WAGES AND INDUSTRIAL CLUSTERS IN
RIO GRANDE DO SUL (BRAZIL)

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Summary

The purpose of this paper is to test if the New Economic Geography hypothesis concerning the existence of a spatial wage structure applies to the state of Rio Grande do Sul, Brazil. The first part of the study applies several spatial analysis techniques, in order to locate industrial clusters and calculate the market potential of the municipalities studied. The second part uses this information, together with demographic data, to run wage regressions aimed at capturing the effects of agglomeration and urban economies on individual wages. The results do not falsify the hypothesis that nominal wages, using the proper controls, are higher in municipalities with higher market potential, and lower in the economically disadvantaged hinterland of the state.

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1. INTRODUCTION

The purpose of this paper is to test whether a spatial wage structure exists in the state of Rio Grande do Sul, Brazil. Inspired by the New Economic Geography Hypothesis (henceforth referred to as NEG), the study aims to measure the effects of locational factors on wages.

The state of Rio Grande do Sul occupies an area of approximately 300,000 km^2 (roughly the size of Italy) and has around 10 million inhabitants. Its socioeconomic indicators are relatively high in comparison to Brazil as a whole[1]. The service sector is the main economic activity of the state (44% of its GDP), followed by manufacturing (41%), and agriculture (15%). However, there are huge regional disparities. The economic history of the different regions has produced a range of features which even today shape public concerns and policies. Reduction of the regional inequalities within the state is usually at the top of the political agenda (although, in practice, public policies are often responsible for increasing these disparities!). Nevertheless, about 61% of the state's industrial production is concentrated in the regions around the axis Porto Alegre-Caxias do Sul.

Rio Grande do Sul possesses a wide range of academic literature on regional issues[2]. Despite the quality of this literature, modern methods of spatial analysis are almost unknown among local researchers, and there are few studies on quantitative geographical methods applied to economic issues. In recent times, there have been interesting long-term studies on the quantitative indicators of industrial concentration (Lautert, 2002), but no explicit spatial analyses. Among the few studies that apply exploratory analysis of spatial data

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[1]The Appendix shows figures of the state, its main cities and the Human Development Index of its
municipalities.
[2] See Alonso et al (1994).

(ESDA) techniques to the economic issues of Rio Grande do Sul is the recent paper by Ruiz and Domingues (2005).

In the first part of the study, several spatial analysis techniques are used in order to identify the industrialized and high market potential areas of the state. Spatial smoothing, ESDA, and implicit spatially constrained clustering techniques are applied to the 467 municipalities of Rio Grande do Sul.

This information is relevant to the second part of the study, which uses census data to estimate the impact of agglomeration economies on individual wages across the population of the state. The specific purpose is to test the prediction of a spatial wage structure in line with NEG models (Krugman, 1991; Hanson, 1997, 1998, 2000). Is labour productivity (and hence the wages) of workers located near the core of the economy higher than on the periphery? In order to answer this, section 2 gives the results of a Mincerian regression which includes the locational variables.

The basic source of data is the sample of the Demographic Census of 2000 (IBGE, 2002). This dataset is considered one of the best available sources in Brazil. One of its main features is that it includes the "informal" sector of the economy, which is very important in Brazil, because of the large number of workers which it employs.[3] After selecting only individuals with the appropriate traits, the sample was reduced to 55,001 manufacturing workers.

The results suggest that NEG predictions of a spatial wage pattern do indeed exist in Rio Grande do Sul. However, the conclusions of the study are to some extent preliminary, and the same database can generate new insights concerning regional issues within the state.

## 2. SPATIAL INDUSTRIAL CLUSTERS IN RIO GRANDE DO SUL

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[3] It has been suggested that, in Brazil, 54% of the workforce is employed in the informal sector of the economy (Gonzales et alli, 2002).

2.1. SPATIAL DISTRIBUTION OF MANUFACTURING EMPLOYEES IN RIO GRANDE DO SUL

Exploratory Spatial Data Analysis is the set of techniques used to describe spatial distribution, uncover patterns of spatial correlation or clusters, and identify outliers (Anselin, 1998). This section will begin with very simple data visualization methods, and then progressively more sophisticated techniques will be applied.

The figure below depicts the map of distribution of raw manufacturing employment, and its participation in the total working population.

