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Innovative Firms and Reduction of Regional Disparities: An analysis of

Brazilian Industrial Sector

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Abstract

Brazil has undergone a process of economic stabilization in the mid-1990s, leading to structural changes and regional disparities reduction. Nevertheless, inequalities among Brazilian regions persist. This paper aims to analyze the contribution of Brazilian industrial innovative firms to reduce regional income disparities, focusing on the Northeast, one of the poorest regions of the country. In the 1990s, many companies have expanded their activities to this region, leading to an industrial relocation that had important consequences on reducing regional disparities. Considering innovation as a driving factor of development, this paper uses the Survey of Technological Innovation (PINTEC) data, which is the most important database on technological innovation in Brazil. The reduction of regional inequalities was measured by the annual average salary, according to the Annual Manufacturing Survey (PIA) data. Two statistical methods were used: Multidimensional scaling (MDS) and Hypothesis Tests about the difference among selected 2000 Pintec and 2008 Pintec variables. For innovative and non-innovative firms in the Northeast and Southeast between 2000 and 2008, the MDS shows that some innovative firms have reduced their salary gap, while non-innovative firms have increased it. In Hypothesis Tests, firms from Southeast are proportionally more innovative than those from Northeast, but Northeastern companies had improvements in cooperative relations, which may have influenced the reduction of

salary disparities between regions. Thus, innovative companies are the ones that effectively contributed for reducing regional disparities showing that for the Brazilian case, innovation was a positive driving factor for development and therefore contributes for reducing regional disparities.

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Keywords: Innovation, Regional Disparity, Industry, Brazil.

JEL classification: O33, R12

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1 Introduction

Brazil is considered an emerging country in the world economic scenario; one of the rising powers alongside China, India, and Russia. However, income disparities are still present and have even deepened in those countries, except for Brazil (Lopez-Calva, 2012). Nevertheless, it has long been distinguished as a country with high inequality and a persistence of poverty and extreme poverty. In the 1990s, there were major structural changes in Brazilian economy, starting with a greater openness to foreign trade in 1988, and more so in 1990. Early in this decade, however, there was a great macroeconomic instability with extremely high inflation rates with an annual average of 764% from 1990 to 1994.

In 1994, the "Real Plan" ended up with a hyperinflation which was not distribution neutral. Macroeconomic stability has allowed for greater economic planning, whether of private firms or public sector, which initiated major social programs to reduce inequalities in the country. After nearly two decades since this process of economic stabilization began, structural changes can be verified in Brazilian economy: growth of gross domestic product (GDP), salary improvements, conditional cash transfer programs, increased access to education, among other economic and social benefits. However, inequalities among Brazilian regions persist. Such inequalities have historical roots that become difficult to eradicate, despite the structural improvements that have occurred in recent decades.

To reduce regional disparities and end up with inequalities, it is necessary to develop the poorest regions by improving public policies already implemented. Considering innovation as a positive driving factor of development, those policies should induce innovation in companies, which will create jobs, add value and generate wealth. Innovative companies tend to be more efficient and competitive, which allows them to pay higher salaries.

In this context, this paper aims to analyze the contribution of innovative Brazilian industrial firms in reducing regional income disparities, focusing on the Northeast, one of the poorest regions of the country, after economic restructuring in Brazil. At that time, many companies had expanded their activities the Northeast to stay closer to the consumer market and to take advantage of cheaper labor and tax incentives offered by some federal units. This industrial relocation has brought positive results in regards to the production restructuring in the Northeast, but has it contributed to reduction of regional disparities?

The starting point of the empirical analysis is the data from Brazilian Survey of Technological Innovation (PINTEC - Pesquisa de Inovação Tecnológica), which is the most important database about technological innovation in industry and high technology services in Brazil. Some selected variables of firms' innovative activities were analyzed comparing the performance of Northeast and Southeast regions in 2000 and 2008. The average salaries of the Brazilian mining and quarrying and manufacturing industries were used to verify the reduction of regional disparities, because the less developed regions tend to pay less to the workers. To verify if the innovative companies raised the

average salary in comparison to non-innovative ones and, consequently, contributed to reduce regional income disparities, data from the Annual Industrial Survey (PIA - Pesquisa Industrial Anual) was used. Two statistical methods were used: Multidimensional Scaling (MDS) to compare average salary between regions and Hypothesis Tests about the difference between selected Pintec variables.

This paper is divided into six sections, including this introduction. Section 2 makes a brief review of the literature on the determinant factors of innovation capability of firms according to the evolutionary theory, which considers innovation as the engine for development. Section 3 describes the Brazilian regions and the historical roots of country's regional inequalities, focusing on industrial development. Section 4 presents methodological aspects, describing the database and the statistical techniques that were used. Section 5 shows the empirical results, and the last section presents some conclusions.

2 Determinants of Innovation

According to Hall (1994), the innovative process corresponds to all activities that generate technological changes and the dynamic interaction between them, not necessarily being novelties. When innovating, the firm searches for a solution to a certain problem that is solved inside a technological paradigm, inside patterns of solutions widely accepted based on the principles of natural sciences. Once the technological paradigm is established, innovations become selective in the capacity of solving problems, at the same time that they uncover other solutions outside that technological paradigm. When the difficulties to find solutions inside that technological paradigm become considerable, there is a strong incentive for a paradigm shift; however this is not a sufficient condition, since a new paradigm also requires advances in the basic science, and other institutional and market conditions (Dosi, 1984).

