Effects of demographic and educational changes on the labor markets of Brazil and Mexico

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Abstract
This paper estimates the impact of demographic and educational changes on the earnings and returns to schooling of workers in Brazil and Mexico. Our analysis takes into account demographic, educational and economic variations within each country over time, using Censuses microdata from Brazil and Mexico. Results suggest that demographic and educational transitions generate impact on earnings and on returns to education. The proportion of people in age-education groups tends to have a negative impact on earnings. These impacts are more detrimental among age-education groups with higher education, but they are having less of a negative effect over time. We also find that the effects of the concentration of skilled labor are greater than those observed in more developed countries. In the United States, the effects of concentration are observed only for those with higher level of education. In Brazil and Mexico, these effects are observed throughout the income distribution.

Keywords
Demographic transition. Education transition. Cohort size. Earnings. Brazil. Mexico.

Preliminary draft, comments are welcome

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1. Introduction

The objective of this paper is to estimate the impact of demographic and educational changes on the earnings of workers in the two largest Latin American countries (Brazil and Mexico). Furthermore, we analyze the economic consequences of people with higher educational attainment (human capital) being concentrated within certain locations on the returns to schooling. The first exercise studies the impacts of the composition of the workforce by age and education on the average earnings of workers. The second exercise looks on how the concentration of skilled workers impacts the returns to schooling across regions of Brazil and Mexico. These two countries have very similar features and are passing through a rapid process of demographic and educational changes with large regional and social inequalities (Barro and Lee 2001; Lam and Marteleto 2005, 2008; Marcílio 2001, 2005; Potter, Schmertmann, Cavenaghi 2002; Potter, Schmertmann, Assunção, Cavenaghi 2010; Riani 2005; Rios-Neto and Guimarães 2010). Our analysis takes into account demographic, educational and economic variations within each country over time. The study of wage differentials and the analysis of the effects of human capital concentration in developing countries are both important subjects to explore, since they are marked by larger economic differentials than developed countries.

Studies have been showing that there are several advantages to living in cities and areas with high population agglomeration (Glaeser and Berry 2005; Glaeser and Gottlieb 2009; Glaeser 2011; Hout 2012; Moretti 2004a, 2004b, 2011). The central advantage is that the concentration of well-educated people benefits everyone else in the population, as well as generates greater knowledge and economic dynamism. In the United States, there is a trend towards the concentration of skilled people in some regions. This concentration has a positive impact on productive gains, which further increases the concentration of qualified people in these areas (Glaeser and Berry 2005). The greatest concentration of skilled people in specific locations occurred in the 1980s and 1990s, leading to an increase in the wages of all workers (Moretti 2004a, 2004b, 2011). People who complete a college degree usually have higher earnings. The larger proportion of people with higher educational attainment benefits the population as a whole, as the result of a spillover effect (Hout 2012).

There are numerous studies evaluating wage differentials and income concentration in several countries. However, there are few comparative studies of the dynamics that have recently been affecting local labor markets. Queiroz and Golgher (2008) studied the concentration of human capital in Brazil, but they did not investigate the reasons or the implications of this concentration. Queiroz and Calazans (2010) emphasize the positive effects of the concentration of skilled workers in the Brazilian labor market. Moretti (2004a, 2004b) investigates the social returns to education in the United States between 1980 and 1990, and demonstrates the positive impact of population concentration on individual incomes. Other studies conclude that there are positive effects on the economic dynamism of American cities resulting from the concentration of skilled workers (Black 1998; Rauch 1993). However, variations in the cohort size of the Brazilian population led to negative impacts on workers' earnings (Amaral et al. 2013). More specifically, higher proportions of the population in age-education groups decrease the income of these groups. These effects are larger for groups with higher educational attainment, but with declining effects over time. Thus, the concentration of skilled workers in specific locations can generate benefits for some groups, but can produce negative results for other groups.

Demographic dynamics and changes in educational composition are important features of populations, especially in developing countries, because they have a strong potential to generate economic growth. Studies indicate that the decline in dependency ratio, caused by rapid fertility decline, has substantially influenced economic development in East and Southeast Asia (Bloom and Finley 2009; Bloom and Freeman 1986; Bloom, Canning, and Fink 2011; Bloom, Canning, and Malaney 2000; Bloom, Canning, and Sevilla 2003; Bloom, Canning, Fink, Finlay 2009; Bloom, Freeman, and Korenman 1987; Feng and Mason 2005; Kelley and Schmidt 2001; Mason 2005; Williamson 2003). The decrease in the dependency ratio is a transitory process. This ratio will increase in upcoming decades, as the elderly population becomes a larger proportion within societies. This population structure creates a window of opportunity for economic growth (first demographic dividend), but it also has a conditional nature. The drop in the dependency ratio will only result in economic development if the appropriate policy environment exists. If beneficial government policies are not applied, developing countries might experience unemployment, instability, and suffer tension within the areas of health services, educational attainment, and social welfare. Developing countries with transitional advantages, such as Southeast Asia, must implement policies to deal with the aging population, while also taking advantage of the remaining years of low dependency ratios. Thus, studies have investigated how changes in age and educational structures influence economic development throughout the decades.

The same demographic changes that have been occurring in Asia are now occurring in Latin America and Africa. However, countries in Latin America and Africa are different from Asian countries because they have lower levels of education and higher socio-economic inequality. Over the past decades, Latin American and African countries have been experiencing a process of population concentration in certain locations. Several factors help to explain this population concentration within certain cities. One key element is migration (Glaeser and Berry 2005). The concentration of skilled workers has a close relationship with regional wage differentials and regional patterns of economic growth. Inequalities in the level and distribution of human capital across regions affect the levels of local earnings. Furthermore, the structure of local labor markets and age-educational changes create positive and/or negative influences on wage levels and income inequality.

This paper is part of a broader discussion of regional differences in income and economic growth. The issue of inter-regional income differentials has motivated numerous studies for various countries, in order to explain the existence and persistence of inequalities over time. However, studies about the concentration of skilled labor in developing countries and comparative analyzes are not regularly performed (Amaral et al. 2013; Queiroz and Golgher 2008; Rigotti 2006). The concentration of human capital in certain locations can result in numerous benefits for the local economy and boost economic growth. However, there is also potential for a negative impact on earnings. Earnings of male workers appear to be significantly influenced by the age-education composition of the workforce, i.e., large cohorts do depress earnings (Amaral et al. 2013; Berger 1985; Biagi and Lucifora 2008; Brunello 2010; Easterlin 1978; Freeman 1979; Katz and Autor 1999; Katz and Murphy 1992; Korenman and Neumark 2000; Moretti 2004a, 2004b; Sapozhnikov and Triest 2007; Shimer 2001; Skans 2005; Welch 1979). This concentration of workers and variation in cohort size might also affect the level of unemployment (Berger 1985; Brunello 2010).