FIGURE 1 - INDUSTRIAL EMPLOYMENT IN RIO GRANDE DO SUL - 2000

(A) TOTAL EMPLOYMENT   (B) PARTICIPATION IN THE POPULATION
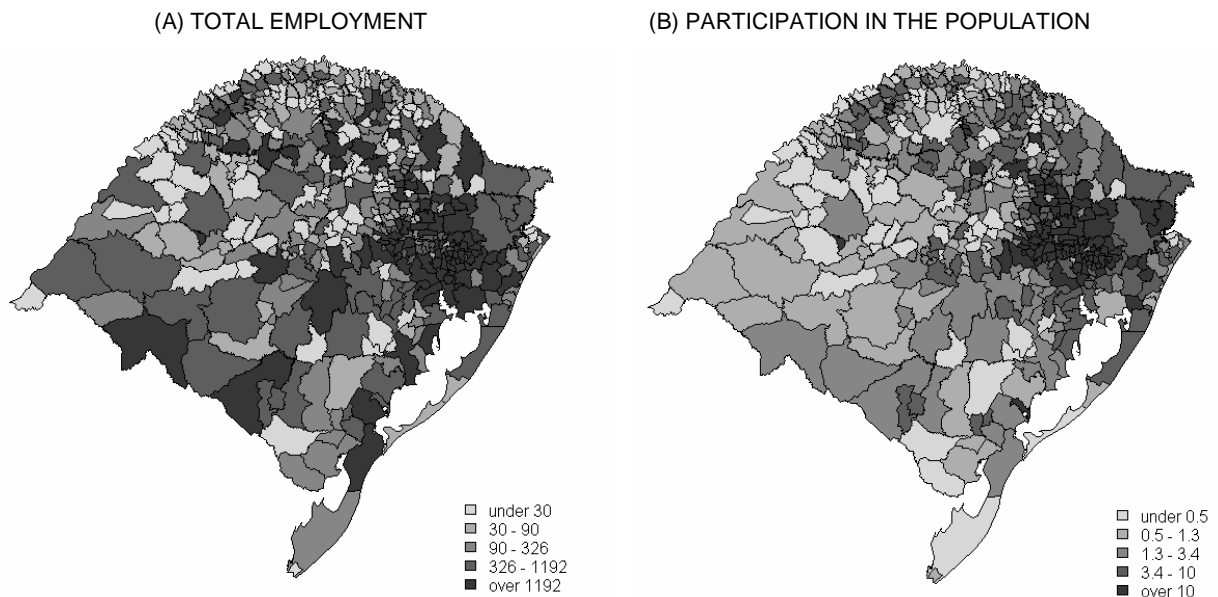

The raw data map creates an illusion that manufacturing employment is well distributed across space. The rate map, on the other hand, indicates that the northern part of the state seems more industrialized than the southern part. One of the problems of this data visualization is that the size of the population of municipalities is very diffuse. The smallest has about 1,000 inhabitants, whilst Porto Alegre has more than 1.3 million. As is widely known, this fact makes the variance of the rate in the smallest municipalities higher than in the largest ones.

In order to reduce the heteroskedasticity of the data, a process of data smoothing is applied. The chosen process goes like this:

$$Smooth_i = \frac{\sum\limits_{j=1}^{R} w_{i,j} Employment_i}{\sum\limits_{j=1}^{R} w_{i,j} Population_i}$$

<div align="right">(1)</div>

The w matrix is a binary distance matrix created by Geoda 0.95. The cut-off distance is the shortest one that creates a w matrix without disconnected spatial units. This criterion results in a highly connected w matrix, with an average of 69 neighbours per municipality. Another departure from the usual procedures is that the matrix is row standardized, but the values of the main diagonal are set as being equal to 1. This gives a more important role to the employment density in the unit during the spatial smoothing process. Figure 2 depicts the results:

FIGURE 2 – SMOOTHED PARTICIPATION OF INDUSTRIAL EMPLOYMENT IN THE POPULATION - RIO GRANDE DO SUL - 2000
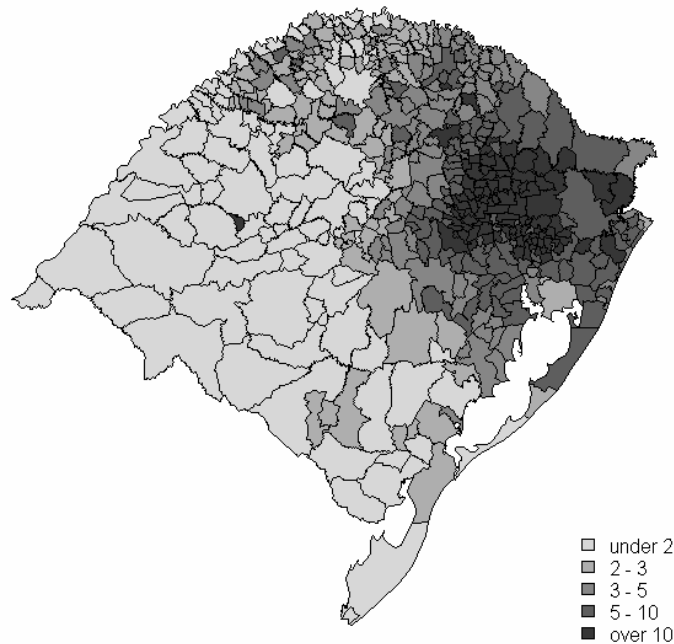
As expected, the results are smoother, and the data appear much more clustered than in Figure 1.