In the current technological paradigm, one determined technology is selected. According to B. Arthur (quoted by López, 1996), the technology is not elected because it proved to be the most efficient, but it turns out to be the most efficient because it was elected. The more they are used, the more attractive the technologies become. The technology is path-dependent, which creates a lock-in effect and constrains the firms to the most spread technologies and to the current technological paradigm, therefore affecting their innovation capacity.

So, one question emerges: what forces allow the firm to generate and adopt innovations? There are a number of factors which influence that capacity to become innovators. They can be grouped in terms of internal and external factors. Internal factors include its specific competencies to solve problems, for example, a firm's absorptive capacity and access to innovations developed by other firms. External factors include: the current technological paradigm, the innovation system that could be national, regional or sectoral, the degree of competition in which the firm is inserted, the macroeconomic context and the regulatory framework.

The competencies to solve problems, the first internal factor, are cumulative overtime. The skills and knowledge owned by the firm, acquired by experience,

determine its capacity to absorb or create knowledge. These specific skills and knowledge depend on investments in research and development (R&D), employees' individual knowledge, size and nature of the firm (public, private, transnational, etc.), activity sector and the degree of specialization.

The second internal factor is directly related to the first one. The absorptive capacity, according to Cohen and Levinthal (1990), is defined as the firm's skills to recognize the value of new information, to assimilate and apply it to commercial uses. This ability is crucial to its capacity to innovate. Thus, the absorptive capacity is the co-product of R&D and tacit knowledge gained in production. In this sense, the training staff means investment in absorptive capacity and in R&D. In that sense, training activities are another way to invest in the absorptive capacity and in R&D, even if no immediate results are obtained.

Concerning the third internal factor, the access to innovations developed by others is not free and, in general, presents high costs. Innovations cannot be easily bought as ordinary commodities, given the lack of information of potential user; the innovator's strategy to avoid competitors by hiding the innovation; protection by patents and other forms of intellectual rights; and the costs of maintaining the firm with a high absorptive capacity. In other words, the firm's capacity to innovate is limited by high cost of internal R&D, or high costs of buying the technology from others, and depends on the endogenously accumulated capacities in the technical/productive fields.

The first external factor, the current technological paradigm as explained above, constrains the capacity to innovate because it defines scientific patterns in which innovations must be circumscribed. Changes in this paradigm may induce the firm to become more or less innovative, depending on its internal factors.

The innovation system, the second external factor, constitutes the organizational system responsible for the development of science and technology (S&T) inside a nation, region or sector. It is a complex institutional arrangement involving firms' R&D laboratories, research institutes and universities, funding agencies, educational institutions and legal institutions (regulating competence conditions, intellectual property rights, etc.). The innovation system must be considered according to its three dimensions: learning capacity, institutions, and the net of interaction between them. Therefore, an effective innovation system – national, regional (Cook, 2001) or sectoral (Malerba, 2002) – is a powerful incentive for firms to become innovators.

The degree of competition in which the firm is inserted is crucial in the decision of creating or adopting innovations. According to evolutionary thought, competition is the engine of innovation. In competitive markets, the innovation becomes the differentiation factor between the firms and their competitors, sometimes being the only way to survive in the market.

The macroeconomic context is another external factor interfering in this process. Firms have difficulty making risky decisions under great uncertainty, paralyzing the innovation process even if they are able to innovate. Conversely, macroeconomic stability generates confidence, encouraging the innovation decision.

Finally, the regulatory framework also affects the innovation process. Some sectors require more regulation according to the kind of activity and market structure in

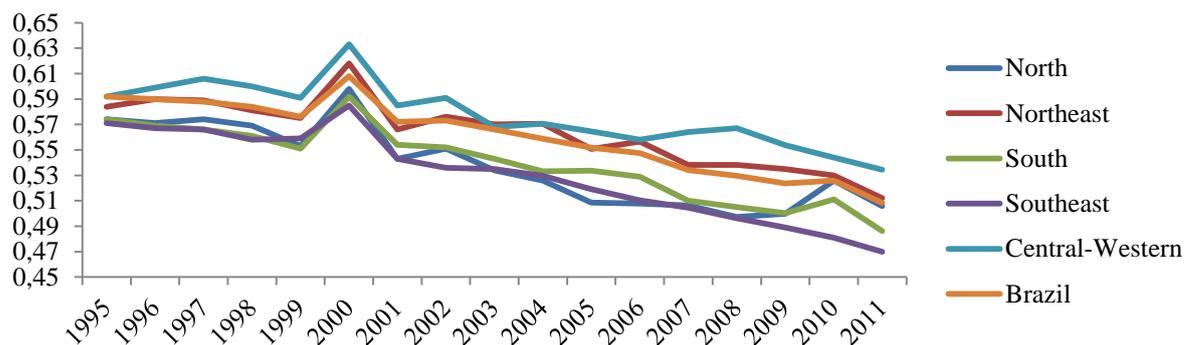
which they are involved. Regulation creates pressure and induces the firm to innovate, thus spurring regulation-induced innovation

3 Regional Disparities and Evolution of Industrial Sector in Brazil

In order to verify the reduction of regional disparities, two important points should be considered. The first one is the origin of inequality, which due to historical roots and structural issues that are difficult to be solved immediately, makes the reduction of inequality very slow. The second point is relative inequality, i.e., there are improvements in the poorest region, which reveal an evolution, but the region remains less developed than the others because of historic inequalities.