2. Data and methods

We perform two exercises to investigate the impacts of demographic and educational changes in the Brazilian and Mexican labor markets. The first exercise studies the impacts of the composition of the workforce by age and education on the average earnings of workers. This analysis uses local-level data to construct age-education cells and follows their changes over time. The second study uses individual data to investigate how the concentration of skilled workers impacts the returns to schooling across regions of Brazil and Mexico. In the following sub-sections we present detailed information on the construction of the database and methods applied to investigate the two questions.

We used microdata from the Brazilian and Mexican Demographic Censuses to estimate the impact of population flows on the earnings of male workers at the local level over time. Brazilian data were obtained from the Brazilian Institute of Geography and Statistics (IBGE) and from IPUMS-International, Minnesota Population Center, University of Minnesota. Mexican data were extracted from IPUMS-International. Data are from 1970, 1980, 1991, 2000, and 2010 for Brazil and 1960, 1970, 1990, 2000, and 2010 for Mexico.

We categorized information on age into four groups: youths (15–24 years-of-age); young adults (25–34 years-of-age); experienced adults (35–49 years-of-age); and older adults (50–64 years-of-age). In the analysis of the returns to education, we considered only males aged 15 to 60 who were in the labor force and perform the analysis across all ages. We also perform some robustness checks using data for those in the prime-age group, between 30 and 50 years old.

The level of education was classified into four groups using information on completed years of schooling and taking into account the specificities of the school systems in Brazil and Mexico. For Brazil, the education groups are: (a) incomplete first phase of elementary school (0–3 years of schooling); (b) complete first phase of elementary school (4 years of schooling) or second phase of elementary school (5–8 years of schooling); (c) secondary school (9–11 years of schooling); and (d) at least some college (12+ years of schooling). For Mexico, the education groups are: (a) no education (0 years of schooling); (b) primary school (1–6 years of schooling); (c) lower secondary ("escuela secundaria") (7–9 years of schooling) or secondary school ("escuela preparatoria o bachillerato") (10–12 years of schooling); and (d) at least some college ("nivel universitario") (13+ years of schooling).

We have the same Census information about the age-education structure of the female workforce and migrants as we do for males. However, the distributions of female workers and migrants by age and education are highly correlated with those of male workers. The way in which the exclusion of women from the equations biases the coefficients for male workers depends on the relationships between male and female workers and migrants. There is no evidence about these biases, which are an empirical issue. We included the effects of female workforce on male earnings. The results did not differ from the ones presented in this paper. However, the correct inclusion of women in the models would require the estimation of exogenous measures of women in the labor market, as well as in the population flows. Since this estimation is not the aim of this study, we decided to focus the analysis on males.

2.1. Demographic changes and earnings

We aggregated Census microdata by year, area, and age-education group. In relation to the geographical areas considered for this study, the 502 Brazilian micro-regions (groups of municipalities) have consistent boundaries over time. These 502 micro-regions differ from those defined by IBGE and available in the Census microdata, but closely approximate those that are defined in the 1991 Census (Potter et al. 2002). For Mexico, the geographical areas used for this study were 2,456 municipalities, using the 1990, 2000, and 2010 Censuses. Mexican municipalities have consistent boundaries in our database only for these last three censuses. We also estimated models by the 32 Mexican states using all censuses, but due to the lack of data variation the results were not consistent (data not shown).

In order to measure the effect of demographic and educational transitions on earnings, the dependent variable was developed as the natural logarithm of the mean monthly earnings for each year, area, and age-education group. In Brazil, information on earnings is based on primary occupation. In Mexico, information on earnings is based on earned income. For 1970, in both countries, information on earnings is based on total income, due to the lack of other available variables.

In Equation (1), $log(Y_{git})$ is the logarithm of wages. Sixteen indicators of age-education groups (G) interacting with time (θ) are included in the model. The first age-education group interacting with time is the reference category. G_{ae} is a set of age-education-group indicators (dichotomous variables) for each age group (a) and education group (e). The model considers 502 micro-regions in Brazil and 2,456 municipalities in Mexico (i), five Brazilian Censuses and three Mexican Censuses (t), 16 age-education groups (g), and 2,510 (502*5) area-time-fixed effects in Brazil and 7,368 (2,456*3) area-time-fixed effects in Mexico (α). This estimation follows a standard Mincerian model (Mincer 1974):

$$log(Y_{git}) = \beta_0 + (\beta_1 G_{12} + \cdots + \beta_{15} G_{44}) * \theta_t + \alpha_{it} + \varepsilon_{git}. \quad (1)$$

Not only age and education have a significant impact on earnings, but also demographic and educational changes generate variation in cohort size and, thus, influence various aspects of the labor market. As a strategy to estimate the impact of cohort size on earnings, the distribution of the male population in our 16 age-education groups (*X*), interacted with time (θ), can be introduced as a set of variables. This exercise is similar to the one illustrated by Borjas (2003), who estimated the impact of immigration on the U.S. labor market. In our case, instead of including the immigration supply in the estimations, we include information on the male population distributed into age-education groups, in order to verify its impacts on earnings:

$$log(Y_{git}) = \beta_0 + (\beta_1 G_{12} + \cdots + \beta_{15} G_{44}) * \theta_t + (\gamma_1 X_{11} + \cdots + \gamma_{15} X_{44}) * \theta_t + \alpha_{it} + \varepsilon_{git}. \quad (2)$$

Because Brazil was divided into 502 micro-regions, 16 age-education groups, and five censuses, the maximum possible number of observations for the regressions is 40,160 and the maximum number of groups (area-time fixed effects) is 2,510. However, only cells with at least 25 observations are included in the estimations, in order to minimize potential problems of heteroskedasticity. The maximum number of observations was reduced to 32,201 and the number of groups to 2,488. In Mexico, we used 2,456 municipalities, which would generate a maximum of 117,888 (2,456*16*3) observations and 7,368 groups for the regressions. Due to our cell-size criteria, the number of observations was reduced to 82,604 and the number of groups to 7,259.