2.2.   INDICATORS OF GLOBAL AND LOCAL SPATIAL AUTOCORRELATION:

2.2.1.   MORAN'S I

Is manufacturing employment in the municipalities of Rio Grande do Sul spatially correlated with its neighbours? Moran's I will be used to evaluate the global autocorrelation of the data (O'Sullivan and Unwin, 2003, p. 197):

$$I = \frac{n}{\sum\limits_{i=1}^{n}\left(y_i - \overline{y}\right)^2} \frac{\sum\limits_{i=1}^{n}\sum\limits_{j=1}^{n} w_{ij}\left(y_i - \overline{y}\right)\left(y_j - \overline{y}\right)}{\sum\limits_{i=1}^{n}\sum\limits_{j=1}^{n} w_{ij}}$$

(2)

Where:

n= number of spatial units

$y_{i,j}$= value of variable y in i or j

$\overline{y}$ = y average

w_{ij}= element i, j from the same W matrix explained above

Using spdep, the Moran I statistic was calculated as 0.33 and H0 (no spatial autocorrelation) was refuted in favour of H1 (positive autocorrelation). The Moran scatterplot provides additional information on the spatial structure of the data:

FIGURE 3 – MORAN SCATTERPLOT FOR THE PARTICIPATION OF INDUSTRIAL EMPLOYMENT IN THE POPULATION - RIO GRANDE DO SUL -2000
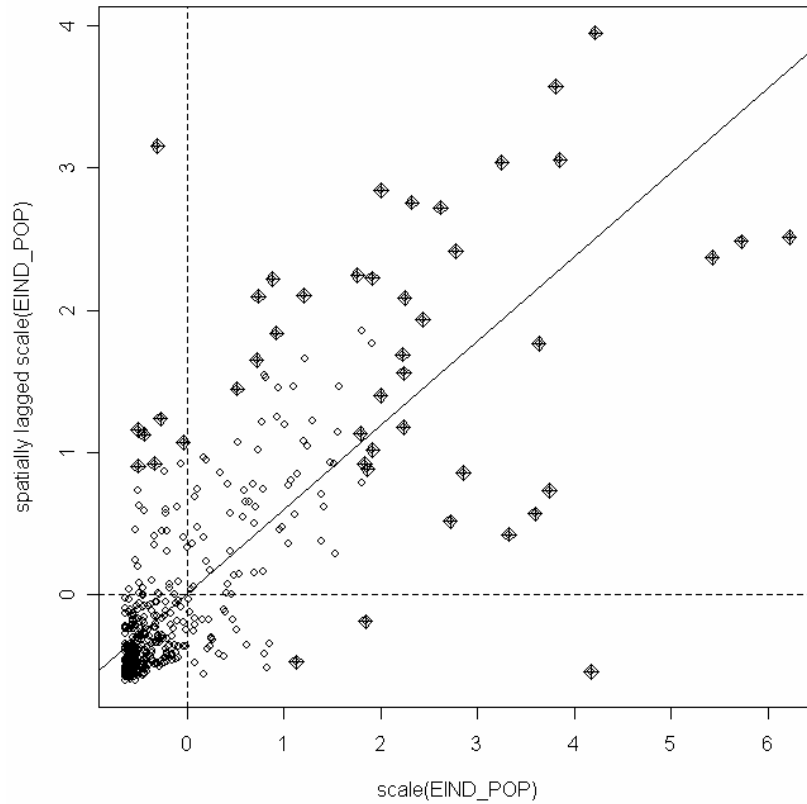
2.2.2. Local Indicators of Spatial Association

The Moran's I statistic indicates global autocorrelation, but is not able to indicate which areas are correlated with its neighbours. In order to solve this, local tests of autocorrelation were developed. Anselin (1995) established that a *Local Indicator of Spatial Association* (LISA) should have two properties: a) show which units have similar values around its neighbourhood; b) the sum of the individual LISA should be proportional to the global indicator of spatial autocorrelation. Local Moran's I (I_i) has both properties (O'Sullivan and Unwin, 2003, p. 203-204):

$$I_i = z_i \sum_{j \neq i}^{n} w_{ij}' z_j \tag{3}$$

$$z_i = \frac{y_i - \overline{y}}{s} \tag{4}$$

z: standardized values of y

w' = normalized values of the W matrix

Intuitively, the value of a local Moran's I is equal to the value of the attribute on the place i times the weighted average of its neighbours. Values of I_i statistically higher than 0 suggest positive spatial autocorrelation, whilst those lower than 0 indicate negative spatial autocorrelation. In the present case, the I_i were calculated using the spdep package.[4]