The Brazilian economic restructuring after 1995 brought distributional improvements, as can be seen by Gini Coefficient based on per capita monthly income (Fig. 1). There have been improvements in all regions, revealing the development of historically peripheral regions, although inequalities still remain. Thus, the analysis of regional inequalities reduction should be viewed in a relative manner.

Fig. 1. Gini Coefficient based on per capita monthly income (people with 10 years or more), according to Brazil and Regions – 1995 to 2011



Source: Authors' elaboration from IBGE (2013b, 2013c).

The current economic characteristics of Brazil's five major geographic regions have been historically determined (Fig. 2):

Fig. 2. Brazilian Major Geographic Regions



Source: <http://www.portalsaofrancisco.com.br/alfa/brasil/imagens/regioes-do-brasil.png>

The North region has much of the Amazon rainforest, one of the largest rainforests in the world; so, there are not many activities in the manufacturing industry, except the Free Zone of Manaus, an industrial center for electronics manufacturing. Also, the mining and quarrying industry has great importance in this region, especially for iron, minerals and wood. It is the region that has the smallest share of Brazilian GDP, around 5%, showing a slight increase in the share of GDP over the period 1995-2010 (Tab. 1).

Tab. 1. Share of Brazilian GDP among Regions - 1995-2010

	North	Northeast	Southeast	South	Midwest
1995	4,2	12,0	59,1	16,2	8,4
1996	4,3	12,5	58,4	16,2	8,6
1997	4,1	12,5	58,5	16,1	8,8
1998	4,2	12,4	58,2	16,2	9,0
1999	4,2	12,4	58,2	16,4	8,8
2000	4,4	12,4	58,3	16,5	8,4
2001	4,5	12,6	57,7	16,7	8,5
2002	4,7	13,0	56,7	16,9	8,8
2003	4,8	12,8	55,8	17,7	9,0
2004	4,9	12,7	55,8	17,4	9,1
2005	5,0	13,1	56,5	16,6	8,9
2006	5,1	13,1	56,8	16,3	8,7
2007	5,0	13,1	56,4	16,6	8,9
2008	5,1	13,1	56,0	16,6	9,2
2009	5,0	13,5	55,3	16,5	9,6
2010	5,3	13,5	55,4	16,5	9,3

Source: IBGE (2013a).

The Northeast is one of the poorer regions in Brazil, besides North region, although there are well-developed metropolitan areas. In addition to inheriting the sugar cane monoculture and a concentrated agrarian structure, the Northeast region has vast semi-arid areas in its interior, which prevents the diversification of agricultural activities. Its share in Brazilian GDP also had a slight increase over the same period and in recent years has been about 13% (Tab. 1).

The Southeast, the most developed region, is also country's most important industrial and financial center, concentrating more than 55% of the Brazilian GDP in 2010. The state of São Paulo alone accounted for about 33% of GDP in this same year. It is the only region that reduced its share in GDP over the period 1995-2010, by around 4 percentage points (Tab. 1).

The South region can be characterized by the occupation of European immigrants, who came to Brazil to work on coffee plantations by the late nineteenth century and occupied small and medium properties. Its participation in Brazilian GDP in recent years was around 17% (Tab. 1).

In the Central-Western is located the country's capital city, Brasilia. It was constructed in 1961 and gave great impetus to economic development of this region. Currently, the Central-Western is an agricultural frontier in the country, with large

plantations of soybeans for export. Its share of Brazilian GDP is around 9% over the period 1995-2010 (Tab. 1).

Despite the fact that poorest regions have reduced Gini coefficient and have increased their share of Brazilian GDP after economic stabilization in the mid-1990s, regional disparities still remain. Regional inequality in Brazil has historical roots. Characterized as a colony of exploitation, beginning with the extraction of Brazilwood in the sixteenth century, the country passed through many economic cycles. The "Sugar Cycle" began in the sixteenth century and left its mark even today in the States of Northeast, the core dynamic of the economy at that time. Even with further "Mining Cycle" and "Coffee Cycle", sugar remains as an important commodity of Brazilian exports.

The Northeast declined in relative importance to the Southeast when the "Coffee Cycle" starts at the end of the eighteenth century. The big difference between this cycle and the "Sugar Cycle" is the accumulation of capital. While in the "Sugar Cycle" capital was managed on the outside, i.e., the surplus was appropriated by European trading companies, in the "Coffee Cycle", capital accumulation was inside the country in the hands of coffee-growing elites from Southeast, concentrated in São Paulo State. This domestic capital accumulation allowed the financing of Brazilian industrialization after the 1929 crisis, which directly affected Brazilian coffee exports and led to the end of the "Coffee Cycle".

Industrial growth began in the 1930s² with Import Substitution Industrialization (ISI). Due to the 1929 crisis, the importing countries of Brazilian coffee had drastically reduced their demand. The severe reduction of coffee exports led to a shortage of foreign currency to import manufactured consumer goods, so the Brazil's alternative was to manufacture those previously imported goods. The industry was settled in São Paulo, the dynamic center of the economy, to the detriment of other regions.

In 1937 an industrial development policy began and was conducted during civil or military governments until the late 1970s, generating an industrial concentration in the Southeastern region.

As set out in the development policy in the 1940s, some state companies were created to promote the basic infrastructure of economy: Companhia Siderúrgica Nacional (CSN) in the steel industry, Companhia Vale do Rio Doce in mining operations, both of which were in Rio de Janeiro (Southeast), and Companhia Hidrelétrica do São Francisco (Chesf) in hydroelectric power generation (Northeast).

