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HUMAN CAPITAL DIFFERENTIALS ACROSS MUNICIPALITIES AND STATES IN BRAZIL

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SUMÁRIO

ABSTRACT

In this paper, we investigate the distribution of more educated and skilled people in Brazilian municipalities and states. Previous evidence shows a high concentration of college educated and high skilled workers in some areas of the country. We investigate whether the increase in the number of high skill workers is faster in municipalities with high initial levels of human capital than in municipalities with lower initial levels. We develop a theoretical model to explain the convergence/divergence of regional skill levels In Brazil. We estimate OLS models based on the theoretical model to explain empirically wage differentials in Brazil. Last, we compute standard segregation and isolation measures to show the trends in the distribution of skilled workers across states and cities in Brazil. We find that educated and qualified workers are concentrated in some areas of the country and recent decades show a higher concentration of them across states and cities.

RESUMO

Neste trabalho, nos investigamos a distribuição de trabalhadores mais educados e qualificados entre as cidades e estados brasileiros. Evidencia empírica anterior mostra uma grande concentração de mão-de-obra qualificada em algumas áreas do pais. Nos investigamos se o aumento da mão-de-obra qualificada e mais rápido nas localidades com um numero inicial mais alto de qualificados. Nos desenvolvemos um modelo teórico para estudar a divergência e convergência regional no Brasil. Alem disso, estimamos os efeitos da concentração e do crescimento de qualificados na renda e nos retornos a educação no Brasil. Por ultimo, usando indicadores clássicos de concentração e segregação mostramos a evolução da distribuição da mão-de-obra qualificada no Brasil nas duas ultimas décadas.

Keywords: Human Capital, Segregation, Regional Differences, Brazil
Palavras-Chave: Capital Humano, Segregação, Diferenças Regionais, Brasil

JEL: J21, J24, R23

1. INTRODUCTION

In the United States and Great Britain, for several years, cities with greater concentration of workers with high levels of education have grown faster, in economic and demographic terms, than cities with less human capital. In addition to that, the growth rate of high-skilled workers is much greater in more educated cities than in less educated ones (Glaeser, 1994; Black and Henderson, 1999). Two questions emerge from this evidence: a) why are more educated people concentrating in more skilled cities?; b) why are people concentrating around skilled workers?

Acemoglu (1996) discusses the social returns to education. Acemoglu argues that private investments in education and training generate benefits to other actors in the economy. Consequently, the social effects of education are larger than private ones, as already mentioned, and the exchange of knowledge and skills through formal and informal interactions among workers can generate positive spillovers for the whole society. Human capital regional externalities are viewed as a central element to the economic growth of regions and nations. Hence, population and skills concentration may not be a handicap for economical development, due to diseconomies of scale, rather the contrary.

Indeed, cities with greater density present a more dynamic pattern of growth, since that firms located in the locality gain from the knowledge generated by other firms located in the same area (Glaeser et. al. 1992). On the other side, geographically isolated firms do not present these scale economies (Glaeser et. al, 1992). Glaeser & Maré (1994) show that cities facilitate the exchange of skills among workers. Cities, due to their higher density of population and of economical activities, improve interpersonal relations. Thus, less productive workers beneficiate from the skill interchanges with the more productive ones. This effect is stronger in localities with a higher level of human capital, considered more productive, because the exchange among workers increases the overall productivity and, consequently, wage levels.

Hanson (2000) enumerates a series of possible explanations for the observed relation between the average level of human capital (measured by the average years of schooling) and regional wages. According to the author, the positive correlation would be reflecting a deeper relation between wages and the composition of the regional structure of production. Other element that might explain the relationship would be the quality of education in particular localities, assuming that workers might stay in the place where they have obtained their education. Schooling may not be seen as only a private good, but also as a public one (Rauch, 1991). Therefore, the regions (localities) with higher levels of schooling should present higher wages, in average, than others, also due to agglomeration effects. Rauch (1991) follows the proposition of Shultz, which suggests that education should be seen as a public good, that has as objective to increase the efficiency of the economy and of institutions.

On the other side, theories of spatial location based on the local effects of human capital (Black & Henderson, 1999) suggest that wages and costs of living should be higher in regions with larger stocks of human capital. Other factors may also influence wage differentials and wage inequality, such as the structure of local labor markets. Besides this, regional wage differentials might compensate for differences in the cost of living and urban amenities across regions.

Despite unabated interest among researchers in issues regarding the distribution of income in Brazil and patterns of regional economic growth, little is known about the distribution of human

capital in Brazil and its impacts on economic growth and regional development. Cano (1985), Diniz (1993) and Pacheco (1998) discuss the pattern of regional development in Brazil; they show that most of the developed area and the ones that are growing faster in recent years are located in the south. Savedoff (1995) and Servo (1999) show that regional wage differentials in Brazil are large and persistent over time; wages in the southern region are significantly higher than other areas.

In this paper, we investigate the distribution of more educated and skilled people in Brazilian municipalities and states. Previous evidence show a high concentration of college educated and high skilled workers in some areas of the country (Golgher, 2006). We investigate whether the increase in the number of high skill workers is faster in municipalities with high initial levels of human capital than in municipalities with lower initial levels. The distribution of human capital across Brazilian municipalities and its pattern of growth is one of the main sources of regional inequalities in the country.

First, we developed a theoretical model for convergence/divergence of regional skill levels. The model aims to explain the tendency of more educated people to move and concentrate to initially skilled areas. The model indicates that concentration occurs for two main reasons: tendency of high technology industries to hire skilled people; and concentration of skilled people increases housing prices driving less skilled persons to other areas.

Then we exploit the convergence and divergence in skill levels for cities. We show a strong correlation between changes in the share of the adult population with high levels of education and the initial share of educated population. The results are robust to a series of specifications and for different municipalities' sizes. This tendency is also correlated to a high level of segregation of skilled workers in Brazil.

Next, we explore the predictions of the model for wage and human capital concentration across municipalities in Brazil. As the model implies, there is a strong relationship between education and income (wage) levels at the city level in Brazil. Moreover, the relationship increases over time and is stronger for cities with already high initial levels of education. The result supports the central idea that there is an increasing demand for high skilled workers in already skilled cities.

2. THEORETICAL MODEL

In this section of the paper we developed a simple theoretical model trying to explain why a concentration of skilled persons may occur in some specific places.

Different regional aspects attract highly skilled persons (Stillwell and Congdon, 1991). Among them are: economic features (unemployment ratios, rent prices, salaries, residential market, presence of industrial activities, etc); social characteristics (low criminality, urban amenities, good educational opportunities, ample range of leisure activities, etc); environmental aspects (low levels of pollution, weather, quality of the environment, quantity of sunshine, etc); and others. In most studies, the main factors considered important in explaining mobility are the economic ones, but some authors also pointed out to the importance of non-economic regional disparities (Knapp et al 1989; Greenwood 1985; Porrel 1982).