2.2. Human capital concentration and returns to education

We estimate the impact of the concentration of human capital and the private returns to education on earnings using regressions models, based on the Mincerian equation. Since we want to understand whether theses effects are specific across different sub-groups of the population, we use quantile regression models to allow for a more robust analysis. Our hypothesis is that the private and social returns to education vary due to the socioeconomic position of workers in their place of residence. Private returns to education are the gain individuals command for an additional year of schooling. Becker (1993) and Mincer (1974) developed the human capital model that defines private returns to education. Becker (1993) suggests that expenditures in education, training and health should be understood as an investment and not consumption, as they increase knowledge and personal skills and can increase productivity. Acemoglu (1996) performed a classic work on the social effects of individual human capital accumulation. The basic premise of the model is that personal investment in education and training create benefits for other agents in the economy, both to the more skilled and to less skilled. Acemoglu (1996) indicates that by investing in human capital individuals become more productive and relate to other employees in the workplace and elsewhere, due to their capacity of transmitting new knowledge and skills to others. Furthermore, by hiring skilled workers, firms have greater incentive to invest in physical capital higher technology. This contact with modern machinery and equipment raises the productivity of all workers, including those who have little invested in human capital (Berry and Glaeser 2005).

The spatial distribution of human capital is associated with unobserved factors that can be correlated with the level of income, so the local educational level becomes endogenous in the model (Moretti 2004a). To solve this problem, we estimate the concentration of highly skilled workers (human capital) through an instrumental variable approach. We use education progression rates, age composition of the population, and local income level to estimate the concentration of educated workers in the current census. In order to avoid endogeneity problems, we use all instruments lagged to the previous census year. The proportion of high-skilled workers is defined by the following equation:

$$P_{(t)} = \beta_0 + \beta_1 L_{1(t-n)} + \beta_2 L_{2(t-n)} + \beta_3 L_{3(t-n)} + e, \qquad (3)$$

where $P_{(t)}$ is the proportion of workers with high educational level (proportion of undergraduates) in time t for each investigated area; $L_{1(t-n)}$ is the enrolment rate in high school in the previous census, n years ago; $L_{2(t-n)}$ is the young-age-dependency ratio in the previous census; and $L_{3(t-n)}$ is the local average wage also in the previous census.

We used a transformation of the earnings equation (Mincerian regression model) to estimate the private and social returns to education across regions in Brazil and Mexico. The model is estimated by the following equation:

$$log(Y_{git}) = \beta_0 + \beta_1 X + \varepsilon_{git}, \qquad (4)$$

where $log(Y_{git})$ is the logarithm of individual earnings. The two main variables of interest are the proportion of workers with high educational level (estimated in Equation 3) and individual schooling (measured in years of education). The proportion of educated workers in the region captures the social returns to education, whereas the individual schooling captures private returns to education. We also add age and age-squared variables, because income varies with age and individuals have a return to experience. In the model, we also include variables to capture labor demand in the region and control for regional characteristics (region of the country and local unemployment rate).

Usually, methods estimate the average value of the conditional distribution that minimizes the sum of squared residuals. Quantile regression models estimate the relationship of the variables in a set of specific quartiles, i.e. the model allows the impacts of education and concentration of human capital to vary at different points of the distribution. An advantage of this application is that we can investigate potential impacts of education on the levels of income inequality. For example, if the returns to education, both private and social, are equal for all income levels, this is evidence that education has no impact on the levels of inequality. In this case, the observed differences could be explained by other reasons (Martins and Pereira 2004). In other words, the quantile regression models allows for a full characterization of the conditional distribution of the dependent variable. Thus, it is possible to distinguish variations in the effect of the predictor on the response variable in each part of the conditional distribution (Despa 2007). The estimated coefficient can be interpreted as the marginal change in the response variable in a specific quantile, associated with a change in a particular explanatory variable.

3. Results

3.1. Demographic changes and earnings

The estimation of an income equation is central to assess the impact of an aging population and educational changes on average income. This analysis seeks to establish whether changes in age and education structures influenced income in Brazil and Mexico. Before estimating the models, it is important to evaluate the distribution of the male population by year and age-education group in the countries (Tables 1 and 2). In general, the proportion of men with 0–3 years of education decreased between 1970 and 2010 in Brazil. For example, the proportion between 15–24 years of age with 0–3 years of education fell considerably from 20.00 percent in 1970 to 2.24 percent in 2010 in Brazil (Table 1). The same happened in Mexico for males with zero years of education and 15–24 years of age, with a decrease from 10.45 percent in 1960 to 0.44 percent in 2010 (Table 2). In addition, the proportion of those with least nine years of education (9–11 and 12+) in Brazil, as well as those with at least seven years of education (7–12 and 13+) in Mexico, increased during the period.

>>> Table 1 <<<

>>> Table 2 <<<

In Table 3 we present the coefficients and standard errors estimated with the fixed-effects model that replicates Mincer's model – Equation (1) – for Brazil. In this baseline model, we interact the indicator variables for age-education groups with each Census year. Thus, the coefficients in the first column are the impacts of age and education on earnings for 1970 (main effects). The interaction coefficients show the differential effects in the other years, in comparison to 1970, for each age-education group. The main effects indicate that, within each age category, earnings are higher for those people with more schooling. We also verify that within each education group, earnings are higher for older men. For instance, men ages 25–34 with zero to three years of schooling earned 1.35 (exp(0.302)) times as much as men ages 15–24 with the same education (the reference category) in 1970. In order to verify these effects for the other years, the interaction terms have to be taken into account. In 2010, young men (25–34) with at least twelve years of schooling earned 3.93 (exp(2.386–1.018)) times as much as the reference category. For Mexico (Table 4), the results follow the same pattern. For example, men ages 25–34 with zero years of schooling earned 1.11 (exp(0.103)) times as much as men ages 15–24 with the same education in 1990. In 2010, young men (25–34) with at least thirteen years of schooling earned 2.57 (exp(0.987–0.0415)) times as much as the reference category. The estimates are thus consistent with what we know about age-earnings profiles and the impact of education on them. Here as in the subsequent estimates, the coefficients of the fixed-effects model are highly significant statistically.

>>> Table 3 <<<

>>> Table 4 <<<

Table 5 (for Brazil) and Table 6 (for Mexico) illustrate the estimated coefficients and standard errors for the second model, which includes the proportion of males in each age-education group in the workforce as independent variables (cohort size, relative supply, labor supply, cell density, or own-quantity effects), and allows them to vary over time by interacting these proportions with Census years (time indicators). As in the previous model, the main effects show the impact on earnings in 1970 for Brazil and in 1990 for Mexico. These main effects have to be added to the interaction terms, in order to infer the trends.