In spdep, the values of Moran's I_i are compared to an analytical reference distribution. The map below highlights the areas of High-High clusters:

FIGURE 4 – MORAN'S HIGH-HIGH INDUSTRIALIZATION CLUSTERS

2.3.   MARKET POTENTIAL

The market potential of a region was defined by Harris (1954) as:

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[4] Geoda and ArcGis use permutations to generate the reference distribution. This produces different results not in the values of the I_i, but in their statistical significance.

$$MP_i = \sum_{j=1}^{R} \left(\frac{M_j}{D_{ij}} \right)$$
(5)

that is, MP_i, the market potential of i, is the sum of the demand in all places j (M_j) weighted by the inverse of the distance (D_{ij}). Previous regional studies of market potential were more interested in issues concerning manufacturing location. Not surprisingly, they found that manufacturing was concentrated near areas of high market potential. (Brakman et al, 2003, p.36).

In this study, market potential will be calculated by using two techniques, the first of which reproduces Harris' (1954) proposal. In the second, the Euclidian distance to the economic centre of the state is estimated. Using GDP by municipality as the weighting variable, this centre was calculated as follows:

$$x_m = \frac{1}{n} \sum_{i=1}^{n} \left(x_i \frac{GDP_i}{\sum_{i=1}^{n} GDP_i} \right) \quad y_m = \frac{1}{n} \sum_{i=1}^{n} \left(y_i \frac{GDP_i}{\sum_{i=1}^{n} GDP_i} \right)$$
(6)

where x_i and y_i are the latitudes and longitudes of the centroids of each municipality. Using GDP data for 2001 (FEE, 2003), the result is latitude 29.5923 South and longitude 52.0526 West. This position corresponds roughly to Santa Cruz do Sul, a town with a number of modern tobacco processing units.

Figure 5 shows the percentiles of the distribution of Euclidian distances from the centroid of each municipality to the economic centre of the state, while Figure 6 represents the market potential. It is clear that the latter statistic provides a richer portrait of the economy of Rio Grande do Sul than the former. The industrial core, i.e. the axis Porto Alegre-Caxias do Sul, has a high market potential, but towns in the hinterland, such as Santa Maria, Pelotas and Rio Grande also show above average values.

FIGURE 5 – PERCENTILES OF THE DISTRIBUTION OF THE EUCLIDIAN DISTANTE TO THE ECONOMIC CENTER
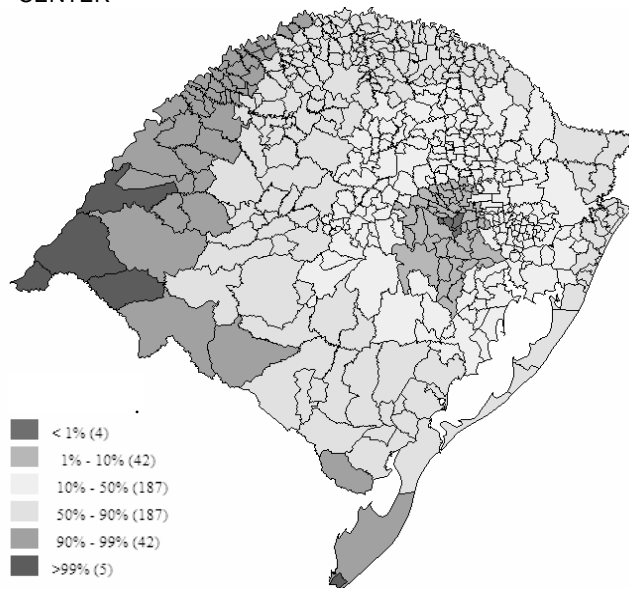

FIGURE 6 – MARKET POTENTIAL

## 2.4. IMPLICIT SPATIALLY CONSTRAINED CLUSTERING

Implicit spatially constrained cluster analysis is a simple way of including spatial dimensions in clustering methods. The survey by Duque and Raúl-Ramos (2005) describes the various methods available, with their strong points and weaknesses. Although they are

much more sophisticated than implicit spatially constrained clustering, this method generates a regionalization which is satisfactory for the purposes of this study.

In order to do it, the clara (clustering for large applications) algorithm in R is applied. This is a partitioning clustering method which is able to deal with very large datasets. The algorithm works roughly in two steps. First, it takes a sample of the data and applies a clustering method (PAM: partition around medoid) that creates k medoids. Then, each observation is assigned to its nearest medoids. The process is repeated several times (five, usually) and the sum of the dissimilarities of the observations to their closest medoid is the algorithm's criteria to find the best solution.