Following the neoclassical theory, population mobility would be partially caused by regional differences in demand and supply of labor and the regional capital/labor ratio would show a convergent trend. Consequently, a region that was initially socially heterogeneous would present a tendency of homogenization (Evans, 1990; Harrigan and Mcgregor, 1993; Graves and Mueser, 1993; and Schater and Althaus, 1993).

However, there is not a strong evidence of convergence in wage levels in many areas. Hence, the concentration of highly educated persons may present many features that were not fully anticipated in the equilibrium models.

The proposed theoretical model discusses some of these features. The basic equations are similar to the ones presented in Berry and Glaeser (2005).

n the model there are two types of workers, the high and the low skilled ones, represented by the letters **h** and **l**. The utility for both types is a function of the residual income and local amenities, $U_i^j = U(RI_i^j, A_i^j)$, where **i** is the index for localities and **j,** for the type of worker. As usual, the utility is an increasing and concave function on both variables: $\partial U_i^j / \partial RI_i^j > 0$, $\partial^2 U_i^j / \partial RI_i^{j2} < 0$, $\partial U_i^j / \partial A_i^j > 0$ and $\partial^2 U_i^j / \partial A_i^{j2} < 0$. Consequently, as the expected residual income of high skilled workers is higher, we have: $\partial U_i^h / \partial RI_i^h < \partial U_i^l / \partial RI_i^l$. For the amenities, the analysis of the partial derivative is not so straightforward, because we may have two contradictory tendencies. It is likely that high skilled workers may have higher levels of amenities consumption. Hence, due to the concavity of the function, the partial derivative for the skilled would be smaller then for the other group. However, normally, in models based in a human capital perspective, it is expected that amenities may be more decisive, when compared to economical variables, in promoting an increase in the utility of higher income groups than for other strata of the population, that is, the relative importance of amenities for the high skill workers is greater (de Hann, 1999).

The residual income is a function of wages and costs: $RI_i^j = RI(W_i^j, C_i^j) = W_i^j - C_i^j$. In this model, wages are determined by five variables: one specific for the individual, the human capital of the person, H^j; three of the locality, the proportion of skilled individuals, the number of workers in the locality and regional localization, respectively, P_i, N_i, R_i; and one that is a interaction between personal and spatial characteristics, local amenities, already cited above. The following equation represents this relation: $W_i^j = W_i^j(H^j, P_i, N_i, R_i, A_i^j)$.

Some of the signs for the partial derivatives are expected to be positive. The higher the level of human capital, other variables being constant, the higher are the wages: $\partial W_i^j / \partial H^j \geq 0$. The larger the number of workers higher might be the salary, $\partial W_i^j / \partial N_i \geq 0$.

Following Moretti (2004), in a standard neoclassical model of wage determination, high and low skilled workers are imperfect substitutes. Hence, an increase in the proportion of the first type of workers impact positively on the wages of the second type. Besides this, it may occur a spillover due to this increase in qualification, and low skilled workers may be also benefited by this second phenomenon. Consequently, the partial derivative is $\partial W_i^l / \partial P_i \geq 0$.

Regarding the high skill group, the relation is not so clear and two trends may have contradictory effects. On the one hand, wages may decrease if there is an increase in the proportion of skilled workers because of the augmentation in the high skilled workers supply, but on the other, this effect may be more than compensated by spillovers. Based on this discussion, the sign of the partial derivative is inconclusive for $\partial W_i^h / \partial P_i$.

The effect of amenities on wages are expected to be negative for the high skilled group, as this type of worker may work for less if they are rewarded by high levels of amenities, $\partial W_i^h / \partial A_i^h \leq 0$, and negligible for the other group, as wages are already low and low skilled might not be willing to make a trade off between salaries and amenities, $\partial W_i^l / \partial A_i^l = 0$.

Regional localization is not a variable but a function of three of them that impact directly on wages in Brazil: urbanization degree, UD_i, if the locality is a state capital or not, Cap_i, and if the locality is the "South" or elsewhere, in the "North", NS_i. This relation is $R_i = R_i(UD_i, Cap_i, NS_i)$. The expected partial derivatives are all positive, that is, it is expected, other variables being constant, that more urbanized localities, that are capitals, in the South/Southeast/Center-West macroregions of Brazil have greater wages for both groups of workers: $\partial W_i^j / \partial UD_i \geq 0$, $\partial W_i^j / \partial Cap_i \geq 0$ and $\partial W_i^j / \partial NS_i \geq 0$.

The costs, primarily housing costs, are also a function of the same variables used in the wages equation: $C_i^j = C_i^j(H^j, P_i, N_i, R_i, A_i^j)$. For costs, all the partial derivatives, but the amenities one, are expected to be positive for both groups of workers: $\partial C_i^j / \partial H^j \geq 0$, $\partial C_i^j / \partial P_i \geq 0$, $\partial C_i^j / \partial N_i \geq 0$ $\partial C_i^j / \partial UD_i \geq 0$, $\partial C_i^j / \partial Cap_i \geq 0$ and $\partial C_i^j / \partial NS_i \geq 0$. For the amenities, we must treat the human capital groups differently. Low skill workers have low income and do not pay privately for amenities via housing costs. Hence, the costs are not a function of amenities for this type of workers. However, the high skill group might increase their housing costs in order to live in an area with a high degree of amenities: $\partial C_i^h / \partial A_i^h \geq 0$

Now we may turn our attention to the amenities that can be seen as a function of three variables, all for localities: natural characteristics, NC_i, social environment, SE_i, and proportion of skilled, P_i : $A_i^j = A_i^j(NC_i, SE_i, P_i^h)$. The first one of these variables is self-explained, as different places with diverse climates, natural beauty endowments or pollution levels may change the utility of the individual. The social environment one is an indication of the quality of life of a locality due to spatial characteristics not related to wages, costs or natural aspects. Variables, such as Bohemian and Diversity index proposed by Florida (2002a,b) may be proxies of the social environment quality. The expected sign for the partial derivatives of these variables are $\partial A_i^j / \partial NC_i \geq 0$ and $\partial A_i^j / \partial SE_i \geq 0$. The last variable, the proportion of high skill workers, would be important only for the skilled workers and is related to the fact that persons with high levels of human capital, other variables being equal, prefer to be among themselves. Therefore, the partial derivative is $\partial A_i^h / \partial P_i^h \geq 0$.