>>> Table 5 <<<

>>> Table 6 <<<

In Brazil (Table 5), among all age-education groups (besides the last one), there are negative impacts of group size on earnings in the earliest period. The estimated coefficients in 1970 on the proportions of men in each age-education group generally indicate greater negative impacts for higher educated workers. These negative effects are offset by the positive interactions throughout time for more educated men. Indeed, by 2010 the positive coefficients on the interaction terms nearly offset the negative coefficients on the main effect terms, so that in the more educated groups the net impact on earnings of a change in the group proportions was much reduced. For men in the three age groups (15–24 years, 25–34 years, and 35–49 years) with 0–3 years of schooling (least educated), the group proportions have negative impacts on earnings in 1970 and they are becoming even more negative over time, as can be noticed by the negative coefficients of year interactions. In Mexico (Table 6), in the earliest period (1990), the greatest negative impacts of age-education-group proportions are observed for young men (25–34) with zero years of schooling and with 7–12 years of schooling. Proportions in age-education groups tend to have positive impacts on earnings among better-educated males (13+ years of schooling) in 1990. In 2010, the interaction terms are more negative for the better-educated groups (13+ years of schooling), which offset the coefficients from 1990.

In order to better understand the estimates, we calculate elasticities to demonstrate the impact of age-education proportions on earnings. Elasticity describes the relationship between two variables, and is defined as the ratio of the percentage change in a dependent variable to a percentage change in an independent variable. For example, an elasticity of –0.2 means that an increase by one percent in the independent variable provokes a fall of 0.2 percent in the dependent variable. Thus elasticity is a measure of responsiveness, and can be calculated for any two related variables. Table 7 (for Brazil) and Table 8 (for Mexico) present elasticities that were calculated as the product of age-education-proportions coefficients (Table 5 for Brazil and Table 6 for Mexico) and the distribution of men by age-education groups over time (Table 1 for Brazil and Table 2 for Mexico). More specifically, the elasticities were estimated using this expression: (exp(coefficient of proportion in an age-education group*distribution of men by age-education group*0.01)–1)*100. For more recent years (interaction terms), the main effect coefficient (1970 in Brazil and 1990 in Mexico) was added to the interaction term for each Census, before multiplying by the distribution of men by age-education groups and year.

>>> Table 7 <<<

>>> Table 8 <<<

Among the least-educated workers (0–3 years of schooling) in Brazil (Table 7), the elasticities are negative over time, without great variations for younger groups (15–24 and 25–34 age groups) across the Censuses. For older groups (35–49 and 50–34 age groups) within this education group, the negative impacts are not as strong in 2010 compared to 1970. These results mean that the proportions of the least-educated men have negative impacts on their earnings (Table 5) in recent years, even with lower shares in the population (Table 1). These estimates might suggest that the Brazilian labor market does not require as many low educated men in recent years, as it did in previous decades. Within each age group in 1970, Table 7 shows that elasticities are more negative among more educated males in the younger groups (15–24 and 25–34 age groups) and among less educated groups in the older group (35–49 and 50–64 age groups). In more recent years, the negative impacts lose magnitude. Exceptions are for older men (35–49 and 50–64 age groups) with 9–11 years of schooling, as well as for men ages 15–24 with 12+ years of schooling. For instance, an increase of ten percent in the number of men with 25–34 years and 12+ years of schooling would reduce their earnings by 1.3 percent (–0.130) in 1970 and 0.4 percent in 2010. We also observe this clear decline in the magnitude (toward zero) of these elasticities over time for those with 35–49 years and 12+ education. For men with 15–24 years and 9–11 years of schooling, there is a decline after 1980. For those with 50–64 years of age and 4–8 years of schooling, elasticities decline in 1991. An increase of ten percent in the number of people with 4–8 years of schooling and between 15 and 24 years of age would reduce their earnings by 2.3 percent (–0.230) in 1970 and 1.1 percent in 2010. Among young men (25–34) with 4–8 years of schooling the impact on earnings declines from –2.0 percent in 1970 to –0.2 percent in 2010 for an increase of ten percent in the group. Among experienced adults (35–49) with 4–8 years of schooling, the elasticities become positive over time.

The Mexican estimates (Table 8) have smaller magnitudes than the Brazilian elasticities (Table 7). Moreover, elasticities in Mexico indicate that relative changes in labor supply (group proportions) have been having less of an impact on relative wages than they did at the start of our sample period. In 1990 among younger Mexicans (15–24 and 25–34 age groups), the elasticities of those with 7–12 years of schooling present the strongest negative impacts on earnings. However, these negative impacts are much less pronounced in 2010. For older groups (35–49 and 50–64 age groups) with zero years of schooling, the elasticities start positive in 1990 and become negative over time. This may be indicative of low demand for labor without education. Among all groups in 2010, the only elasticities with negative impacts below –0.05 are for men ages 50–64 with 7–12 years of schooling (–0.084). Some of the reasons for the small impact of the size of the highest educational attainment groups might be technological shifts and increasing demand for skilled labor.

3.2. Human capital concentration and returns to education

Tables 9 and 10 show the results of the impacts of human capital concentration on social and private returns to education. We find that higher education is related to higher wages, as in expected in the literature. In the case of Brazil, being college graduates receive, on average, 160 percent higher income than those with less than primary education. We find similar result in Mexico, but the magnitude of the coefficient is much smaller. In both countries, as observed in the previous analysis, the returns to education have declined from 2000 to 2010.

In Mexico, we find positive effects of education for all income levels. The results indicate that a one percent increase in the proportion of graduates is related to one percent increase in the wage levels. In Brazil, we also find positive impacts of the concentration, but the highest income groups benefit much more from the concentration than the lower income groups. The impact for workers in the wealthiest distribution (third quartile) is almost three times the impact on wages of the poorest workers (first quartile). In Mexico, the benefits are more similar across the income distribution. In 2010, for both countries, the benefits of concentration of human capital on earnings are higher in low-income groups than in higher income groups. For example, in Brazil an increase of one percent of workers with college degree in the third quartile is related to six percent increase in the average wage in 2000 and almost two percent increase in 2010. In Mexico, we observe an increase of five percent in 2000 and three percent in 2010.

>> Table 9 <<

>> Table 10 <<

>> Figure 1 <<

Figure 1 illustrates the coefficients estimated for the social returns to education across income levels. The effect decreases for Mexico along the income distribution while for Brazil increases. More specifically, the concentration of skilled workers in Brazil has a positive impact on individuals' earnings across the income distribution. One interesting and important result is that wealthier workers in Brazil benefit more from the concentration of skilled workers than those in the lowest quantile. The effects of concentration, however, have declined substantially over the recent period, which are related to the education progress that Brazil is observed in the recent periods. Compared to Mexico, we find that there is not much difference across income distribution, but poorer workers benefit little more than those in the top quintiles.

