.3% of Brazilian industrial GDP. The average wage in the 1990s recorded one of the largest rates of increase in the country, behind only the South Region. However, the

participation of its high-tech industries is very low, 6.8%, while the share of traditional industry is almost 60%.

Finally, the Southeast and South are the most industrialized and most technologically developed regions of Brazil, accounting for about 43% and 15% of nationwide population and almost 48.5% and 29% of industrial GDP, respectively. The Southeast Region employed 32% of total industrial workers in traditional sectors and 11% in high-tech sectors; while the shares for the South Region were 61% and 8,45%, respectively. Considering national participation, these two regions combined account for 86.7% of the jobs in high-tech industries in the country.

As the table 1 shows, during the 1990s total employment decreased, significantly, by about 13%. At the regional level, the Center-West Region showed significant growth in employment (110%) while two regions – North (2%) and Northeast (0.1%) – had smaller growth rates and the Southeast and the South experienced decreased growth rates – 25% and 0.7%, respectively. The Southeast Region registered a large reduction in employment due to industrial restructuring, which used labor-saving technology and because of the migration of employment to other regions of the country. At any rate, considering the nationwide labor market, the tendency was for a decrease in the number of jobs due to the adoption of labor-saving technology.

<<insert table 1 here>>

For a different period, from 1996 to 2003, the data show that participation in Brazilian industrial employment increased in all regions except in the Southeast, confirming the continuity of the process of productive restructuring and the process of relocation of industrial activities. Further, average wages increased substantially during this decade (1990s) in all regions, according to the IBGE microdata. The largest increase occurred in the South Region and the smallest was registered in the Southeast.

3. Methodology

3.1 Knowledge Spillovers Model

Glaeser *et al.* (2001) constructed their model aggregating the main factors that cause externalities from the three models mentioned above: Marshall-Arrow-Romer, Jacobs and Porter. To construct this model, they started from the following function – $A_i f(l_t)$ – which represents a

production function of output of one firm of one industry in a given location, where A_t represents changes in technology and changes in price at time t and l_t is labor input at time t. This model abstracts from capital inputs because they do not have a measure of total productivity. The variables technology, prices and wages are taken as given and each firm maximizes $[A_t f I(l_t) - w_t l_t]$ and the marginal product of labor is equal to wages:

$$A_t f'(l_t) = w_r \tag{1}$$

Rewriting (1) to transform it into growth rates we have:

$$\log\left(\frac{A_{t+1}}{A_t}\right) = \log\left(\frac{w_{t+1}}{w_t}\right) - \log\left[\frac{f'(l_{t+1})}{f'(l_t)}\right] \tag{2}$$

As long as the technology A_t is assumed to have national and local components, the growth rate of technology can be defined as follows:

$$\log\left(\frac{A_{t+1}}{A_t}\right) = \log\left(\frac{A_{local,t+1}}{A_{local,t}}\right) + \log\left(\frac{A_{nacional,t+1}}{A_{nacional,t}}\right) \tag{3}$$

According to the model, the growth of national technology captures changes in the price of the product as well as in the technology of the industry, while local technology captures technological externalities in this industry in the city or region. The latter can be written as:

$$\log\left(\frac{A_{local,t+1}}{A_{local,t}}\right) = g \text{ (specialization, local monopoly, diversity, initial conditions)} + e_{t+1} \tag{4}$$

In this initial function, they aggregate the effects of specialization, local competition and diversity in the development of the cities. Specialization measures if there is a particular industry that is concentrated in a city, which is part of MAR and Porter models; local monopoly is related to the firm size of the most important industries in a city and is an important variable for Porter; diversity measures the opposite of specialization or, in other words, if there are many kinds of industrial sectors in a city, (derived from Jacobs´ model); and, finally, the initial conditions are related to initial wages, employment and so on.

The final equation consider that $f(l) = l^{1-\alpha}$, $0 < \alpha < 1$ and combines the equations (2), (3) and (4). After some mathematical manipulations, the final equation[10] is as follows:

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[10] All steps for constructing the model are in the cited paper.

$$\alpha \log\left(\frac{l_{t+1}}{l_t}\right) = -\log\left(\frac{w_{t+1}}{w_t}\right) + \log\left(\frac{A_{nacional,t+1}}{A_{nacional,t}}\right) +$$

(5)

$+ g$ (specialization, local monopoly, diversity, initial conditions) $+ e_{t+1}$

This function means that the growth in employment in an industry in a given city is related to measures of technological externalities. It was assumed that growth in industrial employment accounts for changes in technology and that prices and wages are constant across city-industries.