Including all the above information in the utility function we obtain the following general expression:

$$U_i^j = U(W_i^j(H^j, P_i, N_i, R_i(UD_i, Cap_i, NS_i), A_i^j(NC_i, SE_i, P_i^j) - C_i^j(H^j, P_i, N_i, R_i(UD_i, Cap_i, NS_i), A_i^j(NC_i, SE_i, P_i^j)), A_i^j(NC_i, SE_i, P_i^j))$$

What does this equation tells us about the concentration or not of skilled workers in some localities? In other words, which one is the sign of the partial derivative of the utility for the high skill and for the low skill groups with relation to the proportion of skilled workers in the population: $\partial U_i^h / \partial P_i = ?$ and $\partial U_i^l / \partial P_i = ?$

Suppose, initially, that, due to prior migration (with very low costs), the utilities are roughly the same among localities for each group of workers. The alternatives will be analyzed separately for each sign possibility. If the partial derivative is positive for the high skill group, other variables being constant, any positive disturbance on P_i, that is, an a exogenous increase of the variable, would implicate in an increase in the utility and a tendency to attract even more high skilled workers and to concentrate this type of workers in the locality with a divergent spatial trend of proportion of skilled. If the derivative is negative, a positive disturbance would implicate in the decrease of the utility, with the tendency to promote out migration of the skilled, what would cause the return of the prior equilibrium. If the derivative for the low skill group is positive, a disturbance that decreases P_i, such as immigration of low skilled workers, would decrease utility of this particular group, with negative impacts on immigration rates, returning to the equilibrium. If this derivative is negative, them, for instance, if immigration occurs, there would be an increase in utility with further immigration, and a positive feedback mechanism would arise, with spatial divergence of the skills levels.

The analysis above was done taking one derivative at a time. Now let's see what happens if both derivatives are studied together. Box 1 presents all the possibilities. If $\partial U_i^h / \partial P_i > 0$ and $\partial U_i^l / \partial P_i < 0$, possibility 3 in the table, any positive disturbance on the P_i value would increase the utility of the high skill group and decrease the low skill one. These would cause, for instance, immigration of skilled and out migration of the other group, the proportion of skilled will increase even more and a spatial divergence of skill levels, would occur. If the disturbance in P_i were negative, the same would occur. If $\partial U_i^h / \partial P_i, < 0$ and $\partial U_i^l / \partial P_i > 0$, possibility 4, any positive disturbance (the same would happen with a negative disturbance) on the P_i value would decrease the utility of the high skill group and increase the low skill one and would promote a return to equilibrium. In possibilities 1 and 2, $\partial U_i^h / \partial P_i > 0$ and $\partial U_i^l / \partial P_i > 0$. These implicate that any positive disturbance on the P_i value would increase both utilities, that would first encourage the migration of both groups with conflicting effects for the value of P_i. If $\partial U_i^h / \partial P_i >> \partial U_i^l / \partial P_i$, then migration of high skilled would be greater than for the low skill group, the proportion of skilled would increase more, both utilities would raise even further with divergence on the skill levels and concentration of population in

the locality. Notice that is the disturbance is negative, there would be an out migration of both groups and the population would concentrate elsewhere. As in possibility 2, both derivatives are positive in possibility 1 and also $\partial U_i^h / \partial P_i \leq \partial U_i^l / \partial P_i$, then migration of low skilled would have a greater impact and the equilibrium would be reassured with a slight variation of population in the locality. If $\partial U_i^h / \partial P_i < 0$ and $\partial U_i^l / \partial P_i < 0$, any positive disturbance on the P_i value would decrease both utilities. If the impact on the utility of the high skill is greater, that is, $\partial U_i^h / \partial P_i << \partial U_i^l / \partial P$, there would be a return to equilibrium with a loss of population (the contrary would occur with a negative disturbance in possibility 5). But if $\partial U_i^h / \partial P_i \geq \partial U_i^l / \partial P$, there would be preferentially out migration of the low skill group, with a further decrease in both utilities, a concentration of skills, with a further decrease in utilities, with a decrease of the population of the locality, while the proportion of skilled increases.

Returning to the equations of the model and obtaining the derivatives, we have for the high skill group:

$$\partial U_i^h / \partial P_i = (\partial U_i^h / \partial W_i^h)(\partial W_i^h / \partial P_i + (\partial W_i^h / \partial A_i^h)(\partial A_i^h / \partial P_i^h))$$
$$+ (\partial U_i^h / \partial C_i^h)((\partial C_i^h / \partial P_i) + (\partial C_i^h / \partial A_i^h)(\partial A_i^h / \partial P_i)) + (\partial U_i^h / \partial A_i^j)(\partial A_i^h / \partial P_i)$$

Similarly for the low skill group:

$$\partial U_i^l / \partial P_i = (\partial U_i^l / \partial W_i^l)(\partial W_i^l / \partial P_i) + (\partial U_i^l / \partial C_i^l)(\partial C_i^l / \partial P_i)$$

Based on these equations, how could we explain the above possibilities presented in Box 1? In other to illustrate the above possibilities, one of each is discussed below for fictitious examples. Surely, in a heterogeneous country such as Brazil, all the possibilities may occur in different places at the same time.

In possibility 1, both derivatives are positive. For the low skill group, suppose that due to spatial segregation, an increase in the proportion of high skill persons have a negligible impact on the costs of living, that is, $(\partial C_i^l / \partial P_i) \cong 0$. As $(\partial U_i^l / \partial W_i^l) > 0$ and $(\partial W_i^l / \partial P_i) > 0$, then necessarily $\partial U_i^l / \partial P > 0$. For the high skill group, make the initial assumption that the proportion of skilled and the presence of amenities do not impact on wages greatly, that is, a greater proportion of high skilled workers do not change significantly the salaries of this type of worker and places with higher levels of amenities do not have lower wages because of them: $\partial W_i^h / \partial P_i \cong 0$ and $\partial W_i^h / \partial A_i^h \cong 0$. For simplicity, suppose also that the supply of housing for high-income group is elastic, so $\partial C_i^h / \partial P_i \cong 0$ .The above equation for this type of worker turns approximately to: $\partial U_i^h / \partial P_i = [(\partial U_i^h / \partial C_i^h)(\partial C_i^h / \partial A_i^h) + (\partial U_i^h / \partial A_i^j)](\partial A_i^h / \partial P_i)$. Now, as $(\partial A_i^h / \partial P_i) \geq 0$, if $(\partial U_i^h / \partial A_i^j)$ is slightly greater than the modulus of $(\partial U_i^h / \partial C_i^h)(\partial C_i^h / \partial A_i^h)$, that is, the positive impact of the amenities on the utility is a little greater than the negative effect of the variation of utility

due to costs multiplied by the variation of costs due to amenities the above possibility 1 is fulfilled. The increase in the proportion of skilled workers because of a slightly increase in their number, would promote a small augmentation in the wages of low skill workers without a similar growth of costs due to spatial gentrification, with a expansion of utility for this type of worker. On the other hand, the small increase in the proportion of skilled, promoted an increase in the amenities levels for the high skill workers, because they prefer to live among them selves, without a comparable negative effect on utilities due to an increase of housing costs. As the effect for the low skill is grater, immigration of this type of worker would be larger and the prior equilibrium would be attained.