Our main hypothesis is that the labor force in Brazil is more evenly distributed in the territory compared to Mexico. As a result, in Brazil there is a "shortage" of skilled labor. Workers are very complementary in the labor market and generate positive externalities, especially among wealthier and more educated. We assume that complementary workers are those with different skills that create benefits to other individuals in the labor market or in the firm. They cannot easily substitute one another and to improve productivity it is important to have both workers in the same sector. In Mexico, as the markets are more concentrated, competition is greater. Mexican wealthier workers have a degree of substitution, that is, firms can easily find replacements for other workers what creates more completion for positions in the labor market and reduce the gains to education. As a consequence, the positive impacts of human capital concentration in Mexico are not as large as in Brazil, even though both countries are very unequal.,

In summary, we observe that rapid changes in population age structure and educational level of the workforce had negative impacts on income levels (Tables 7 and 8). However, the concentration of skilled workers across regions in both countries had positive effects on the returns to education (Tables 9 and 10). We also find that the results are stronger, in both cases, for Brazil than in Mexico.

4. Final considerations

The advance of this study beyond the preceding literature is the inclusion of the age-education cell sizes (proportion of males in each age-education group, cohort size, relative supply, labor supply, cell density, or own-quantity effects) into the models. In Brazil, fertility decline varied over time and across 502 micro-regions (groups of municipalities), based on information from the 1970, 1980, 1991, 2000, and 2010 Demographic Censuses. School attendance has grown substantially from very low levels, but still with great regional variation. Estimations suggest that changes in the composition of the workforce influence the levels of earnings. Cohort size is an important factor for determining income. The proportion of people in age-education groups tends to have a negative impact on earnings, with greater effects for higher educated groups. These results are consistent with previous studies, which indicate that age-education groups are not perfect substitutes, generating negative impacts of cohort size on workers' income. Even though there has been an increase in the demand for high-educated workers in Brazil during recent decades, this variation was not significant enough to compensate for the increase in the supply of these better-qualified workers. An analysis of changes in age and educational compositions was also performed for Mexico, using data from the 1990, 2000, and 2010 Demographic Censuses. This study indicates a decrease in the proportion of the young population over time, as well as an increase in the proportion of people with higher levels of educational attainment. Results are consistent with the findings that cohort size depresses earnings. However, the estimated effects had smaller magnitude in Mexico than in Brazil.

We also find that the concentration of skilled workers, in recent years, is related to higher returns to schooling in Brazil and Mexico. This pattern is not surprising since regional differences in Brazil and Mexico are known in the literature. The existence of these differences is sustained by labor market conditions, which are produced and appear to be maintained by the process of regional economic development. We found that there are social effects of human capital, i.e. locations with higher average human capital have higher salary levels and lower private rates of return to formal education. Table 9 and Table 10 show a positive and significant effect of the predicted proportion of undergraduates in the income level of workers across the income distribution. The concentration of human capital in specific regions generates benefits for the entire set of resident workers in the region. Even the less productive workers observe positive effects on their productivity and their wages. Figure 1 indicates that across the income distribution, for all quartiles, there is a positive effect of the concentration of skilled workers. For example, a one percent increase in the proportion of workers with college degree in Brazil increases wages in the third quartile by six percent in 2000 and 2,7 percent in 2010. We argue that these effects are a result of the characteristics of the labor markets in Brazil and Mexico. Since the percentage of workers with higher education is small, the labor market faces two effects in opposite directions. On one side, there is a complementary effect, because more educated workers could benefit others with the same and lower levels of education by increasing overall productivity levels. On the other side, least-educated workers – a large share of labor force – compete with each other in the labor market and could be considered substitutes to each other, thus depressing wages. In the case of less developed economies, the negative effects are surpassing the positive ones. The results indicate that, especially for men ages 30–50 in Mexico and Brazil, the largest concentration of skilled labor have greater impacts on more educated workers across the income distribution (results not shown). This seems to indicate that recent technological changes have a greater impact on the returns of workers in these countries.

This paper finds that that the concentration of skilled workers is related to a higher average wage. However, we found that the poorest and most unequal countries (Brazil and Mexico) have a factor much stronger correlation than observed in Canada and the United States (results not shown). This indicates that there is greater wage inequality among Brazilian and Mexican regions than observed in more developed economies. This pattern is not surprising to Mexico and Brazil, since regional differences are known in the literature. The existence of these differences is sustained by the conditions of local labor markets, since in both countries we have more developed regions coexisting with regions still under development. The conditions of labor markets were produced and appear to be maintained by the regional economic development process. In summary, we found that there are social effects of human capital locations with higher average human capital have a higher level of wages and lower rates of private return to formal education. The concentration of human capital in regions generates benefits for the entire set of resident workers in the region even the least productive workers observe a positive effect on their productivity and their wages.

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Table 1. Male population distributed into particular age-education groups, as percentage shares, Brazil, 1970–2010.

Age-education groups	1970	1980	1991	2000	2010
15–24 years; 0–3 years of schooling	20.00	13.05	9.81	5.95	2.24
15–24 years; 4–8 years of schooling	13.57	17.49	16.9	15.55	9.12
15–24 years; 9–11 years of schooling	2.17	4.93	5.06	8.99	12.46
15–24 years; 12+ years of schooling	0.57	1.04	0.91	1.25	3.04
25–34 years; 0–3 years of schooling	14.62	10.13	7.66	5.57	3.85
25–34 years; 4–8 years of schooling	7.07	10.22	11.57	10.87	7.65
25–34 years; 9–11 years of schooling	1.17	2.71	5.06	5.95	9.23
25–34 years; 12+ years of schooling	0.83	2.07	2.34	2.17	4.59
35–49 years; 0–3 years of schooling	17.47	13.02	10.37	7.93	8.04
35–49 years; 4–8 years of schooling	6.81	8.60	10.41	12.12	9.56
35–49 years; 9–11 years of schooling	0.84	1.46	3.03	5.36	7.71
35–49 years; 12+ years of schooling	0.75	1.36	2.51	3.10	4.08
50–64 years; 0–3 years of schooling	10.42	8.69	7.86	6.76	8.44
50–64 years; 4–8 years of schooling	3.07	4.17	4.79	5.60	3.94
50–64 years; 9–11 years of schooling	0.28	0.53	0.91	1.51	3.72
50–64 years; 12+ years of schooling	0.35	0.52	0.81	1.33	2.34
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Sample size (n)	**6,772,670**	**7,895,865**	**4,992,270**	**6,287,104**	**6,721,044**
Population size (N)	**25,760,594**	**31,848,780**	**43,434,534**	**53,177,963**	**62,707,571**

Sources: 1970, 1980, 1991, 2000, and 2010 Brazilian Demographic Censuses (Brazilian Institute of Geography and Statistics – IBGE).