In the 1950s, other important federal organizations for development were created, such as the National Bank for Economic Development (BNDE - Banco Nacional de Desenvolvimento Econômico) in 1952, for long-term financing, and in 1953, Petróleo Brasileiro S/A (Petrobras), a Brazilian oil corporation to ensure the monopoly of oil extraction in Brazil (Giambiagi and Villela, 2005). Both settled in the federal capital at that time, the city of Rio de Janeiro, located in the Southeast.

² Brazil had a poorly developed industry before 1930, which provided non-durable consumer goods for the coffee agro-export sector.

From 1956, the ISI progressed considerably, mainly in the capital goods and durable consumer goods with installation of large automobile manufacturers and their industrial chains in the Southeast.

The ISI model was in crisis in the early 1960s, when inflation rate reached high levels creating economic and political disarray in the country. Military governments began in 1964, and made significant fiscal and financial reforms. In 1968, the so-called "Economic Miracle" occurred, when GDP grew at average rates of 12% per year, with great influence from the industrial sector, whose average growth was 18% per year from 1968 to 1973.

With a tripling of oil prices in 1973, oil-importing countries decelerated the pace of growth. Contrary to the global trend, Brazil decided to continue the process of import substitution, with the completion of the Brazilian industrial complex defined by implementation of intermediate products industries. At that time, the sectors of metallurgy, chemistry, and oil extraction had great impetus in the Northeast. In the South, the mining sector was the one that grew the most. Nevertheless, the industry remains very concentrated in the Southeast.

The second oil shock in 1979 and the rise in international interest rates in 1980 caused problems of external debt in underdeveloped economies like Brazil, even causing the Mexican moratorium in 1982. High rates of domestic inflation, high international interest rates, lack of liquidity in the international credit market, among other factors left Brazil with serious macroeconomic imbalances and raised the concerns about the short run. After the transfer from military to civilian government, inflation control and macroeconomic stability became the main objectives of economic policy, and investment for economic growth and planning for regional development are largely ignored (Guimarães Neto, 1997). Hence, the 1980s was the so-called "lost decade" of the Brazilian economy.

Openness to international trade, which began in 1988 as a global economic trend, accelerated in 1990, when an industrial restructuring process began due to increased competition from Brazilian companies in world trade. Some sectors like textiles underwent profound structural changes, becoming more competitive at the end of the decade, despite the closing of several companies.

The price stabilization with the Real Plan launched in 1994 and the improvement of macroeconomic indicators, combined with economic liberalization, deregulation and others companies' internal factors, led to industrial decentralization in the Southeast, bringing benefits to other regions (Sabóia, 2001, 2004; Silveira, 2005, Garcia, 2010). From 1996 to 2008, the number of jobs and share in total employment increased for all regions, except for the Southeast. The number of establishments also augmented in all regions, but share in total establishments decrease for the most developed region (Tab. 2).

Tab. 2. Employees, establishments and remuneration in Brazilian industry by regions – 1996-2000-2008

Variable	North			Northeast			Southeast			South			Midwest			Brazil		
	1996	2000	2008	1996	2000	2008	1996	2000	2008	1996	2000	2008	1996	2000	2008	1996	2000	2008
Employees (thousands)	134,8	156,3	264,6	532,5	594,9	924,2	3091,9	2993,6	3952,5	1139,5	1274,4	1829,0	156,3	212,2	354,8	5055,0	5231,0	7325,0
Employees (%)	2,7	3,0	3,6	10,5	11,4	12,6	61,2	57,2	54,0	22,5	24,4	25,0	3,1	4,1	4,8	100,0	100,0	100,0
Establishments	2887	3736	5564	11323	14187	20499	7001	79084	95862	28703	35420	50025	5455	7369	10446	123369	139796	182396
Establishments (%)	2,3	2,7	3,1	9,2	10,1	11,2	60,8	56,6	52,6	23,3	25,3	27,4	4,4	5,3	5,7	100,0	100,0	100,0
Establishments average size	47	42	48	47	42	45	41	38	41	40	36	37	29	29	34	41	37	40
Total remuneration (millions R\$)	1073,4	1368,9	4352,6	3299,8	4013,4	12100,2	34260,7	39224,8	97020,6	8052,9	10516,5	29655,4	861,6	1332,5	4900,6	47548,4	56456,1	148029,4
Remuneration (%)	2,3	2,4	2,9	6,9	7,1	8,2	72,1	69,5	65,5	16,9	18,6	20,0	1,8	2,4	3,3	100,0	100,0	100,0
Average Remuneration (thousands R\$)	8	9	16	6	7	13	11	13	25	7	8	16	6	6	14	9	11	20

Source: Authors' elaboration from IBGE/PIA 1996, 2000, 2008.

Notes: 1. Establishments' average size in number of employees per establishment.

2. Remuneration is salary and others remunerations.

3. Average remuneration in total remuneration per number of employees.

4 Methodology

4.1 Database

To verify the contribution of innovative Brazilian industrial firms in reducing regional income disparities, innovation was considered to be a positive driving factor of development. Not only did innovation account for economic growth, but also structural changes that lead to improvements in underdeveloped regions. The innovation concept is the same as that of the Oslo Manual of Organization for Economic Cooperation and Development (OECD), and aligns with the database used in this paper, the Survey of Technological Innovation (Pintec - Pesquisa de Inovação Tecnológica)(IBGE, 2012a, 2012b). The survey is performed by IBGE, whose main objective is to provide data for the construction of indicators that reflect the innovation activities of Brazilian companies. Pintec is a sample survey, whose development is in accordance with the methodological and conceptual guidelines of Oslo Manual. Four editions are available from 2000, 2003, 2005, and 2008 reference years.