3. SKILL CONVERGENCE AND DIVERGENCE ACROSS MUNICIPALITIES

In this section we analyze the relationship between initial levels of human capital and the rate of change in the share of high skilled individuals across municipalities in Brazil. We used data from the 1991 and 2000 Brazilian Censuses (FIBGE, 1991, 2000). Our units of observation are the 4267 minimum comparable areas (MCA) for these two Censuses. The use of MCA means that the data for municipalities in both Censuses were aggregated to a consistent set of area boundaries with the maximum numbers of areas.

Initially, we show the direct relationship between the change in skill level and the initial level of human capital in each municipality in figures 1 to 4. We perform out analyses with all municipalities and for those with more than 100000 inhabitants with the basic connection between the growth in adults with certain education level and the initial educational level with no other control. We present results for adults with at least high school education, and for those with a college degree or more.

The regression lines in Figures 1-4 show a stronger effect for larger municipalities, and for adults with at least high school education. The coefficient for the share of people with high school is 0.0958 with r-squared of 38,6 for cities with more than 100000 people. The results presented in Figure 2 show that as the share of high school educated workers in the larger municipalities increased by 1% in 1991, the share of adults with high school education increased 2.2% percentage points in 2000.

The figures above showed that the relationship between initial levels and changes in these levels are feeble and positively correlated, but may be caused by other correlated variables. We use an OLS model regressing the change in the percentage of adults with certain educational level to the initial level of adults with that same level, controlling for other variables. We control for population size (ln of population in 1991), age and sex distribution (sex ratio and share of population with age between 20-64 year old in 1991), and regional fixed effects.

Table 2 shows the results after controlling for other variables. Panel A presents the results of workers with at least a high school degree and panel B shows the same results for data with at least a college degree. As can be seen in both panels, for all municipalities the coefficients for the share of population with high school or college degrees were negative and significant. This indicates that, after controlling for the other variables, there is a convergent trend in Brazil. However, for the larger municipalities, those with more than 100000 inhabitants, the results were positive and significant for this same variable indicating a divergent tendency.

Berry and Glaeser (2005) point out that the analysis presented above might be problematic because the change in share of adults with certain educational level might not be normally distributed. In order to overcome this difficulty, the same type of analyses was done with the log change of the share in workers with certain educational level. We present the results in Table 3.

The results for all municipalities were very similar to the ones obtained above in Table 2, indicting, also in these models, that a convergence trend is observed. However, the data for the most populated municipalities showed a convergence tendency, contrary to the observed in Table 2.

4. REGIONAL INCOME DIFFERENTIALS

Previous evidence suggests a high degree of concentration of the skilled in Brazil and that regions with high levels of human capital are those where we observe higher growth rates in educational attainment. Our model suggests that concentration of skilled workers might affect the patterns of regional wages and inequality. Also, empirical evidence suggests that regional differences explain part of regional wage differentials in the country.

A variety of relevant and important models that analyze the determination of local wages can be identified. One of the models is the neoclassic. This model proposes that, due to the forces related to the market, there would be a convergence on wages in the long run with the homogenization of regional differences (Molho, 1992). The same author presents an alternative version to the neoclassic models. Those models show that long run differences in wages exist to compensate differences among regions in variables such as costs of living and urban amenities. In this context, wages would vary among workers not only because of different levels of human capital, but also due to differences on regional characteristics of the labor market and composition of the labor force, a proposed above in the theoretical model.

Savedoff (1990 and 1992) examines the determinants of wage differentials in the metropolitan regions in Brazil. The author observed that there are huge regional differences in the wages of Brazilian workers, although exists a high level of interrelation among the studied regions, indicating that does not exist a regional homogenization tendency in the country. The papers concluded that the differentials exist because of the differences in the organization of the local economy and is a function of the demand and of the supply of labors in each region.

The literature presented before and the proposed theoretical model suggested that cities with higher levels and concentrations of human capital, other variables being constant, should observe higher wage levels. We analyze this relation using a simple OLS model. The independent variable was the logarithm of municipal wages. Some variables were included in the model in order to control other regional heterogeneities. These are the logarithm of the rent values, the logarithm of municipal population, the sex ratio, the proportion of population with age between 20-64 years old, and local dummies. Two other independent variables, for which is given particular attention is the proportion of workers with 12 or more years of schooling and the observed change in this proportion in the period between 1991 and 2000.

We found that the relationship between share of highly educated adults and the log of average wage is positive and significant. A 1% increase in the number of workers with at least high-school increases average wage in 3 percentage points. Although the proportion of skilled positively impacted regional wages in Brazil, changes in this proportion did not show statistical significance.

Hence, the empirical model indicates that regions with higher proportions of skilled tend to show greater mean salaries. Higher mean wages may indicate that both groups, the non-skilled and the skilled, might have larges revenues. Consequently, regions with greater proportions of skilled and larger wages may attract low skilled in relatively greater numbers with a tendency regional homogenization in skill levels.

5. SEGREGATION OF THE SKILLED

The previous section showed that municipalities with higher initial level of skilled workers tended to observe greater increase in the share of qualified workers. This was observed only when we investigate larger cities, but the results were not very robust. In the last decade, there was an increase in the concentration of qualified workers. In this section, we use standard measures to show the degree of human capital concentration In Brazil over time.

Table 4 shows the change in human capital segregation across Brazilian municipalities in the 1990's for three different levels of education: at least high school, at least college degree and a graduate degree. The first column shows an increase in the mean municipal value for the percentage of workers with a certain level of education. In 1991, only 3.5% of adults had at least high-school education, in 2000, the number increased to 4.5%. The standard deviation increased from 3.13 to 3.69, indicating that the municipalities were very heterogeneous in their educational level. This can also be seen by the minimum and maximum values observed. Panel B and C show the results for the other schooling levels.

The 1990's also experienced an increase in the percentage of municipalities where a number of workers have college education (data not shown). In 1991, in almost 8% of municipalities there was not a single adult with college education. In 2000, this number was only 2.7%. In addition to that, the number of municipalities where there was more than 5% of adults with college degree almost doubled. If in one hand, there seems to be a faster increased of skilled workers in areas with greater initial levels of human capital, on the other hand the number of municipalities with some educated worker is increasing.

The evidence presented in the previous section and paragraphs give some idea of the pattern of distribution of skilled in Brazil. It, however, does not give an idea of the segregation of workers in Brazil. We calculate standard measures of segregation (Berry & Glaeser, 2005) to measure the degree to which high-educated workers are segregated.

The first measure is the index of dissimilarity. This index is estimated by the following expression:

$$I = \frac{1}{2} \sum_{MCA} \left| \frac{Adults\ with\ educ.level}{Total\ adults\ with\ educ.level} - \frac{Adults\ without\ educ.level}{Total\ adults\ without\ educ.level} \right|$$

This index is zero if skills are evenly distributed and increase the greater the heterogeneity. It indicates the share of adults with some level of education that would have to move to a certain place to be a homogenous distribution of workers with that level of education in the country. The numbers are quite high compared to other countries, in the US it ranges from 11% to 12.8%, and do not vary much between 1991 and 2000. The result shows that educated people, independent of city size and region, are very segregated in Brazil. For instance, the dissimilarity index decreased from 0.34 to 0.32 for the high school level between 1991 and 2000, indicating a slight homogenization. For the college degree level, the same values were 0.34 and 0.33, roughly similar ones. For the graduate level, the indexes were higher and segregation was even more concentrated.