Table 2. Male population distributed into particular age-education groups, as percentage shares, Mexico, 1960–2010.

Age-education groups	1960	1970	1990	2000	2010
15–24 years; 0 years of schooling	10.45	6.81	1.90	0.94	0.44
15–24 years; 1–6 years of schooling	21.49	21.50	12.20	8.78	4.28
15–24 years; 7–12 years of schooling	3.73	7.60	21.15	20.96	21.36
15–24 years; 13+ years of schooling	0.39	1.23	2.69	2.84	3.81
25–34 years; 0 years of schooling	8.12	6.05	2.00	0.89	0.66
25–34 years; 1–6 years of schooling	14.63	14.64	10.29	7.79	5.27
25–34 years; 7–12 years of schooling	1.54	2.23	8.61	13.09	12.19
25–34 years; 13+ years of schooling	0.53	1.30	4.24	4.28	5.37
35–49 years; 0 years of schooling	8.98	8.01	3.69	1.70	1.25
35–49 years; 1–6 years of schooling	14.08	14.85	12.72	11.32	8.54
35–49 years; 7–12 years of schooling	1.24	1.75	4.74	8.61	13.68
35–49 years; 13+ years of schooling	0.48	0.96	2.91	4.98	5.93
50–64 years; 0 years of schooling	6.73	5.22	3.58	2.27	1.88
50–64 years; 1–6 years of schooling	6.89	6.77	7.21	7.77	7.66
50–64 years; 7–12 years of schooling	0.52	0.70	1.30	2.25	4.44
50–64 years; 13+ years of schooling	0.20	0.40	0.76	1.53	3.25
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Sample size (n)	**126,959**	**118,679**	**2,235,704**	**2,754,866**	**3,432,405**
Population size (N)	**8,506,253**	**11,867,900**	**22,357,040**	**27,417,925**	**34,203,291**

Sources: 1960, 1970, 1990, 2000, and 2010 Mexican Demographic Censuses (IPUMS-International).

Table 3. Coefficients and standard errors estimated with fixed-effects model from Equation (1) for the logarithm of mean real monthly earnings from main occupation⁺ as the dependent variable, Brazil, 1970–2010.

Independent variables	**Coefficients (Standard errors)**				
Constant	5.340*** (0.00374)				
	Main effects	**Interactions with year**			
Age-education indicators	**1970**	**1980**	**1991**	**2000**	**2010**
15–24 years; 0–3 years of schooling (reference group)	—	—	—	—	—
15–24 years;	0.461***	-0.179***	-0.173***	-0.264***	-0.391***
4–8 years of schooling	(0.0116)	(0.0164)	(0.0164)	(0.0164)	(0.0166)
15–24 years;	1.087***	-0.252***	-0.313***	-0.567***	-0.847***
9–11 years of schooling	(0.0131)	(0.0177)	(0.0177)	(0.0175)	(0.0177)
15–24 years;	1.566***	-0.274***	-0.357***	-0.491***	-0.893***
12+ years of schooling	(0.0182)	(0.0237)	(0.0243)	(0.0230)	(0.0219)
25–34 years;	0.302***	0.0633***	0.00410	-0.00774	-0.0895***
0–3 years of schooling	(0.0115)	(0.0163)	(0.0163)	(0.0164)	(0.0166)
25–34 years;	1.061***	-0.115***	-0.259***	-0.328***	-0.643***
4–8 years of schooling	(0.0117)	(0.0165)	(0.0165)	(0.0165)	(0.0167)
25–34 years;	1.760***	-0.198***	-0.345***	-0.511***	-1.073***
9–11 years of schooling	(0.0141)	(0.0187)	(0.0184)	(0.0183)	(0.0185)
25–34 years;	2.386***	-0.267***	-0.377***	-0.487***	-1.018***
12+ years of schooling	(0.0161)	(0.0211)	(0.0212)	(0.0208)	(0.0201)
35–49 years;	0.469***	0.0886***	0.0476***	0.0165	-0.132***
0–3 years of schooling	(0.0115)	(0.0163)	(0.0163)	(0.0164)	(0.0166)
35–49 years;	1.353***	-0.0474***	-0.174***	-0.299***	-0.691***
4–8 years of schooling	(0.0118)	(0.0166)	(0.0166)	(0.0166)	(0.0168)
35–49 years;	2.159***	-0.151***	-0.294***	-0.424***	-1.048***
9–11 years of schooling	(0.0162)	(0.0210)	(0.0204)	(0.0200)	(0.0201)
35–49 years;	2.671***	-0.215***	-0.215***	-0.253***	-0.852***
12+ years of schooling	(0.0169)	(0.0224)	(0.0218)	(0.0212)	(0.0208)
50–64 years;	0.475***	0.0824***	0.0456***	0.0589***	-0.0490***
0–3 years of schooling	(0.0115)	(0.0163)	(0.0163)	(0.0164)	(0.0166)
50–64 years;	1.447***	-0.0575***	-0.177***	-0.207***	-0.647***
4–8 years of schooling	(0.0123)	(0.0170)	(0.0170)	(0.0169)	(0.0171)
50–64 years;	2.256***	-0.0923***	-0.190**	-0.288***	-0.935***
9–11 years of schooling	(0.0222)	(0.0282)	(0.0275)	(0.0259)	(0.0253)
50–64 years;	2.675***	-0.128***	-0.104***	-0.0950***	-0.555***
12+ years of schooling	(0.0220)	(0.0287)	(0.0281)	(0.0265)	(0.0255)
Number of observations	32,201				
Number of groups	2,488				
Fraction of variance due to area-time fixed effects	0.934				
F (75; 29,638): all coefficients=0	5,626.81***				
F (2,487; 29,638): area-time fixed effects=0	29.09***				

* Significant at p<0.1, ** Significant at p<0.05, *** Significant at p<0.01.
⁺ Nominal earnings were converted to base 1 in January 2002, taking into account changes in currency and inflation (Corseuil and Foguel 2002).
Standard errors are reported in parentheses.
Sources: 1970, 1980, 1991, 2000, and 2010 Brazilian Demographic Censuses (Brazilian Institute of Geography and Statistics – IBGE).

Table 4. Coefficients and standard errors estimated with fixed-effects model from Equation (1) for the logarithm of mean nominal monthly earnings from main occupation as the dependent variable, Mexico, 1990–2010.