To verify the reduction of regional income inequalities, the salaries of the Brazilian mining and quarrying and manufacturing industries were used because the less developed regions tend to pay workers less. To verify whether the innovative firms raised the salaries of their employees and consequently reduced regional disparities, data from the Annual Survey of Industry – Enterprise (PIA-Empresa - Pesquisa Industrial Annual-Empresa)³ was used. The average annual salaries paid by the Brazilian mining and quarrying and manufacturing industries for the years 2000 and 2005 were deflated by the National Consumer Price Index (INPC - Índice Nacional de Preços ao Consumidor)⁴.

In order to analyze the differences among industrial sectors in both regions regarding internal factors which influence the firms' capacity to become innovators (section 2), such as innovative activities undertaken (R&D, R&D by other firms), cooperation, spending in innovative activities (investment in R&D) and qualification level of employees (employees' individual knowledge and skills, training activities), the following variables from Pintec data were selected:

- Region's Innovation rate, which is the number of innovative firms divided by the total number of firms;
- Four most important innovative activities according to the high percentage of innovative firms that undertake the activity. The four variables are determined by the proportion of firms that attributed a high degree of importance to the

³ Annual Survey of Industry – Enterprise is elaborated by IBGE and it "... gathers a group of financial and economic information which allow the estimation of basic structural characteristics of industrial activities in the country and the monitoring of their evolution over time. It presents, among other aspects, data about employed persons, salaries, withdrawal and other compensation, revenue, costs and expenditure, production costs and gross value added" (IBGE, 2012c).

⁴ INPC is prepared by IBGE continuously. "The data collection period of INPC ... goes mainly from day 01 until day 30 of the month of reference. The target population of INPC includes families dwelling in the urban localities of the areas, with monthly income ranging from 1 (one) to 5(five) minimum wages, and whose head of the household is paid a salary for their main activity" (IBGE, 2013d).

following activities in relation to the total activities of innovative firms: Internal R&D activities⁵, External R&D acquisition⁶, Machinery acquisition⁷ and Training⁸.

- The proportion of spending in innovative activities (Spending in internal R&D activities and Spending in machinery acquisition) related to net sales of all firms.
- The proportion of Employees in internal R&D activities related to the total number of employees.
- The proportion of Employees with high level of qualification⁹ related to the total of employees in internal R & D activities.
- The proportion of firms with Cooperative relationships with universities and research institutes for innovation related to the total number of firms.

4.2 Statistical Techniques

Two statistical procedures were used: Multidimensional Scaling (MDS), and Hypothesis Tests about the difference between some variables from 2000 and 2008 Pintec data.

The MDS is a technique that uses iterative mathematical procedures¹⁰. There is no statistical inference, only explanatory, which makes it possible to simply represent spatially through a map, the dissimilarities between the considered experimental units. Dissimilarity measures imply that the lower the values of the analyzed ordered pair, the more similar the units that are represented by those values (Corrar et al., 2007).

As the purpose of this study is to confirm (or not) the hypothesis of reducing the salary gap between regions as a proxy for reducing regional disparities through innovation, we seek to build a single perceptual map. Therefore, aggregate analysis is used.

Among the mapping techniques, this paper employs the method of dissimilarity of decomposition, in which the dissimilarities are obtained from the distances of the data¹¹. The multidimensional scaling program decomposition technique that is used is ALSCAL, provided by SPSS[®]. Among the types of dissimilarity measures employed was the Squared Euclidean, in order to maximize the distance between points.

⁵ Systematic creative work developed by the firm.

⁶ The activities described in footnote 9 that are developed by other organizations (companies or technological institutions) and are acquired by the firm.

⁷ The acquisition of machinery, equipment and hardware that were bought specifically for the implementation of new or technologically improved products and processes.

⁸ The training oriented to the development of technologically new or significantly improved products and processes, related to the enterprise's innovative activities, and may include the acquisition of external specialized technical services.

⁹ Post-graduate or graduate.

¹⁰ Techniques that set proximity between certain elements, which in a number of dimensions seek to reproduce the original dissimilarities between pairs of objects with the lowest possible setting error.

¹¹ In the decomposition method, data is collected without any qualitative assessment of attributes included in the program, and decomposed into dimensions that seek to mirror the existing structure.

The choice of model, whose procedures and type depends on the specification of the data used (non-metric or metric) and the amount of dissimilarity matrices¹², was defined as the application of the classical model of MDS. This model consists of only one dissimilarity matrix.

After constructing the map, the dimensions are identified as either an objective dimension, with the use of formal methods of labeling, or a perceived/subjective dimension when it represents a judgment/hypothesis. In general, the objective of the dimensions is to compare the positions of objects in relation to their characteristics (Hair et al., 2009).

The resulting map of this technique is called a perceptual map whose points represent: 1) the positions of units in relation to the dimensions and 2) the dissimilarities of the units. Each point represents a unit. Its location and distance from other units symbolize, respectively, the structure of the sample and the intensity of dissimilarity (Corrar et al., 2007). Thus, nearby points identify similar elements and distant points represent dissimilar elements. Applied industrial innovation data, the comparison of two ordered pairs (manufacturing industry in the Northeast and Southeast, for example) in two moments (2000 and 2008) represents an analysis of salary increase or decrease in that industry.