Thus, $\log\left(\frac{w_{t+1}}{w_t}\right)$ and $\log\left(\frac{A_{nacional,t+1}}{A_{nacional,t}}\right)$ were not calculated in the Glaeser *et al* (2001) model to

measuring the effects of technological spillovers on employment and wages growth.

3.2 Definition of variables

The Glaeser *et al.* (2001) model that was utilized in the present work is equation (5). However, the determination of some variables had several minor modifications in order to adjust to the Brazilian situation. One of the changes is associated with the geographical territorial division under study. In the case of Brazil, the focus was at the microregional level, which aggregates a varied number of municipalities, with one of them functioning as an economic and administrative center. Besides the availability of data, this level was considered more appropriate because it can account for the specialization of a particular region, which tends to spread to neighboring municipalities. The other change was to consider only industrial employment rather than all employment sectors. The reason for this is that if the tertiary sector is added, employment in most of the microregions would be specialized in activities such as trade and government administration. Since the main objective is to analyze industrial agglomeration, it was not useful for the research to use all employment sectors but rather to focus on industrial employment. Any other changes will be described for each variable explained below.

To measure specialization the following equation was used for each microregion (MR):

Specialization[11] =   [industrial employment in M-R/total industrial employment in MR]
                      [industrial employment in Brazil/total industrial employment in Brazil]

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[11] Industrial employment was used rather than total employment as utilized in Glaeser *et al*. model because the analysis includes only the industrial sector.

This variable shows the importance of particular industries in a city. A value greater than one indicates that the microregion is more specialized in a given industry than the average of the country in the same industry.   To verify the degree of specialization, the five largest industries[12] were taken for each microregion.

Local monopoly was defined as follows:

Competition = [firms in microregional industry/workers in MR industry]
                     [firms in Brazilian industry/workers in Brazil industry]

In this case, the interpretation is that the more competitive local environment is related to a value greater than one. However, this paper will not consider this variable because the data are not reliable.

Finally, the diversity in Glaeser *et al.* (2001) model was taken as the participation of the six largest industries minus one in a city in the total industry in a city. In our case, the diversity was adapted as follow:

Diversity = employment of the largest industries in a MR minus one
                        total industry employment in a MR

To calculate this variable, we used the same five largest industries that were used to determine the specialization indeed. For each microregion, there are five diversity indices; in calculating each one, one out of the five largest industries was excluded each time. [13]

The initial conditions utilized in this study were the same utilized by Glaeser *et al.* (2001): log of Brazilian employment in 2000/Brazilian employment in 1991 in the industries out of top five; employment in the 5 largest industries in 1991; and average wage in the 5 largest industries in 1991. The regional impacts were captured a little differently from the Glaser *el al.* (2001) model; they included one dummy for the South region of USA. In our case, because of the great disparities among the regions, we used *n*-1 dummies variables in the model for *n*

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[12] Glaeser *et al.* took the six largest cities. We used five because there were not six industries in many microregions.
[13] Suppose, for example, that in a given microregion the five largest industries are furniture, garment, footwear, textile and food. To determining the first index it has to consider the employment of garment, footwear, textile and food except furniture; the second one it has to take furniture, footwear, textile and food except garment, and so on.

regions.   This was important to account for changes at the microregion level and to observe differences across regions associated with their degree of development.

         The model was run in two ways. First, we used nationwide microregion data in order to analyze the effect of independent variables upon the whole country. Then we put four dummies in four of the five regions,[14] alternating the region that was excluded. Five different results were obtained. Secondly, we ran the model with all microregion data and only one regional dummy for each running in order to obtain five results, one for each region. This procedure was used to check the results of the first model mentioned above. Thus, a total of 20 runs were conducted, ten for specialization and ten for diversification.

3.3 The data

The data of employment and income were extracted from microdata of the Demographic Census organized by the Brazilian Institute of Geography and Statistics (IBGE) for two years, 1991 and 2000. The regional level utilized for the research was the microregion, which aggregates several municipalities. This level was chosen in order to verify if industrial agglomerations that include many municipalities contributed more than other locations to employment and wage growth. Because there are no recent available data for the microregion level, the final year was 2000, when the last Census was taken. There are 558 microregions in the country. Then the initial sample constituted by 2790 observations, 5 for each microregion.   After the outliers were excluded, the final sample had 2672 observations for each variable.