Independent variables	Coefficients (Standard errors)		
Constant	9.043*** (0.00787)		
Age-education indicators	**Main effects 1990**	**Interactions with year 2000**	**Interactions with year 2010**
15–24 years; 0 years of schooling (reference group)	—	—	—
15–24 years; 1–6 years of schooling	0.268*** (0.0164)	-0.0900*** (0.0230)	-0.102*** (0.0233)
15–24 years; 7–12 years of schooling	0.399*** (0.0166)	-0.0856*** (0.0232)	-0.116*** (0.0234)
15–24 years; 13+ years of schooling	0.549*** (0.0196)	0.108*** (0.0272)	-0.00760 (0.0271)
25–34 years; 0 years of schooling	0.103*** (0.0182)	-0.0217 (0.0257)	0.0377 (0.0260)
25–34 years; 1–6 years of schooling	0.423*** (0.0164)	-0.0926*** (0.0230)	-0.0988*** (0.0233)
25–34 years; 7–12 years of schooling	0.704*** (0.0167)	-0.0709*** (0.0233)	-0.183*** (0.0235)
25–34 years; 13+ years of schooling	0.987*** (0.0185)	0.292*** (0.0258)	0.0415 (0.0261)
35–49 years; 0 years of schooling	0.187*** (0.0170)	-0.0607** (0.0239)	-0.0321 (0.0242)
35–49 years; 1–6 years of schooling	0.496*** (0.0164)	-0.103*** (0.0230)	-0.139*** (0.0233)
35–49 years; 7–12 years of schooling	0.796*** (0.0171)	-0.0162 (0.0237)	-0.156*** (0.0239)
35–49 years; 13+ years of schooling	1.163*** (0.0189)	0.372*** (0.0261)	0.142*** (0.0264)
50–64 years; 0 years of schooling	0.100*** (0.0168)	-0.107*** (0.0235)	-0.0538** (0.0238)
50–64 years; 1–6 years of schooling	0.363*** (0.0164)	-0.0460** (0.0230)	-0.0762*** (0.0233)
50–64 years; 7–12 years of schooling	0.753*** (0.0195)	0.0336 (0.0266)	-0.0781*** (0.0267)
50–64 years; 13+ years of schooling	1.266*** (0.0248)	0.308*** (0.0337)	0.192*** (0.0337)
Number of observations	82,604		
Number of groups	7,259		
Fraction of variance due to area-time fixed effects	0.968		
F (45; 75,300): all coefficients=0	1,182.49***		
F (7,258; 75,300): area-time fixed effects=0	22.47***		

* Significant at p<0.1, ** Significant at p<0.05, *** Significant at p<0.01.
Standard errors are reported in parentheses.
Sources: 1990, 2000, and 2010 Mexican Demographic Censuses (IPUMS-International).

Table 5. Coefficients and standard errors estimated with fixed-effects model from Equation (2) for the logarithm of mean real monthly earnings from main occupation+ as the dependent variable, Brazil, 1970–2010.

Independent variables	Coefficients (Standard errors)				
Constant	5.403*** (0.00846)				
	Main effects	**Interactions with year**			
Age-education indicators	**1970**	**1980**	**1991**	**2000**	**2010**
15–24 years; 0–3 years of schooling (reference group)	—	—	—	—	—
15–24 years; 4–8 years of schooling	0.554*** (0.389)	-0.277*** (0.0534)	-0.196*** (0.0565)	-0.229*** (0.0704)	-0.441*** (0.0513)
15–24 years; 9–11 years of schooling	1.184*** (0.0370)	-0.211*** (0.0474)	-0.289*** (0.0476)	-0.642*** (0.0466)	-1.028*** (0.0702)
15–24 years; 12+ years of schooling	1.625*** (0.0390)	-0.244*** (0.0501)	-0.329*** (0.0529)	-0.590*** (0.0476)	-0.853*** (0.0461)
25–34 years; 0–3 years of schooling	0.344*** (0.0427)	0.151*** (0.0521)	0.0415 (0.0496)	-0.00355 (0.0480)	-0.0821* (0.0484)
25–34 years; 4–8 years of schooling	1.111*** (0.0377)	-0.199*** (0.0496)	-0.294*** (0.0497)	-0.447*** (0.0525)	-0.758*** (0.0768)
25–34 years; 9–11 years of schooling	1.797*** (0.0383)	-0.167*** (0.0489)	-0.318*** (0.0483)	-0.573*** (0.0474)	-1.110*** (0.0554)
25–34 years; 12+ years of schooling	2.392*** (0.0380)	-0.233*** (0.0476)	-0.302*** (0.0468)	-0.519*** (0.0451)	-1.090*** (0.0448)
35–49 years; 0–3 years of schooling	0.677*** (0.0597)	0.172** (0.0707)	0.0276 (0.0673)	-0.0854 (0.0650)	-0.188*** (0.0671)
35–49 years; 4–8 years of schooling	1.369*** (0.0371)	-0.0968** (0.0489)	-0.139 (0.0472)	-0.336*** (0.0463)	-0.856*** (0.0541)
35–49 years; 9–11 years of schooling	2.137*** (0.0395)	-0.146*** (0.0497)	-0.182*** (0.0483)	-0.364*** (0.0470)	-0.915*** (0.0488)
35–49 years; 12+ years of schooling	2.609*** (0.0484)	-0.199*** (0.0484)	-0.0859 (0.0466)	-0.236*** (0.0445)	-0.883*** (0.0446)
50–64 years; 0–3 years of schooling	0.694*** (0.0486)	0.184*** (0.0615)	0.00508 (0.0615)	-0.0107 (0.0578)	-0.196*** (0.0635)
50–64 years; 4–8 years of schooling	1.446*** (0.0367)	-0.105** (0.0478)	-0.137*** (0.0465)	-0.292*** (0.0446)	-0.686*** (0.0452)
50–64 years; 9–11 years of schooling	2.221*** (0.0543)	-0.0801 (0.0659)	-0.0601 (0.0639)	-0.228*** (0.0606)	-0.770*** (0.0598)
50–64 years; 12+ years of schooling	2.545*** (0.0475)	-0.0845*** (0.599)	-0.00979 (0.0586)	-0.0610 (0.0549)	-0.454*** (0.0529)
	Main effects	**Interactions with year**			
Proportions in age-education groups	**1970**	**1980**	**1991**	**2000**	**2010**
15–24 years; 0–3 years of schooling	-0.306** (0.114)	0.00153*** (0.158)	0.204*** (0.155)	-0.429** (0.169)	-2.622*** (0.416)
15–24 years; 4–8 years of schooling	-1.700*** (0.154)	1.365*** (0.220)	1.159*** (0.256)	0.482 (0.379)	0.484 (0.317)
15–24 years; 9–11 years of schooling	-11.43*** (0.967)	5.665*** (1.070)	7.521*** (1.117)	10.08*** (1.013)	11.38*** (1.074)
15–24 years; 12+ years of schooling	-25.89*** (3.201)	10.35*** (3.909)	12.89*** (4.641)	23.37*** (3.787)	16.88*** (3.302)
25–34 years; 0–3 years of schooling	-0.677*** (0.222)	-0.640*** (0.291)	-0.218 (0.299)	-0.761** (0.307)	-1.874*** (0.378)
25–34 years; 4–8 years of schooling	-2.795*** (0.298)	2.524*** (0.373)	2.481*** (0.371)	2.770*** (0.420)	2.476*** (0.835)
25–34 years; 9–11 years of schooling	-14.13*** (2.075)	7.791*** (2.265)	11.86*** (2.265)	13.05*** (2.134)	12.98*** (2.124)
25–34 years;	-15.71***	9.321***	9.601**	12.82***	14.79***