The second measure is the index of isolation. It is estimated by the following expression:

$$I = \sum_{MCA} \left| \frac{Adults\ with\ educ.levelregion}{Total\ adultsregion} * \frac{Adults\ with\ educ.levelregion}{Total\ adultswitheduclevel} - \frac{Adults\ with\ educ.level}{Total\ adults} \right|$$

It measures the degree in which skilled workers are surrounded by similar individuals and varies between 0 to 1 with the increase in regional heterogeneity. The results are impressive for college educated adults and for those with some graduate degree (MA or PhD). The evidence suggests that skilled workers are almost concentrated in a few cities in the country, and that they live in areas that are much more educated than the cities where the average person lives.

6. EMPIRICAL EVIDENCE FOR CONVERGENCE AND DIVERGENCE TRENDS IN BRAZILIAN STATES

As was noticed in the previous section, the dissimilarity and the isolation index did not show a clear tendency of convergence or divergence between municipalities in Brazil, but they did show that Brazil is highly heterogeneous. Consequently, due to these regional differences, it is expected that convergence/divergence may be observed with specific samples of municipalities or with a diverse aggregation of data.

We perform a similar analysis for each of the regions of the country (North, Northeast, Southeast, South and Center-West). The results were very similar to the ones presented for the whole country in table 4. This indicates that the tendencies observed for all Brazilian municipalities were not distinct than the ones observed in the regions

This section analyses the Brazilian data for states. There are 26 of these plus the Federal district. The use of more aggregated data permits the use of the PNAD database, which has a much smaller sample than the Censuses. Some states with small population in the North Region were analyzed together because of small ample sizes. The data for the proportion of the population with a BA degree and with a graduate degree or studying in the years of 1986, 1992, 1998 and 2004 were obtained from the PNADs of these years.

Table 6 shows the results for the first and last of these years for all the analyzed areas in Brazil. It is also shown the variations in the two proportions in the period. It can be seen that there was an increase in the proportion of BA holders in all states in Brazil, showing the enlargement in the schooling levels in the country. The data for Brazil was 2.34% in 1986 and 4.74% in 2004, with an increase of above 100% in the period. The highest values were observed in Federal District, Rio de Janeiro and São Paulo, all above 7% in 2004. The lowest numbers were observed in the northeast Region in Alagoas, Bahia and Maranhão with values below 2%, but all with an increase above the national mean. This indicates a regional homogenization, which was not clear in the previous section.

The data for the proportion of the population with a Graduate degree or a student for a MS or PhD is also shown in table 6. This proportion was less than 1% in 2004 in Brazil. Although this data may appear a small one, the increase that was observed was extremely high. In 1986, Brazil had 0.12% of its population in the mentioned category, and in 2004, the values was 0.83%, with an increase of more than 600%. In the beginning of the period, only São Paulo and Rio de Janeiro states had values superior to 0.2%. Eighteen years later, all the states showed a number above this one, with the exception of Alagoas.

Table 7 presents the values for the dissimilarity index for the four mentioned years, 1986, 1992, 1998 and 2004, for both proportions cited above. It can be easily seen that the dissimilarity index decreased for both of them, indicating that occurred a convergence between states for skilled population in both levels.

The proportion of BA holders or of graduate degree graduates or students may be a good indicator of skilled population, but might not be a reasonable indicator for convergence/divergence of skill levels if the increase in these levels is as fast as is in the recent past in Brazil. For instance, when levels increase more than seven fold in 18 years, as was observed for the graduate students and graduate degree holders, regional equilibrium might not be attainable because it may demand more time to do so. People will migrate and/or the labor market might adjust itself because of different levels of supply and demand for skilled and non-skilled.

In order to test this hypothesis, the same dissimilarity indicator for the same years were estimated for the proportion of workers in creative activities, as defined by Florida (2005). Following this author, this type of activities demands more skilled workers, independently of formal education, although the correlation of both variables is positive and strong. Table 8 shows the dissimilarity index for this proportion. It can be seen that a tendency of concentration is occurring for the creative economy.

The data for states showed that schooling levels were convergent in Brazil, while the number of skilled workers, as defined by Florida (2005), showed a divergence. These may appear to be conflicting tendencies if a regional equilibrium exists, but due to the fast increase in schooling levels, without the concomitant increase in the number of skilled positions in the labor market, this might not be attainable in the short run.

7. REGIONAL DIFFERENCES IN SKILL LEVELS TENDENCIES FOR BRAZILIAN STATES

The data above showed that a convergence or nor of skill levels may be observed depending on the used indicator. The theoretical model proposed that some regions may present a tendency of convergence, while others may not do so. This is particular true for a country as large and diverse as Brazil.

These difficulties were partially over come with the use of Cluster analyses presented in this section. This technique was utilized to identify regional differences for the Brazilian states with the use of different indicators. These indicators for 2004 are the proportion of the population with a college degree, proportion of the population with a graduate degree or studying for a master or Ph.D degree, proportion of workers in the creative economy, proportion of workers with a college degree and in technical activities, and mean regional income. Besides these, the variations between 1986 and 2004 for the first and third variables were also included.

Five clusters were obtained for the areas presented before and the results are shown in table 9. The first column discusses the characteristics of each clusters and the second presents the cluster membership. Each one of the clusters is discussed separately. First line shows the areas that had the highest values for all indicators and were the most developed in Brazil. These regions had a small increase in the proportion of the population with college degree, indicating the homogenization of schooling levels in Brazil, but had a greater increase in the proportion of skilled in the creative economy than the rest of country, showing the further development of the labor market. The areas in this cluster were Federal District, Rio de Janeiro and São Paulo. The second group of states counted with Rio Grande do Sul, Espírito Santo, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Paraná and Santa Catarina. These were the areas with medium/high values for the indicators and also medium values for the variations, indicating the emergence of these states in the developing ladder. The states in thee two first clusters area the most developed in Brazil and are all localized in the South, Southeast and Center-West regions. The states with an intermediate development with also medium values for the variations are shown in the third cluster. This cluster and the next two count with states of the North and Northeast regions, and the Goiás state. The least developed, but with an increasing schooling level are presented in the next cluster. Notice that the levels of formal education were very low for these states, what may indicate that the schooling levels are improving relatively due to the extremely low initial levels. The last cluster show low/intermediate values for the values and small variations, indicating a declining relative position among the Brazilian states.

This cluster analyses and the previous studies with states indicate that a schooling levels convergence is occurring, but this may be so because the initial levels were very low in some areas. When other indicators were included, a divergence was noticed with an increase in the heterogeneity of “North/South” Brazil.