4. The Results

Two tables, which summarize the principal results, were constructed as follows: table 2 reveals the impact of independent variables on employment variations and while table 3 examines the impact on wages variations. It was somewhat difficult to decide how to construct both tables because we obtained five results with four dummies (four out of five regions) and five results with only one dummy (one for each region) for specialization. We obtained the same number of results for diversification.   However, after analyzing all of them, we could observe many consistent results, which means that the same logic was repeated in all functions. The most representative function of employment growth was that which considered four dummies for the

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[14] It is necessary in order to not obtain the singular matrix.

following regions[15]: North, Northeast, Southeast and South. Taking away the dummy of Center-West Region did not alter the main results. This region had the lowest participation in Brazilian industrial GDP in 2000, about 3.4%.

<<insert table 2 here>>

The table 2 shows that the initial conditions variables – log of variation of Brazilian employment in the period 1991-2000 in the industries out of top five and employment in the five largest industries in the initial period (1991) –, had no influence upon employment variation in the Brazilian microregion as a whole nor on any particular region, neither for specialization nor for diversity. Given these results, the dummies of the regions were not presented in the table.

However the average wages in the initial period (1991) had a significant influence on explaining changes in employment in the 1990s. It is interesting to note that, in both columns, the nationwide result has a positive signal, which implies that the higher the initial wages, the higher the employment growth. However, in the Southeast Region, which was the only one that showed a consistent significance in the model, the sign was negative, indicating that in Southeast microregions, high wages had a negative impact upon employment. We can infer that this opposite tendency in relation to other Brazilian regions is due to the degree of industrial development and concentration. It is the most developed region with the highest wages in the country (table 1) that may be related to the very well organized and powerful trade unions. With the increased exposure of the Brazilian economy to international trade and the fiscal wars, firms migrated to other regions in order to gain competitive advantages. In the function in which the dummy of the Southeast was taken out, the wages of four regions registered a positive influence upon employment (table 4, Appendix A). The interpretation of this phenomenon may be ascribed to the fact that the firms that migrated from the Southeast to other regions, established in locations where the wages level were lower than those of the Southeast, though the workers in these other regions were sufficiently qualified for the same tasks.

With reference to specialization and diversity, both contributed to employment variation when the entire country was considered. However the signs were reversed. Specialization had a negative influence upon employment in the 1990s, while diversity had a positive influence.

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[15] All of 10 functions running presented the same consistent result.

Initially, the results could be interpreted to imply that diversified locations were more effective in creating new jobs; then the government would have to stimulate investments in these regions. However, in the regional analysis, different influences of specialization and diversity can be seen depending upon of the region. Related to specialization, the results were significant for two regions, but with opposite signs: in the Northeast Region, specialization had a negative impact on employment variation in the 1990s while in the South, it had a positive impact. This occurred while total employment increased in the Northeast Region while decreasing in the South.[16] We can conclude that in the first region employment was created in non-specialized microregions while in the specialized ones, the tendency was to decrease the number of jobs. On the other hand, in the South Region where there are many consolidated industrial clusters, and these locations were able to attract many investments, although most probably, the productivity has increased more in these specialized microregions than in others. We can suggest some reasons for this employment tendency. For the most of the country in specialized locations, the productivity gains could have been more intensive than in other locations including the South Region. However, in the latter, the consolidated clusters created a larger number of new jobs.

In relation to diversity, two regions presented a significant result: in the North Region the sign was positive, like the nationwide result, and in the South the sign was negative. This outcome reinforces the pattern of industrial concentration in the South Region, since diversity had a negative impact upon employment during the 1990s.

Table 3 shows the impact of the same variables presented in the table 2 upon the wages growth, but now dummies for the Northeast, Southeast, South and Center-West Regions were considered. Now the North Region was omitted as a better option because it did not change the main results. This region presents the second smallest industrial Brazilian GDP, corresponding to 4.5%, in 2000.

<<insert table 3 here>>

As in the case of employment, initial conditions presented similar results. The log of employment variation in the period 1991-2000 in the industries not among the five largest and employment in the five largest industries, in 1991, did not have any influence upon the wage variation in 1990s. Therefore, the dummies of these variables were not included in the table.