The perceptual map is represented in Euclidian spaces in n dimensions through which objects/units (average salaries) are plotted according to their elements (industries). In general, metric order variables are configured in spaces of $(n-1)$ dimensions, whereas the ones of ordinal scale are configured in spaces of $(n-2)$ dimensions (Corrar et al., 2007, p. 404).

In constructing the model, the chosen algorithm constructs the distances by determining the ones that best fit. This quality is tested by various criteria (Corrar et al., 2007; HAIR et al., 2009). Among these, this study uses the comparison of analysis of the fit quality index with analysis close to the correlation coefficient. It is considered a good fit above level 8.0. It also uses the scatter plot of Shepard, whose setting of the model is given by fitting data to the line (Corrar et al., 2007, p. 408).

The second statistical techniques are Hypothesis Tests about the difference between the proportions of two populations, P_1 and P_2 , based on data provided by Pintec survey from 2000 and 2008. The purpose of this section is to test if the variable X , taken for each region and year indicated, has the same rate when compared between regions, for the same period.

Formally, tested hypotheses are the ones that do not involve differences between the two population proportions. The populations for each variable are taken from the Northeast and Southeast, using data related to the years 2000 and 2008. For example, when a variable is identified as occurring in the years 2000 and 2008, corresponding to the Southeast and Northeast, it is analyzed to see if the indexes differ between the two regions in the same year, as in an inter-regional view.

Formally, we apply the following three ways to test the hypothesis:

¹² It is given by a symmetric square matrix, ensuring the dissimilarities between all objects, two by two (CORRAR, 2007).

$H_0: P_{r1t} - P_{r2t} = 0$	$H_0: P_{r1t} - P_{r2t} = 0$	$H_0: P_{r1t} - P_{r2t} = 0$
$H_a: P_{r1t} - P_{r2t} < 0$	$H_a: P_{r1t} - P_{r2t} \neq 0$	$H_a: P_{r1t} - P_{r2t} > 0$

Where:

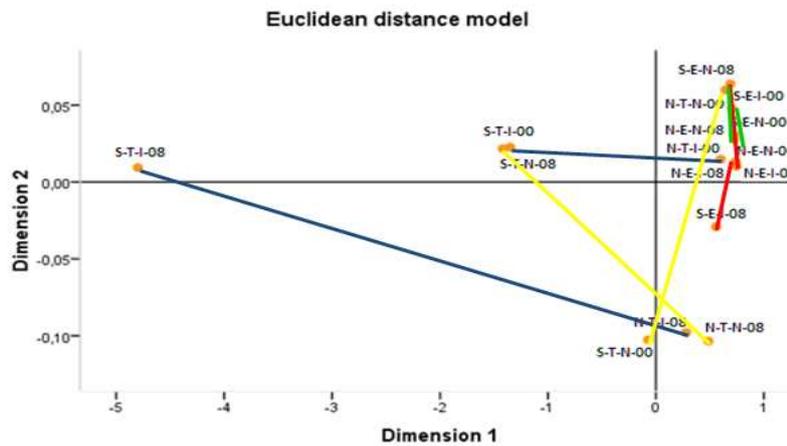
r 1= Southeast region, r2 = Northeast region and t = years 2000 or 2008.

The initial assumption is that proportions P_1 and P_2 only differ in their location, keeping the same distribution and dispersion.

5. Empirical results

In MDS, each point refers to an industry located in a particular industrial sector and year, by character of innovation (Fig. 3). The initial letter at the points of scaling indicates the region where the industry is located: S for Southeast and N for Northeast. The second letter refers to the type of industry: T for Manufacturing and E for Mining and Quarrying. The third letter corresponds to the innovative character: I for Innovative and N for Non-innovative. Finally, the numbers follow the years analyzed: 00 for 2000 and 08 for 2008.

Fig. 3. Multidimensional Scaling for innovative and non-innovative industries from Southeast and Northeast in Brazil – 2000 and 2008



Source: Authors' elaboration.

The red and the blue lines point to the changes that occurred in the innovative firms. The red line corresponds to mining and quarrying industry and the blue line refers to manufacturing industry. Also, green and the yellow lines correspond to changes observed in non-innovative firms. The green line corresponds to mining and quarrying industry and the yellow one refers to manufacturing industry.

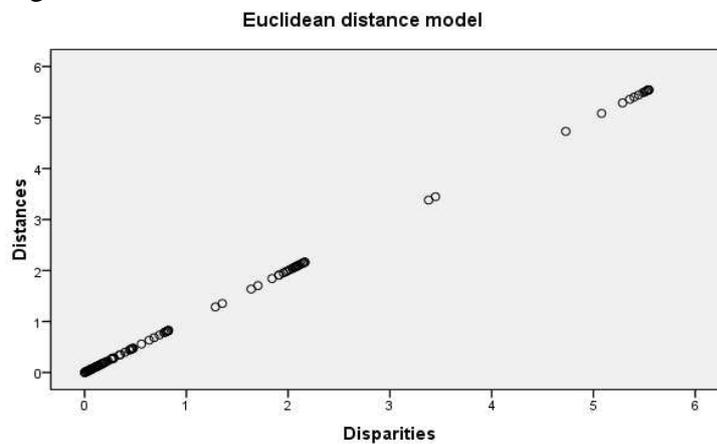
The red line has greater distance in 2000 than in 2008, showing that the salary gap decreased in mining and quarrying innovative industries. The blue line has a

smaller distance in 2000 than in 2008, showing that the salary gap increased in manufacturing innovative industries. On the other hand, the green and the yellow lines have also smaller distances in 2000, indicating that the salary gaps increased among non-innovative industries from Northeast and Southeast regions.