8. CONCLUSION

This paper analyses the concentration of human capital across municipalities in Brazil. We investigate how the initial level of educated workers in one region can affect the growth of skilled workers in one area. We find that this relation is stronger for cities with more than 100000 inhabitants; we observe a positive correlation between those two variables. The inclusion of other controls alters the coefficient of initial human capital level considerable.

Considering that human capital accumulation and the presence of skilled workers is an important factor for regional development and economic growth and to promote convergence across Brazilian regions we investigate the concentration of skilled people in Brazil. Our results show that educated people are very segregate in Brazil despite city size and regional differences. The highly educated people in Brazil tend to live in a few cities and live in areas that are much more educated than cities where average person lives.

The concentration of human capital has direct effect on the returns to education and wage levels. Consistent with previous estimates, an increase in 1 percentage point in the number of people with at least high school education increases average wage in 3 percentage points, even after controlling for other variables. The estimate is greater than what is observed for the US, the concentration of human capital increases wages in about 1%.

One major shortcoming of the paper is to understand if the concentration of human capital in Brazil is also a result of incentives to skilled workers to migrate to some areas of the country. The second limitation is that we do not consider the long-term investments in human capital (education) in some areas of the countries that might have affect the concentration and movement of human capital in the country.

The results raise a series of questions to understand the concentration of people, and especially skilled people, in some areas of the country. In further research, we aim to test some hypothesis. First, we will investigate whether there is a tendency of skilled firms to hire only skilled people and whether this relation has increased over time. Second, we will investigate if the housing market creates a mechanism to expel less skilled people, with lower wages, to cheaper places what increases the number of skilled people in places where they can afford to live.

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FIGURE 1

Change in percentage of Workers with HS, Brazil, 1991-2000(all municipalities)

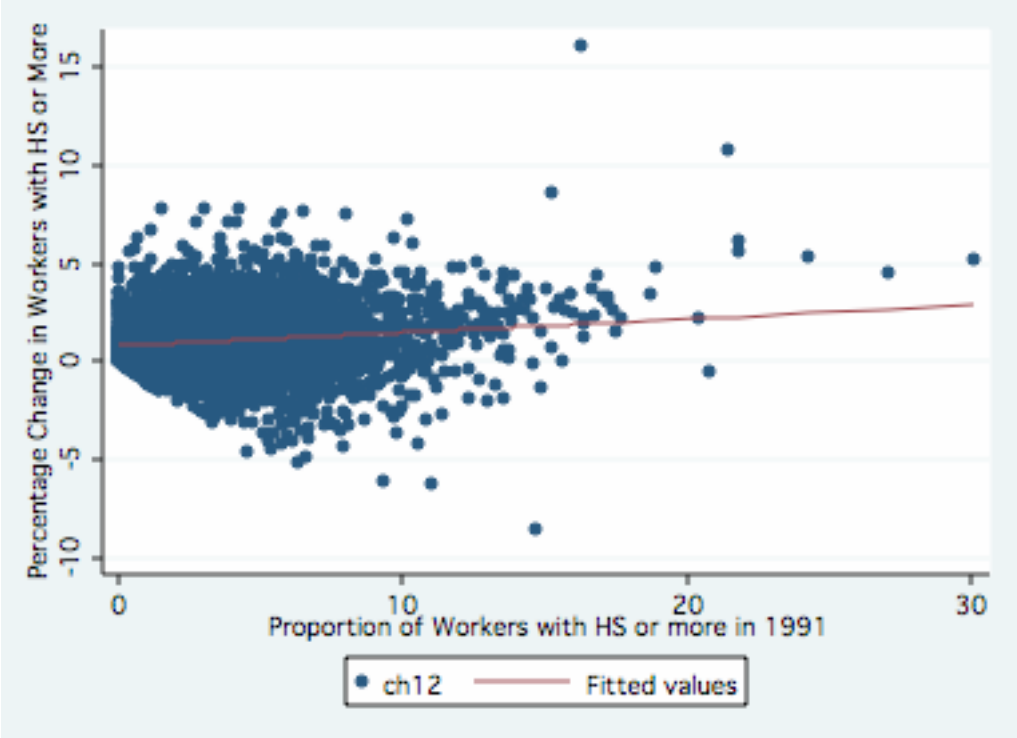

FIGURE 2

Change in percentage of Workers with HS, Brazil, 1991-2000 (Municipalities with more than 100000 inhabitants)

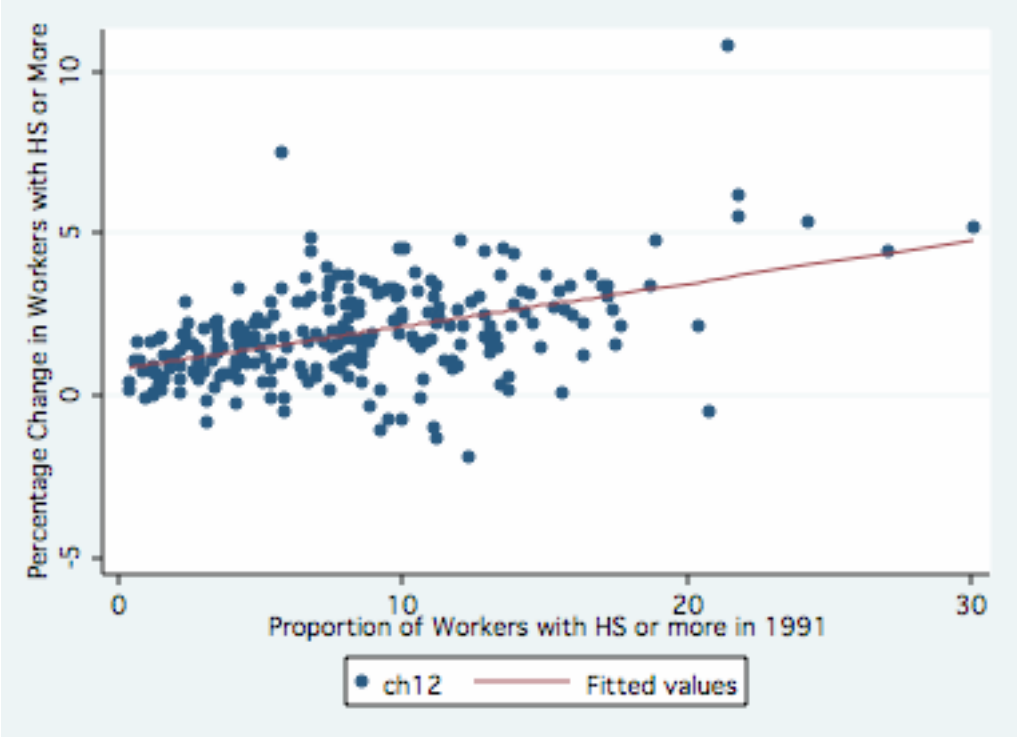

FIGURE 3

Change in percentage of Workers with BA, Brazil, 1991-2000 (all municipalities)