In order to locate the industrial clusters, only four variables were used: latitude and longitude of the centroid of the municipality, market potential, and manufacturing employment in the working population (spatially smoothed), as calculated in previous sections of this paper. There is a variety of criteria for selecting the optimum number of clusters. For the purposes of this study it was decided to consider the average size of the silhouette. In this case, the highest average size of the silhouette was reached with k=3. The resulting map is the depicted in Figure 5

FIGURE 5 – IMPLICIT CLUSTERING REGIONALIZATION CLARA (K=3)
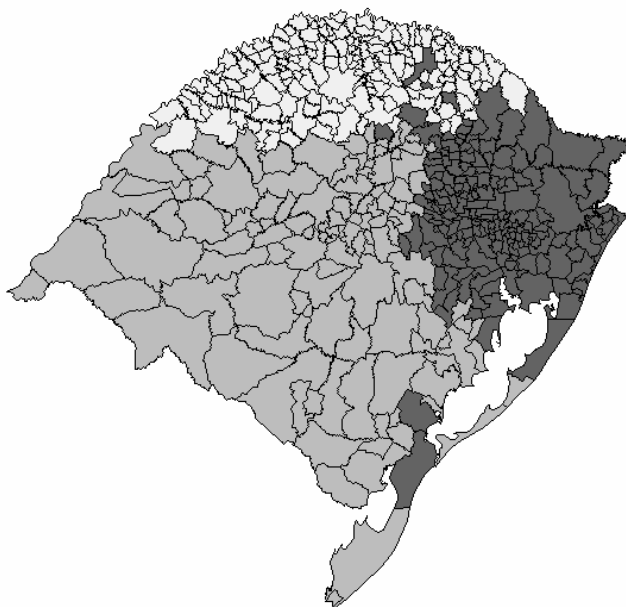
There are three basic clusters. One includes the industrial core of the state, the so-called Porto Alegre–Caxias do Sul axis. The municipalities in this cluster are the most industrialized, and/or are close to the most economically dynamic areas of the state, with high market potential. The two other clusters correspond, in general, to the non-industrialized municipalities and are far from the industrial core. The cluster in the south includes the municipalities of what is called the "Campanha" of Rio Grande do Sul, and is usually considered to be the state's main regional problem. The northern cluster consists of the "Planalto" region. The clusters identified are roughly contiguous, but not completely so. The spatially constrained implicit clustering does not, in fact, guarantee contiguity. For instance, Rio Grande and Pelotas, both situated in the south of the state, were included in the cluster of the industrial core. Although this also breaks with the spatial contiguity of the cluster, it makes economic sense. This area has an important industrial base, and the population of both municipalities (about 500,000 inhabitants) provides a sizeable market.

3. MANUFACTURING WAGES IN RIO GRANDE DO SUL

In this section the impact of locational variables on manufacturing wages in Rio Grande do Sul is estimated by using a wage regression which considers the proxies calculated in the previous section. It is appropriate, however, to present an overview of the theories that have guided the econometric tests.

3.1. THEORETICAL OVERVIEW

The main hypothesis is that locational externalities generate higher labour productivity and hence higher wages. Although this was a longstanding intuition, it was formalised and developed by New Economic Geography. Krugman, Fujita, Venables, and Thisse, for example, constructed models which explain the formation of a centre-periphery distribution of economic activity. In the long run, and with the right parameters, nominal wages would be higher in the centre and lower outside it. In other words, salaries would be positively related to market potential.

One of the criticisms that were made of NEG is that it was difficult to test its models. Many do not have unique equilibrium solutions, and can only be solved by simulation or demand variables that are not easily available. However, this kind of criticism is no longer

valid. Head and Mayer (2003) have pointed out that there are a considerable number of empirical studies inspired by NEG. There are of course still many problems in the literature, one of which is how to be sure that the data cannot be explained by another competing theory[5]. Nevertheless, it is important to stress that NEG models, especially those related to the wage equation, have received substantial empirical support.

Gordon Hanson (1997; 1998) was one of the first economists to test an NEG model. His 1998 paper tests the Krugman (1991) model as developed by Thomas (1997). The model starts with two identical agents who consume two types of goods: manufactured goods and housing services. There is monopolistic competition, increasing returns on the production of manufactured goods, and *iceberg* transport costs. Adopting plausible parameters, production is concentrated in few locations.

Intuitively, agglomeration is a consequence of companies trying to reach local markets, reducing transport costs and minimising fixed costs. On the other hand, the centripetal forces are the competition near the centre and higher wages (Hanson, 1998). According to this approach, agglomeration economies make it possible to pay higher wages, which can be balanced against the higher costs of living, and/or losses in well-being, of living near industrial areas (Brakman et al, 2003, cap. 3).

Hanson (1998) modifies the Krugman (1991) model with the aim of estimating its structural parameters. Hanson's econometric regression, using data from continental USA counties, gives strong support to the predictions of the model: increasing returns on manufacturing together with higher wages near the economic centre.