Therefore, multidimensional scaling set for innovative and non-innovative Southeast and Northeast industries, by comparison, between 2000 and 2008, shows that mining and quarrying innovative industries reduced their salary disparities while, in the same period, non-innovative industries and manufacturing innovative industries have increased their salary disparities.

To confirm that conclusion is statistically assured and uses an adequate data sample, the indicator RSQ has adjustment level of 1.0000, greater than 0.8, indicating an optimal fit, and confirmed by the scatter plot of Shepard (Fig. 4).

Figure 4 - Scatter plot of Shepard for the multidimensional scaling for Northeast and Southeast regions



Source: Authors' elaboration.

In the second statistical technique, the Hypothesis Test about difference between the proportions of two populations, the procedure described above was applied to selected variables (see section 4.1) from Pintec data from 2000 and 2008 related to innovation and learning for each region, always at a significance level of 5%. The investigation aimed to confront the Southeast and Northeast for each variable in both years and then compare the results.

Concerning the Innovation rate, the null hypothesis was not rejected for the year of 2000, meaning that innovation rate was the same for both regions at that time. Nevertheless, the null hypothesis was rejected for 2008, i.e., statistical evidence shows that the innovation rate was different for the regions, and suggested that it was greater in the Southeast.

Regarding the type of innovative activity, for the variable High importance of internal R&D activities the null hypothesis was rejected when comparing the two regions. Specifically, the companies from Southeast used more internal R&D activities as innovative activities than those in Northeast for the two years analyzed.

For the variable High importance of external R&D acquisition, the null hypothesis was accepted for both regions in 2000 and 2008. That is, the proportion of firms that attributed high importance of external R&D acquisition was the same because there is no statistically significant difference between the two regions.

Regarding the variable High importance of machinery acquisition, the null hypothesis was not rejected indicating there is a distribution with the same proportion between the regions. The same proportion of firms in the Southeast and Northeast attached high importance to the acquisition of machinery as innovative activity developed.

For the variable Training, the null hypothesis was valid for the year of 2000 and it was rejected for 2008. This means that the proportion of companies in the Southeast and Northeast that attributed high importance to training was the same in 2000, but this changed in 2008 and it was greater in Southeast.

Concerning the spending on innovative activities, the null hypothesis was rejected for the variable Spending in internal R&D activities to net sales when comparing both regions in 2000 and 2008, showing that the ratio of expenses on innovative activities to net sales in the Southeast was higher than in Northeast. For the variable Spending in machinery acquisition, the null hypothesis was accepted for 2000 and 2008, meaning that both regions maintained the same ratio of expenses in machinery acquisition during the period analyzed.

Regarding the variable Employees in internal R&D activities, the null hypothesis was rejected when comparing the two regions, emphasizing that this variable had more effect in the Southeast, over the years analyzed.

For the variable Employees with high level of qualification in internal R&D activities, for 2000 and 2008, the null hypothesis was rejected. Statistical evidence shows that the proportion of employees with high level of qualification related to the total of employees in internal R&D activities in the Southeast was higher than in Northeast.

Concerning cooperative relations, for the variable Cooperative relationships with universities and research institutes, the null hypothesis was rejected when comparing regions in 2000, being higher to the Southeast. This means that companies in the Northeast gave less importance to cooperative relations with universities and research institutes to develop innovations at that time. For 2008, the null hypothesis was accepted, i.e., the proportion of firms with this type of cooperative relation was the same in both regions, suggesting that the proportion over time changed. Therefore, the companies in Northeast began to cooperate more with universities and research institutes.

6 Conclusions

Brazil underwent a restructuring process after stabilization of the economy in the mid-1990s and nowadays is considered one of the rising powers alongside China, India and Russia. This restructuring process has brought about economic and social improvements, including better distribution of income in the country and in each of its

five major regions. Nevertheless, inequalities still remain, and thus the analysis of regional inequalities reduction should be viewed in a relative manner.

Historical reasons, including the Brazilian industrialization process concentrated in the Southeast, led to social inequality, making the Northeast one of the country's poorest regions. The productive restructuring process of the 1990s reduced these disparities but did not eliminate them.

Using a new approach to verify the reduction of regional income disparities, this paper investigated the role of innovation because it is considered to be a positive driving factor for development and, consequently, it is an element that contributes to economic and social improvements in underdeveloped regions.

The variable used to verify these improvements was the average salary in the innovative and non-innovative firms of the manufacturing and mining and quarrying industries. When comparing the innovative firms and non-innovative firms for both industries in the Northeast and Southeast between 2000 and 2008, the mining and quarrying innovative industries reduced salary disparities between regions while the non-innovative industries and the manufacturing innovative industries increased them. Therefore, for this specific period, mining and quarrying innovative firms paid their employees better and contributed to reducing regional income disparities.

Going further in the analysis, some of the variables that contribute to improved innovation in the industrial sector were examined and compared between the regions. The main findings are presented below:

- Firms from Southeast are proportionally more innovative than those from Northeast.
- Regarding the innovative activities, it was found that firms in the Southeast used more internal R&D as innovative activities than those in the Northeast, which did not change over time. Southeast and Northeast firms attach equal importance to external R&D and to the acquisition of machinery as innovative activities.
- Spending on innovative activities, for internal R&D, were higher in both years for the Southeast, but were similar for acquisition of machinery in both regions in 2008.
- Concerning the qualification of employees, the firms from Southeast did more training and had more skilled people in their innovative activities.
- Regarding cooperative relations, Northeastern companies began to cooperate more with universities and research institutes during the analyzed period.