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[16] See Table 1.

In relation to wages in the beginning of the period of the study, a consistent outcome was obtained because the values presented for the whole country and for the Southeast Region – as in the employment function – were significant in explaining the variation in the wages in 1990s. Now, the sign was negative for all Brazilian microregions and positive for the Southeast. It means that the high initial wages had a negative impact for the country, except in this specific region. According to table 2, the higher initial wages, the lower employment growth in the Southeast; both results suggest that in the most developed region of the country, the industrial restructuring substantially augmented industrial productivity - fewer workers but with higher wages.

On the contrary, for the other four regions, the higher number of workers was related to lower wages, which can be confirmed with the function in which the Southeast Region is omitted. The coefficients for each region were significant and presented a negative sign (table 4, Appendix A). For these regions, the outcome indicated that the low initial wages locations attracted firms to invest and to create jobs there. The wages in this case represented a factor of competitiveness gain for firms for the most of the country.

Specialization and diversity were also significant in explaining the variation in wages in 1990s. Their influences were the opposite from those found for employment growth. Now specialization presented a positive impact on wages while diversity had a negative influence. It means that for the whole country, the specialized microregions tended to augment the wages and to diminish the employment. On the contrary, the diversified microregions tended to decrease the wages and to increase the employment. It confirms the inference that at a nationwide level, in specialized microregions, the productivity increased more than in diversified because in the first fewer workers are receiving higher wages and in the latter many workers are receiving lower wages.

However, in the regional analysis, this interpretation is valid for only one region, the Northeast. In this region, specialization had a positive influence upon wages and a negative influence upon employment in the 1990s. It suggests that the specialized microregions in Northeast tended to decrease their employment but the workers had increased wages. It can be the result of the migration of some industries from the southern part of the country, due to the fiscal war, concentrating their new investments in some locations. In contrast, the industrial diversity in 1991 had a negative impact on the wages variation in the Northeast Region but none

on employment. At any rate, we can infer that diversified microregions created more jobs than the specialized one and with low remuneration because the employment in Northeast has increased almost 2,5%, according table 1.

5. Summary and Conclusion

The Glaeser *et al.* (2001) model was adapted for the Brazilian case with the purpose of verifying if the specialized microregions in some kinds of industries had more influence upon industrial employment and wage growth than the more diversified ones. Many changes occurred in Brazilian industry in the 1990s, such as the restructuring process, which generated the rise in productivity and industrial relocation.

The main results of this research study can be summarized as follow: (1) the log of the variation of Brazilian employment in the period 1991-2000 in industries not among the top five and the initial employment in the five largest industries were not significant in explaining changes in employment and wages in the 1990s; (2) the initial wages were the only significant variable among the initial conditions, which influenced the employment and the wages variations, in a positive and negative way, respectively; (3) analyzed nationwide, specialization had a negative impact upon employment and a positive impact upon wages; (4) diversity had an impact opposite to that of specialization, which means a positive effect on employment and negative on wages; and (5) the regional analysis showed that there are many differences among the regions of the country, which were reflected in the different influences of independent variables in the functions, mainly specialization and diversity.

In the most industrialized regions of the country, employment decreased in 1990s, 25% in the Southeast and 0.7% in the South. Among those variables selected, the only one that influenced the Southeast was the initial wages, which had a negative impact upon employment and a positive impact upon wages. Both effects together may indicate two changes: the first one is that industrial restructuring increased productivity, decreasing employment and increasing wages. The second change is the relocation process in which many firms migrated to locations where wages were lower, within the region or to other regions. This process occurred mainly in São Paulo State, the most industrialized state in Brazil, where many firms moved from the Metropolitan Area, where the wages were high, largely due to the presence of strong and

organized trade unions, and where infrastructure congestion translated into more expensive transportation costs.

In the South, the important result was related to the influence of specialization and diversity upon employment, positive and negative, respectively. This region is known as specialized in many industries such as furniture, footwear, garment, agribusiness, textile, metal-mechanic and so on. Although total employment in the region decreased 0.7%, specialized locations attracted more investments than diversified ones. The consequence was increased employment in the former and decreased employment in the latter.