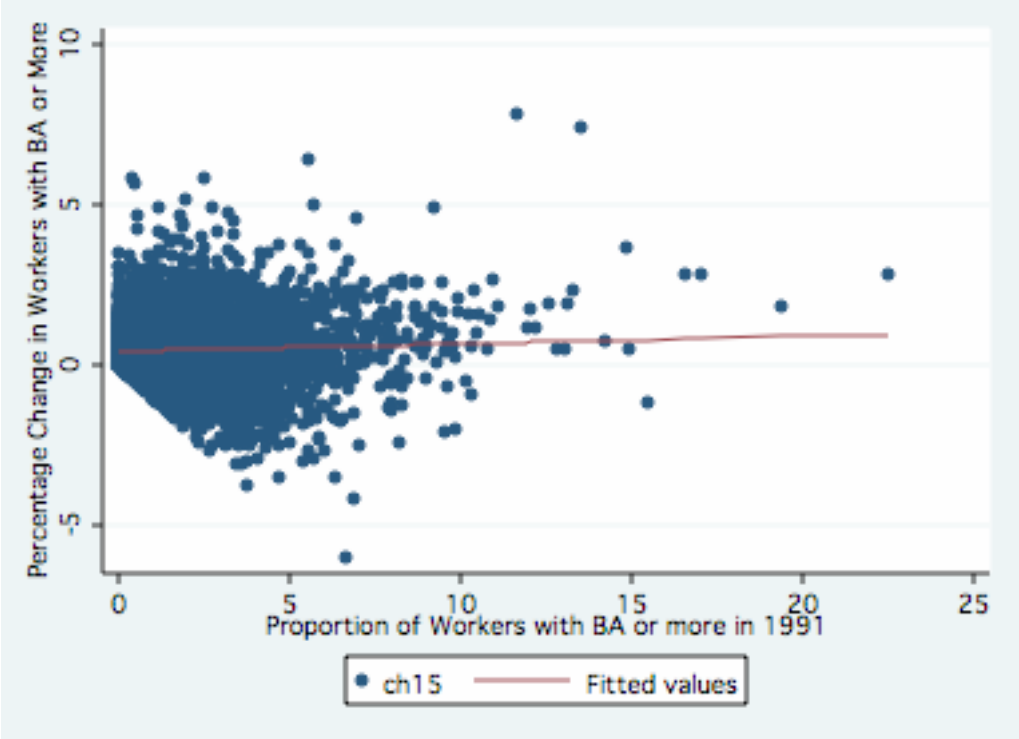

FIGURE 4

Change in percentage of Workers with BA, Brazil, 1991-2000 (Municipalities with more than 100000 inhabitants)

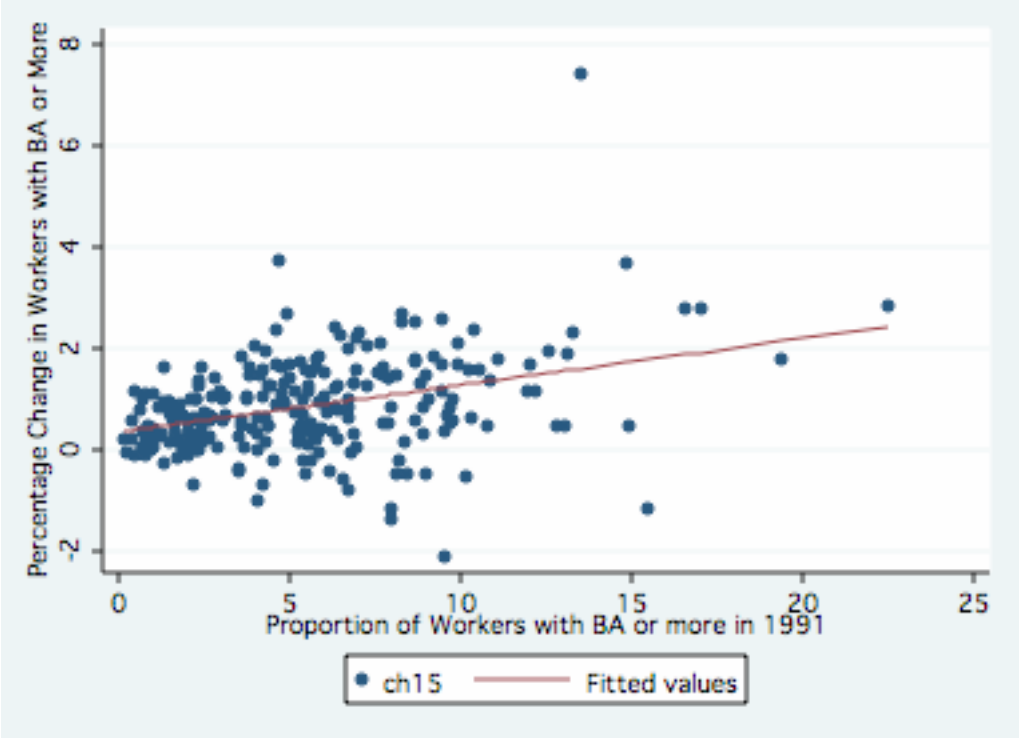

Table 5. Trends in Regional Wage Convergence, Brazil, 2000

Dep. Variable: Log Wage

Variables	Coefficient	Std. Err	P>|t|
Log Rent	0.128	0.0064	0
Log Population	0.079	0.0041	0
Sex Ratio	0.006	0.0010	0
Prop. Population 20-64	0.029	0.0014	0
Prop. Workers w/ 12+ educ.	0.030	0.0016	0
Change in % 12+ educ	-0.006	0.0041	0.13
Northeast	-0.462	0.0197	0
Southeast	-0.170	0.0217	0
South	-0.126	0.0232	0
Mid-West	-0.057	0.0244	0.02
Constant	2.871	0.1560	0
R-squared			0.7931

Source: Brazilian Population Census, 1991 & 2000

Table 2. Change in Percentage of Workers according to educational attainment

Panel A: Workers with High School Education or more

	All Municipalities		More than 100000 inhabt.	
Variable	Coefficient	St. Err	Coefficient	St. Err
Share w/ HS in 1991	-0.1219	0.0178	0.0958	0.0232
Log Population 1991	0.2360	0.0345	-0.0353	0.1400
Sex Ratio 1991	-0.0300	0.0052	0.0539	0.0250
Share Pop. 20-64 yrs old	0.1244	0.0079	0.1388	0.0403
Regional Fixed Effects	Yes		Yes	
Observations	4267		250	
R-squared	0.198		0.386	