As expected, the variables analyzed show a better position of the Southeast in relation to the Northeast because the most developed region had a stronger regional innovation system than the poorest. Nevertheless, the Northeast had some advances since 2000.

In conclusion, innovative activities are mostly explained by machinery acquisition in both the Southeast and Northeast regions, although the Northeast had improvements in cooperative relations, which may have influenced the reduction of salary disparities between regions. Although improvements must be done in a way that promotes innovation in the firms of the Northeast, innovative companies alone appear to have contributed to reducing regional disparities.

In the case of Brazil, innovation seems to be a positive driving factor for development. Therefore, a policy that induces innovations, by reducing their costs and increasing their diffusion, and reinforces innovation systems, will probably be able to reduce regional income inequality, contributing to country's lasting development.

References

Cohen, W. and Levinthal, D. (1990) "Absorptive capacity: a new perspective on learning and innovation", *Administrative Science Quarterly*, 35, pp.128-152.

Cook, P. (2001) "Regional innovation systems, clusters and the knowledge economy", *Industrial and Corporate Change*, 10(4), pp.945-974.

Corrar, L. J., Paulo, E. and Filho, J. M. D. (eds.) (2007) *Análise Multivariada: para os cursos de Administração, Ciências Contábeis e Economia*. São Paulo: Atlas.

Dosi, G. (1984) *Technical change and industrial transformation: the patterns of industrial dynamics*. London: Macmillan.

Garcia, R. (2010) *Uma Análise dos Processos Recentes de Desconcentração Regional nas Indústrias Têxtil e de Calçados e a Importância dos Sistemas Locais de Produção*", *Revista Econômica do Nordeste*, 41(1), pp.97-113.

Giambiagi, F. and Villela, A. (eds.) (2005) *Economia Brasileira Contemporânea (1945-2004)*. Rio de Janeiro: Elsevier.

Guimarães Neto, L. (1997) "Desigualdades e Políticas Regionais no Brasil: caminhos e descaminhos", *Planejamento e Políticas Públicas*, 15, pp.42-99.

Hair Jr, J. F. et. al. (2009) *Análise Multivariada de Dados*. Porto Alegre: Bookman.

Hall, P. (1994) *Innovation, Economics and Evolution: Theoretical Perspectives on Changing Technology in Economic Systems*. New York : Harvester Wheatsheaf.

Instituto Brasileiro de Geografia e Estatística - IBGE (2011a) *Pesquisa Industrial de Inovação Tecnológica 2000*. Available at: <http://www.ibge.gov.br/home/estatistica/economia/industria/pintec/default.shtm> (Accessed: 20 September 2011).

Instituto Brasileiro de Geografia e Estatística - IBGE (2011b) *Pesquisa de Inovação Tecnológica 2008*. Available at: <http://www.ibge.gov.br/home/estatistica/economia/industria/pintec/2008/default.shtm> (Accessed: 20 September 2011).

Instituto Brasileiro de Geografia e Estatística - IBGE (2011c) *Annual Survey of Industry - Enterprise 2009*. Available at: <http://www.ibge.gov.br/english/estatistica/economia/industria/pia/empresas/2009/defaultempres.shtm> (Accessed: 22 September 2011).

Instituto Brasileiro de Geografia e Estatística - IBGE (2013a) *Contas Regionais do Brasil 1995-2010*. Available at: <http://www.ibge.gov.br/home> (Accessed: 8 January 2013).

Instituto Brasileiro de Geografia e Estatística – IBGE (2013b) Pesquisa Nacional por Amostra de Domicílio – PNAD, 1995 to 2011. Available at: <http://www.ibge.gov.br/home> (Accessed: 8 January 2013).

Instituto Brasileiro de Geografia e Estatística – IBGE (2013c) Censo 2000, 2010. Available at: <http://www.ibge.gov.br/home> (Accessed: 8 January 2013).

Instituto Brasileiro de Geografia e Estatística (IBGE) (2013d). Extended National Consumer Price Index - IPCA and National Consumer Price Index – INPC. Available at:

http://www.ibge.gov.br/english/estatistica/indicadores/precos/inpc_ipca/defaultinpc.shtm (Accessed: 28 January 2013).

López, A. (1996) *Competitividad, Innovación y Desarrollo Sustentable: una Discusión Conceptual*. Buenos Aires: CENIT. DT 22.

Lopez-Calva, L. F. (2012) "Declining Income Inequality in Brazil : the proud outlier". *Inequality in Focus*, 1 (1), Washington, D.C : World Bank.

Malerba, F. (2002) "Sectoral systems of innovation and production", *Research Policy*, 31, pp.247–264.

Sabóia, J. M. (2001) "Descentralização Industrial no Brasil na Década de 90: um processo dinâmico e diferenciado regionalmente", *Nova Economia*, 11 (2), pp.85-122.

Sabóia, J. M. (2004) "A Indústria Brasileira no Nordeste e as Desigualdades Inter e Intra-regionais", *Econômica*, 6 (1), pp.61-102.

Silveira, R. (2005) "Concentração Industrial Regional, Especialização Geográfica e Geografia Econômica: Evidências para o Brasil no período 1950-2000", *Revista Econômica do Nordeste*, 36(2), pp.189-208.