In the poorest part of the country, the Northeast and North regions, there were several important effects of independent variables upon employment and wages in the 1990s. With reference to Northeast Region, the results show that initial wages, specialization and diversity had a significant impact upon the dependent variables. Contrary to the results in the Southeast Region, initial wages had a negative effect on wage growth. Specialization had a positive and diversity a negative influence on wages in the 1990s. Specialization also had an impact on employment growth, but negatively. The Northeast received several types of industries, mainly from the southern part of the country, the industrial relocation due in large part to low wages. Interpreting these results as a whole we can infer: (1) firms chose locations in Northeast Region, which paid lower wages; (2) firms specialized in a particular industry, such as leather and footwear, textile and agribusiness, migrated to some locations causing a reduction in the employment, due to the increase of the productivity, but augmented the wages; (3) diversified microregions absorbed a larger number of employees but paying lower wages. In the case of the North Region, only diversity had a positive impact upon employment growth. Finally, the Center-West is a region that is developing rapidly due to agribusiness. However for this study, none of the variables had any influence upon employment and wage growth.

The main objective of this paper was to verify the effect of industrial agglomeration on employment and wages in a decade in which this type of concentration became important in fostering development. It was assumed that this kind of geographical arrangement is more propitious than others to generate increasing returns conducive to more rapid economic growth. The results showed that changes, which occurred in the Brazilian industrial sector, in the 1990s, influenced the impact of specialization and diversity upon employment and wages, and that there are many differences across regions. On the whole, the outcome showed that the specialized

microregion was important in fostering employment in a region where the clusters were consolidated. In a region where the clusters formation initiated in the 1990s, the tendency was to decrease the employment and increase the wages, indicating a process of productivity augmentation. The implication is that mature industrial concentrations can foster growth more than other locations at least in Brazilian case, what can confirm our principal hypothesis about presence of increasing returns in specialized locations.

This result suggests future research, which should focus on particular Brazilian regions and for a more extensive period, in order to obtain a more in-depth understanding of the effects of agglomeration on economic development. A longer time period would also provide the basis for understanding the degree to which the results were the outcomes of Plano Real or longer run forces that are continuing to reshape the Brazilian spatial economy.

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Table 1. Employment and average wages in Brazilian Regions – 1991-2000

Variables	North	Northeast	Southeast	South	Center-West	Total
Employment - 1991	302.599	861.159	3.015.369	1.007.728	274.169	5.461.024
Employment - 2000	308.571	881.845	2.263.809	1.000.611	301.998	4.756.834
Variation (%)	1,97	2,40	- 25	- 0,7	10,15	- 12,89
Average Wage 1991	106,11	70,27	230,75	92,00	96,06	-
Average Wage 2000	406,94	342,97	730,89	535,46	521,50	-
Variation (%)	383	488	316	582	542	-

Source: IBGE, Microdata, 1991 and 2000.

Table 2. Effects of specialization and diversity upon employment growth in the five largest industries in Brazilian microregions – 1991-2000

Variables	Coefficients - specialization[17]	Coefficients - diversity
Constant	0,721635 (3.336145)*	0,599926 (2,700996)*
Log (Brazilian employment in 2000/Brazilian employment in 1991) in the industries out of top five	0,222213 (1,043514)^{NS}	0,192294 (0,908046)^{NS}
Employment in the 5 largest industries in 1991	0,000006 (0,196685)^{NS}	0,000003 (0,478872)^{NS}
Average wage in the 5 largest industries in 1991	0,000450 (2,127405)**	0,000432 (1,974813)**
Dummy N in average wage in the 5 largest industries in 1991	0,000011 (0,028059)^{NS}	-0,000051 (-0,130817)^{NS}
Dummy NE in average wage in the 5 largest industries in 1991	-0,000133 (-0,501355)^{NS}	0,000098 (-0,361938)^{NS}
Dummy SE in average wage in the 5 largest industries in 1991	-0,000425 (-1,993263)**	-0,000405 (-1,835528)***
Dummy S in average wage in the 5 largest industries in 1991	-0,000046 (-0,173868)^{NS}	-0,000012 (-0,044010)^{NS}
Industrial specialization in 1991	-0,010755 (-2,453537)**	
Dummy N in industrial specialization in 1991	-0,009175 (-1,198230)^{NS}	
Dummy NE in industrial specialization in 1991	-0,030134 (-2,671577)*	
Dummy SE in industrial specialization in 1991	0,000452 (0,078107)^{NS}	
Dummy S in industrial specialization in 1991	0,012200 (2,703024)**	
Industrial diversity em 1991		0,212864 (2,762486)*
Dummy N in industrial diversity in 1991		0,197789 (1,712123)***
Dummy NE in industrial diversity in 1991		-0,017713 (-0,188683)^{NS}
Dummy SE in industrial diversity in 1991		-0,067583 (-0,712974)^{NS}
Dummy S in industrial diversity in 1991		-0,312573 (-3,206091)*
Teste F	6,257422 (0,000000)	7,390550 (0,000000)

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[17] Significance Level: * - 1%; ** - 5%; *** - 10%..