This paper does not perform a similar structural test of the Krugman (1991) model, since the lack of data makes it difficult to carry out a correct replication of Hanson's tests. In other words, the choice of variables and the research objectives were guided by Hanson's paper, but the results cannot be compared with his, nor understood in a structural way. Instead of using data from municipalities, an estimate will be made using individual census data. The research strategy is to estimate a wage regression (Mincer, 1974) and include locational proxies. In formal terms:

$$w_i = f(X_i, Y_n) \qquad\qquad (7)$$

Where:

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[5] FINGLETON (2004) compares two non-nested models (NEG and Urban Economics) to explain local wage rates in Great Britain. In this case, the empirical test supports the Urban Economics model.

w_i = hourly wage of person i in Brazilian Reais.

X_i = vector including individual characteristics that may impact on the productivity of work or wages.

Y_n = vector with measurable locational aspects within the municipality where the individual i works.

3.2.   VARIABLES AND SOURCE

3.2.1.   Individual variables based on a sample of 10% of the total population of the 2000 Brazilian National Census (IBGE, 2002):

- Schooling: number of years of study;
- Age: measured in years;
- Dummies for the colour of individuals: The criterion adopted mirrored the official one, i.e. self-identification of colour (yellow, white, native Brazilian, brown, and black)[6].
- Dummy for gender.

3.2.2.   Locational Variables

- AGGLOMERATION (smoothed): see section 1.1
- MARKET POTENTIAL: see section 1.3
- REGIONAL CLUSTERS: see section 1.4
- URBANIZATION RATE: share of the population of a municipality living in urban areas in 2000. Source: PNUD (2003).
- URBAN POPULATION: total population living in urban areas in 2000. Source: PNUD (2003).

3.3.   ESTIMATION AND RESULTS

The selected sample from the Census data for Rio Grande do Sul considers manufacturing workers in formal employment, who are literate, and between 18 and 65 years old. The use of this criterion reduced the sample to exactly 55,001 individuals. The strategy of

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[6] Although it may sound politically incorrect to use colours to express ethnic features, these categories are officially adopted by the Brazilian Federal Statistical Institute (IBGE). Ethnical relations and definitions are

the analysis was to include all the demographic data available as explanatory variables in the Mincerian regression.

The data bank with the municipal data of the first section of the study was merged with the individual data relating to the place of work, and not the place of residence. All regressions were carried out using R 2.1.1 (2005) and ordinary least squares and, whenever it made sense, all variables were transformed according to their natural logarithm.

TABLE 1 – ECONOMETRIC RESULTS – DEPENDENT VARIABLE: LN (WAGE PER HOUR IN MAIN OCCUPATION)

	I	II	IIII
CONSTANT	-9.683***	-11.062***	-10.906**
	(-3.59)	(-4.28)	(-4.23)
WOMAN	-0.351***	-0.350***	-0.350***
	(-78.77)	(-81.33)	(82.41)
YELLOW	0.026	-0.007	-0.007
	(0.04)	(-0.09)	(-0.108)
BRAZILIAN NATIVE	-0.047	-0.086*	-0.087*
	(-1.06)	(-2.03)	(-2.044)
BROWN	-0.077***	-0.082***	-0.082***
	(-8.61)	(-9.58)	(-9.627)
BLACK	-0.133***	-0.159***	-0.159***
	(-12.94)	(-15.99)	(-16.040)
AGE	5.449*	3.781	3.729
	(2.31)	(1.67)	(1.652)
AGE^2	-0.816	-0.344	-0.328
	(-1.19)	(-0.53)	(-0.501)
AGE^3	0.024	-0.020	-0.022
	(0.37)	(-0.33)	(-0.357)
SCHOOLING	1.043***	1.053***	1.053***
	(22.15)	(23.35)	(23.35)
SCHOOLING^2	-1.046***	-1.052***	-1.052***
	(-31.53)	(-33.11)	(-33.11)
SCHOOLING^3	0.323***	0.320***	0.320***
	(44.54)	(46.06)	(46.05)
MARKET POTENTIAL		0.159***	0.152***
		(26.670)	(49.34)
AGGLOMERATION (SMOOTHED)		0.506***	0.538***
		(8.863)	(11.75)
CAMPANHA		-0.075***	-0.075***
		(-6.397)	(-7.68)
PLANALTO		-0.004	
		(-0.454)	
URBANIZATION RATE		0.060***	0.049***
		(5.198)	(5.84)
URBAN POPULATION		-0.005	
		(-1.447)	
R²	0,417	0.466	0.465
F value	3581	2822	3198

Note: t values between parentheses: * significant at 0.05; ** significant at 0.01; *** significant at less than 0.001.

especially complex in Brazil. In fact, more than 70% of self-identified white Brazilian males have at least 10%

Model I is just a benchmark, but it supports the hypothesis concerning gender and racial discrimination in the job market. Women's wages are about 30% lower than men's, and black or brown individuals receive 7% and 12% less wages than white individuals respectively, controlling for age and schooling. Obviously, the results may also be influenced by non-observable parameters, for instance, different levels in the quality of education available to each group, or even different levels of occupation available in manufacturing.