Panel B: Workers with College degree or more

	All Municipalities		More than 100000 inhabt.	
Variable	Coefficient	St. Err	Coefficient	St. Err
Share w/ HS in 1991	-0.164	0.018	0.059	0.021
Log Population 1991	0.141	0.022	-0.109	0.098
Sex Ratio 1991	-0.024	0.003	0.013	0.015
Share Pop. 20-64 yrs old	0.076	0.005	0.083	0.029
Regional Fixed Effects	Yes	Yes	Yes	Yes
Observations	4267		250	
R-squared	0.162		0.2906	

Source: Brazilian Population Census, 1991 & 2000

Table 3. Log Change in number of Workers according to educational attainment

Panel A: Workers with High School Education or more				
	All Municipalities		**More than 100000 inhabt.**	
Variable	**Coefficient**	**St. Err**	**Coefficient**	**St. Err**
Share w/ BA in 1991	-0.0961	0.0043	-0.01134	0.0031
Log Population 1991	0.0655	0.0085	0.0241	0.0150
Sex Ratio 1991	-0.0085	0.0027	0.0099	0.0040
Share Pop. 20-64 yrs old	0.0262	0.00297	-0.00043	0.0069
Regional Fixed Effects	Yes		Yes	
Observations	4079		250	
R-squared	0.1524		0.254	
Panel B: Workers with College degree or more				
	All Municipalities		**More than 100000 inhabt.**	
Variable	**Coefficient**	**St. Err**	**Coefficient**	**St. Err**
Share w/ BA in 1991	-0.147	0.008	-0.015	0.004
Log Population 1991	0.062	0.010	0.005	0.015
Sex Ratio 1991	-0.014	0.002	0.000	0.004
Share Pop. 20-64 yrs old	0.031	0.004	-0.002	0.007
Regional Fixed Effects	Yes	Yes	Yes	Yes
Observations	4079		250	
R-squared	0.1446		0.168	

Source: Brazilian Population Census, 1991 & 2000

Table 4. Segregation by Skill, Brazil, 1991-2000

Panel A: Workers with High-School Education						
Year	**Mean**	**St.D**	**Max**	**Min**	**Dissimilarity**	**Isolation**
1991	3.55	3.13	30.3	0	0.34	0.044
2000	4.59	3.69	35.3	0	0.319	0.049
Panel B: Workers with College Education						
Year	**Mean**	**St.D**	**Max**	**Min**	**Dissimilarity**	**Isolation**
1991	2.12	2.04	22.4	0	0.34	0.84
2000	2.59	2.34	25.3	0	0.33	0.83
Panel C: Workers with Graduate Education						
Year	**Mean**	**St.D**	**Max**	**Min**	**Dissimilarity**	**Isolation**
1991	0.059	0.156	3.19	0	0.442	0.992
2000	0.073	0.154	3.25	0	0.452	0.989

Source: Brazilian Population Census, 1991 & 2000

Table 5 – Proportion of the population with a BA degree and with a Graduate degree for states in Brazil in different years

State/region	Proportion of the population with BA degrees			Proportion of the population with Graduate degrees or studying for one		
	1986	2004	Variation (%)	1986	2004	Variation (%)
Alagoas	0.70	1.96	180	0.00	0.15	-
Amazonas	1.31	2.45	88	0.00	0.26	-
Bahia	0.87	1.79	107	0.03	0.36	1068
Ceará	1.03	2.83	174	0.06	0.55	850
Distrito Federal	5.37	10.03	87	0.08	2.17	2599
Espírito Santo	2.29	4.70	105	0.02	0.79	4545
Goiás/Tocantins	1.45	3.39	135	0.01	0.53	3502
Maranhão	0.37	1.40	281	0.00	0.28	-
Mato Grosso	0.89	3.78	323	0.00	0.73	-
Mato Grosso do Sul	1.68	4.86	189	0.07	1.02	1400
Minas Gerais	1.82	4.24	133	0.07	0.82	1092
Pará	1.85	2.03	9	0.05	0.32	560
Paraíba	1.42	3.57	151	0.11	0.61	435
Paraná	1.94	5.62	190	0.12	0.95	722
Pernambuco	1.46	3.53	142	0.03	0.46	1400
Piauí	0.43	2.41	463	0.00	0.22	-
Rest of the North Region	1.88	2.42	29	0.03	0.45	1560
Rio de Janeiro	4.52	7.53	67	0.22	1.35	516
Rio Grande do Norte	1.35	2.77	105	0.00	0.45	-
Rio Grande do Sul	2.39	5.64	136	0.12	0.98	726
Santa Catarina	1.87	5.56	197	0.17	1.27	658
São Paulo	3.80	7.10	87	0.27	1.28	383
Sergipe	0.83	3.21	285	0.00	0.46	-
Brazil	**2.34**	**4.74**	**103**	**0.12**	**0.83**	**609**

Source: PNADs, 1986 and 2004.

Table 6 – Dissimilarity index for the proportion of the population with a BA degree and with a Graduate degree for states in Brazil

Year	Dissimilarity index	
	BA degree	Graduate degree
1986	0.247	0.359
1992	0.224	0.295
1998	0.227	0.273
2004	0.197	0.212

Source: PNADs, 1986, 1992, 1998 and 2004.

Table 7 - Dissimilarity index for the proportion of workers in the creative economy

Year	Dissimilarity index
	Proportion of workers in the creative economy
1986	0.090
1992	0.102
1998	0.101
2004	0.131

Source: PNADs, 1986, 1992, 1998 and 2004.

Table 8 - Cluster analyses for the Brazilian states

Cluster characteristics	Cluster membership
Highest values for all indicators with a small increase in the proportion of the population with a college degree and a greater increase in the proportion of skilled in the creative economy	Federal District, Rio de Janeiro and São Paulo
Medium/high values for the indicators and for the variations	Rio Grande do Sul, Espírito Santo, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Paraná and Santa Catarina
Medium values for all the variables	Ceará, Goiás/Tocantins, Paraíba, Pernambuco and Sergipe
Least developed with an increasing schooling	Alagoas, Maranhão and Piauí
Low/medium values for the variables and relatively declining	Amazonas, Bahia, Pará, rest of the North Region and Rio Grande do Norte

Source: PNADs, 1986 and 2004.

Box 1

Possibilities of the model regarding the proportion of skilled

Possibility	$\partial U_i^h / \partial P_i$	$\partial U_i^l / \partial P_i$	Comparison	Consequence
1	> 0	> 0	$\partial U_i^h / \partial P_i \leq \partial U_i^l / \partial P_i$	Equilibrium in skill levels with slight variation of population
2	> 0	> 0	$\partial U_i^h / \partial P_i >> \partial U_i^l / \partial P_i$	Divergence in skill levels and population concentration
3	> 0	< 0	-	Divergence in skill levels
4	< 0	> 0	-	Equilibrium in skill levels
5	< 0	< 0	$\partial U_i^h / \partial P_i \geq \partial U_i^l / \partial P_i$	Divergence in skill levels and population concentration
6	< 0	< 0	$\partial U_i^h / \partial P_i << \partial U_i^l / \partial P_i$	Equilibrium in skill levels with slight variation of population