Table 3. Effect of specialization and diversity upon the wage growth in the 5 largest industries of Brazilian microregion – 1991-2000

Variáveis	Coefficients - specialization[18]	Coefficients - diversity
Constant	1,553701 (9,398959)*	1,572369 (8,720332)*
Log (Brazilian employment in 2000/Brazilian employment in 1991) in the industries out of top five	-0,064701 (-0391870)^{NS}	-0,058577 (-0,352825)^{NS}
Employment in the 5 largest industries in 1991	-0,000001 (-1,112319)^{NS}	0,0000001 (0,070206)^{NS}
Average wage in the 5 largest industries in 1991	-0,001429 (-4,958698)*	-0,001413 (-5,085885)*
Dummy NE in average wage in the 5 largest industries in 1991	-0,000060 (-0,162728)^{NS}	-0,000101 (-0,274265)^{NS}
Dummy SE in average wage in the 5 largest industries in 1991	0,000874 (2,978685)*	0,000855 (3,022039)**
Dummy S in average wage in the 5 largest industries in 1991	0,000213 (0,592795)^{NS}	0,000207 (0,591094)^{NS}
Dummy WC in average wage in the 5 largest industries in 1991	-0,000019 (-0,050575)^{NS}	-0,000042 (-0,113649)^{NS}
Industrial specialization in 1991	0,004428 (2,068989)**	
Dummy NE in industrial specialization in 1991	0,049155 (2,441878)*	
Dummy SE in industrial specialization in 1991	-0,001500 (-0,457486)^{NS}	
Dummy S in industrial specialization in 1991	-0,002241 (-0,873428)^{NS}	
Dummy WC in industrial specialization in 1991	-0,004221 (-1,474642)^{NS}	
Industrial diversity em 1991		-0,031810 (-0,673508)^{NS}
Dummy NE in industrial diversity in 1991		-0,197618 (-2,302319)**
Dummy SE in industrial diversity in 1991		0,033599 (0,571377)^{NS}
Dummy S in industrial diversity in 1991		-0,039011 (-0,632554)^{NS}
Dummy C-W in industrial diversity in 1991		0,065397 (0,825536)^{NS}
Test F	94,70248 (0,000000)	88,16649 (0,000000)

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[18] Significance Level: * - 1%; **- 5%; *** - 10%.

APPENDIX A

Table 4. Impact of average wage in the 5 largest industries in 1991 without dummy for the Southeast Region upon the employment and wage growth

Variables	Coefficients – specialization	Coefficients – diversity
EMPLOYMENT		
Average wage in the 5 largest industries in 1991	0,000027 1,024939 NS	0,000025 0,933611 NS
Dummy N in average wage in the 5 largest industries in 1991	0,000354 1,095947 NS	0,000437 1,280621 NS
Dummy NE in average wage in the 5 largest industries in 1991	0,000306 1,856766***	0,000293 1,821667***
Dummy S in average wage in the 5 largest industries in 1991	0,000393 2,428694**	0,000379 2,343355**
Dummy WC in average wage in the 5 largest industries in 1991	0,000405 1,835528***	0,000425 1,993263**
WAGES		
Average wage in the 5 largest industries in 1991	-0,000555 -10,14520*	-000557 -10,18911*
Dummy N in average wage in the 5 largest industries in 1991	-0,000874 -2,978685*	-0,000957 -3,022039*
Dummy NE in average wage in the 5 largest industries in 1991	-0,000934 3,878041*	-0,000957 0,0001*
Dummy S in average wage in the 5 largest industries in 1991	-0,000660 -2,977118*	-0,000649 -2,955706*
Dummy WC in average wage in the 5 largest industries in 1991	-0,000893 -3,519672*	-0,000898 -3,483609*

Significance Level: * - 1%; ** - 5%; *** - 10%.