Model II adds locational variables to Model I. Even when controlled for individual traits, wages are higher in locations with higher market potential, i.e. in industrialized and more urbanized clusters. All estimators for variables aimed to represent these dimensions have the features expected, and were statistically significant at more than 99%. In Model III, the non-significant variables, Campanha and Urban Population, were removed. The results were very similar to the previous Model, with no major changes in the values of the estimators.

Based on the results of Model III, working in a municipality located in the Campanha cluster reduces wages by 7%. Based on Model III, the marginal effect of an increase of 1% in the market potential or in the agglomeration was estimated to generate an increase of 0.15% and 0.54% in wages respectively. A hypothetical increase of 1% in the urbanization rate of the municipality is related to an increase of 0.05% in individual salaries.

It is important to stress that the results refer to nominal and not to real wages. As indicated above, one of the conditions of equilibrium of the model is that there are no differences in real wages among similar individuals.[7]

FINAL REMARKS

This paper has aimed to test the effects of the locational dimension on manufacturing wages in present-day Rio Grande do Sul. Several analytical techniques were used to highlight the spatial patterns of the distribution of industrial activity in the state. They have shown how clustered this sector is and have estimated the market potential of each municipality.

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of genes of African origin (PENA and BORTOLINI, 2004, p. 43).

[7] MIRANDA et al (2002) ran Mincerian regressions for individuals, using another data source, and using dummy variables for the Southeastern and Northeastern regions of Brazil. They found that it would be necessary to establish a price index 60% higher in the Southeast in order to equalize real wages between the regions. The authors took this result as an indication of regional differences in Brazil, and did not make any reference to New Economic Geography models.

Regression analysis using individual census data suggested that "space matters" in terms of the wages of workers. The results support the hypothesis of New Economic Geography, which asserts that nominal wages, with the proper controls, would be lower in places with lower market potential, low urbanization, low agglomeration economies, and far from the economically dynamic regions of the state.

One of the contributions this paper tries to make is to show the usefulness of merging spatial data and individual data in the study of issues concerning regional economics. This has made it possible to estimate the role of agglomeration, urbanization economies and market potential on the wages of manufacturing workers. Nevertheless, it is necessary to exercise caution when interpreting the results. Hanson (2000) drew attention to the problems concerned with measuring agglomeration economies and their effects. There may be unobserved exogenous local variables which make it difficult to understand precisely how agglomeration economies work.

The next steps of this research will be aimed in two directions: a) to gather data to make it feasible to perform a structural test of the NEG models; b) to improve the database in order to include information about the activities of each individual which may be biasing the tests. Apart from technical issues, the results of the study are important to policymakers concerned about the regional economic disparities within the state. In order to facilitate the development of effective regional policies, the measurement of agglomerative forces is relevant to decisions concerning which sectors and locations should receive further public incentives.

REFERENCES

Anselin L. 2004. Geoda: geodata analysis software. Illinois.

_____. 1995. Local Indicators of Spatial Association — LISA, *Geographical Analysis* **27**: 93–115.

_____. 1998. Exploratory spatial data analysis in a geocomputational environment. Longley P, Brooks S, McDonnell R and Macmillan W. (eds) *Geocomputation: A Primer*. Wiley and Sons: 77-94. New York, NY.

Alonso J, Benetti M, Bandeira P. 1994. Crescimento econômico da região sul no Rio Grande do Sul: causas e perspectivas. *Fundação de Economia e Estatística Siegfried Emanuel Heuser* **1**: 229. Porto Alegre, RS, Brazil.

Brakman S, Garretsen H, Van Marrewijk C. 2003. *An introduction to Geographical Economics*. Cambridge University: Cambridge.

Duque J C and Raúl-Ramos J. Surinach. 2005. *Supervised regionalisation methods: a survey*. Unpublished manuscript.

FEE - Fundação de Economia e Estatística. 2003. *PIB Municipal do RS - 1985-01*. CD-ROM. FEE: Porto Alegre, RS, Brazil.

Fingleton B. 2004. *The new economic geography versus urban economics : an evaluation using local wage rates in Great Britain*. ERSA conference papers, European Regional Science Association.

Fujita M, Krugman P and Venables A. 2002. *Economia Espacial*. Futura: São Paulo, SP, Brazil.

Gonzales, R H et al. A informalidade no mercado de trabalho brasileiro e as políticas públicas do governo federal. Brasília: MTE, 2002..

Hanson G. 2000. *Scale economies and the geographic concentration of industry*. NBER working paper 8013. Available at http://www.nber.org/papers/w8013.

_____ . 1997. Increasing returns, trade and the regional structure of wages. *Economic Journal* **107**: 113-133.

_____ *Market potential, increasing return, and geographic concentration*. 1998. NBER Working Paper, n. 6429, Cambridge. Mass.
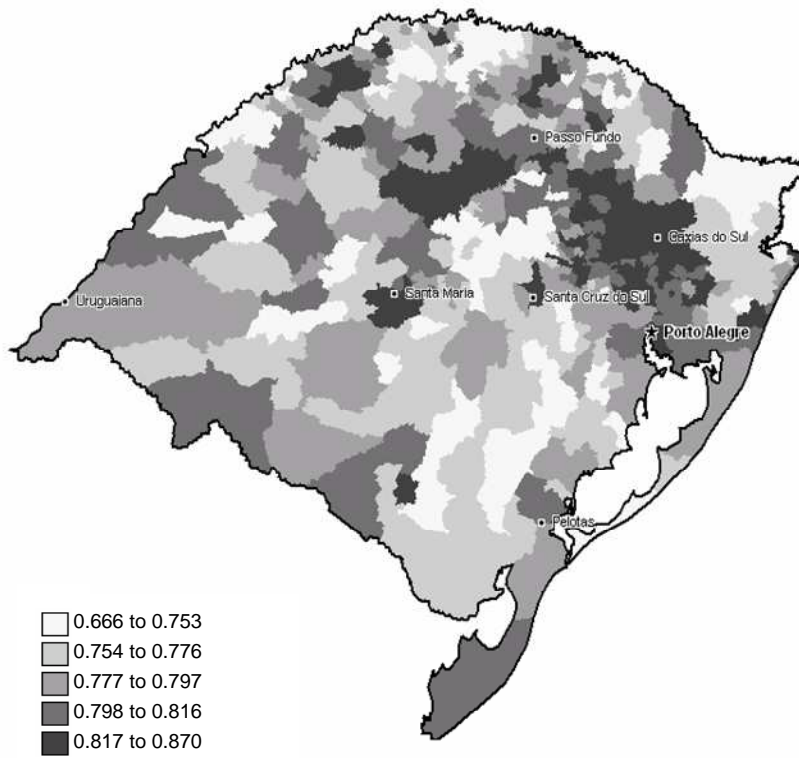
Harris C. The market as factor of localization of the industry in the United States. *Annals of the Association of American Geographers* **39**: 123-141.

Head K and Mayer T. 2004. *The Empirics of Agglomeration and Trade*. (ed.) Handbook of Regional and Urban Economics, chapter 59: 2609-2669.

IBGE. 2002. *Censo Demográfico 2000: Microdados da Amostra - RS - 2ª edição*. On CD-ROM. INGE: Brasília, DF, Brazil.

Krugman P. 1991. Increasing returns and Economic Geography. *Journal of Political Economy* **99**: 483-499.

Lautert V. 2004. A dinâmica da concentração geográfica na indústria do Rio Grande do Sul (1872-2000). In *II Encontro de Economia Gaúcha Conference Papers – May 20th and 21th*. Porto Alegre, RS, Brazil.

Mincer J. 1974. *Schooling, experience and learning*. Columbia University: New York, NY.

Miranda R, Oliveira C, Almeida M, Mac Dowell M and Ellery Jr R. 2002. II Regional wage difference in Brazil: Is there a regional problem? *II Encontro Brasileiro de Estudos Regionais e Urbanos Conference Papers*.

O'Sullivan D and D. J. Unwin. *Geographic Information Analysis* Wiley: Hoboken, NJ, 2003.

Pena S and Bortolini M C. 2004. Pode a genética definir quem deve se beneficiar das cotas universitárias e demais ações afirmativas? *Estudos Avançados*, v. 18, n.50.

PNUD. 2003. *Atlas do Desenvolvimento Humano no Brasil*. CD-Rom. Brasília: PNUD.

R Development Core Team. 2005. *R: A language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org.

Ruiz R M and Domingues E P. 2005. Corredores Industriais na Região Sul. *VIII Encontro de Economia da Região Sul Conference Papers*.

Schmitz H. 1995. Global Competition and Local Co-operation: Success and Failure in the Sinos Valley, Brazil. *World Development*, v. 23, n.1, jan: 9-28.

Thomas A. *Increasing returns, congestion costs and the geographic concentration of firms*. Mimeo. International Monetary Fund. Washington.

APPENDIX

FIGURE 1 – BRAZIL AND RIO GRANDE DO SUL

FIGURE 1 – HUMAN DEVELOPMENT INDEX - RIO GRANDE DO SUL (2000)

- 0.666 to 0.753
- 0.754 to 0.776
- 0.777 to 0.797
- 0.798 to 0.816
- 0.817 to 0.870

SOURCE: PNUD (2003).