12+ years of schooling	(2.786)	(3.010)	(3.004)	(3.025)	(2.849)
35–49 years;	-1.392***	-0.677***	0.00364	-0.138	-0.747**
0–3 years of schooling	(0.294)	(0.368)	(0.356)	(0.354)	(0.378)
35–49 years;	-2.270***	1.932***	1.463**	1.825***	2.871***
4–8 years of schooling	(0.311)	(0.417)	(0.381)	(0.361)	(0.471)
35–49 years;	-11.47***	8.236**	6.138*	8.418***	7.936***
9–11 years of schooling	(3.045)	(3.518)	(3.176)	(3.085)	(3.070)
35–49 years;	-7.347**	6.888*	2.332	6.277*	7.527**
12+ years of schooling	(3.289)	(3.753)	(3.443)	(3.378)	(3.352)
50–64 years;	-2.380***	-0.891*	0.556**	0.00884	0.942*
0–3 years of schooling	(0.359)	(0.475)	(0.485)	(0.468)	(0.491)
50–64 years;	-3.937***	-3.828***	2.480***	4.274***	2.678***
4–8 years of schooling	(0.663)	(0.857)	(0.819)	(0.754)	(0.829)
50–64 years;	-27.86**	20.93	12.02	19.51	19.21
9–11 years of schooling	(12.18)	(13.53)	(12.66)	(12.32)	(12.20)
50–64 years;	1.119	5.357	0.196	2.032	-5.357
12+ years of schooling	(9.101)	(10.82)	(9.844)	(9.331)	(9.164)
Number of observations	32,201				
Number of groups	2,488				
Fraction of variance due to area-time fixed effects	0.940				
F (155; 29,558): all coefficients=0	2,996.23***				
F (2,487; 29,558): area-time fixed effects=0	18.07***				

* Significant at p<0.1, ** Significant at p<0.05, *** Significant at p<0.01.

⁺ Nominal earnings were converted to base 1 in January 2002, taking into account changes in currency and inflation (Corseuil and Foguel 2002).

Standard errors are reported in parentheses.

Sources: 1970, 1980, 1991, 2000, and 2010 Brazilian Demographic Censuses (Brazilian Institute of Geography and Statistics – IBGE).

Table 6. Coefficients and standard errors estimated with fixed-effects model from Equation (2) for the logarithm of mean nominal monthly earnings from main occupation as the dependent variable, Mexico, 1990–2010.

Independent variables	**Coefficients (Standard errors)**		
Constant	9.021*** (0.0144)		
Age-education indicators	**Main effects 1990**	**Interactions with year 2000**	**2010**
15–24 years; 0 years of schooling (reference group)	—	—	—
15–24 years; 1–6 years of schooling	0.192*** (0.0356)	-0.0496 (0.0494)	-0.0321 (0.0498)
15–24 years; 7–12 years of schooling	0.573*** (0.0656)	-0.252*** (0.0886)	-0.306*** (0.0877)
15–24 years; 13+ years of schooling	0.505*** (0.0408)	0.266*** (0.0566)	0.0859 (0.0557)
25–34 years; 0 years of schooling	0.175*** (0.0333)	-0.00551 (0.0469)	0.0381 (0.0472)
25–34 years; 1–6 years of schooling	0.378*** (0.0420)	-0.0536 (0.0582)	-0.0335 (0.0585)
25–34 years; 7–12 years of schooling	0.876*** (0.0409)	-0.180*** (0.0561)	-0.306*** (0.0561)
25–34 years; 13+ years of schooling	0.952*** (0.0352)	0.368*** (0.0489)	0.0863* (0.0492)
35–49 years; 0 years of schooling	0.196*** (0.0320)	0.0225 (0.0448)	0.0453 (0.0452)
35–49 years; 1–6 years of schooling	0.534*** (0.0496)	-0.0364 (0.0685)	-0.131* (0.0686)
35–49 years; 7–12 years of schooling	0.874*** (0.0388)	-0.0624 (0.0522)	-0.201*** (0.0523)
35–49 years; 13+ years of schooling	1.045*** (0.0350)	0.485*** (0.0482)	0.241*** (0.0486)
50–64 years; 0 years of schooling	0.0931*** (0.0323)	-0.0369 (0.0452)	0.0477 (0.0456)
50–64 years; 1–6 years of schooling	0.433*** (0.0391)	-0.00721 (0.0538)	-0.0662 (0.0540)
50–64 years; 7–12 years of schooling	0.682*** (0.0423)	0.106* (0.0571)	0.0580 (0.0570)
50–64 years; 13+ years of schooling	1.067*** (0.0457)	0.463*** (0.0619)	0.331*** (0.0620)
Proportions in age-education groups	**Main effects 1990**	**Interaction with year 2000**	**2010**
15–24 years; 0 years of schooling	1.013 (1.077)	0.479 (1.486)	-0.0260 (1.494)
15–24 years; 1–6 years of schooling	0.819*** (0.222)	-0.254 (0.307)	-0.594* (0.306)
15–24 years; 7–12 years of schooling	-0.794*** (0.294)	0.894** (0.394)	0.973** (0.388)
15–24 years; 13+ years of schooling	2.359* (1.210)	-5.845*** (1.671)	-3.491** (1.623)
25–34 years; 0 years of schooling	-2.422** (0.946)	-0.260 (1.338)	0.0507 (1.315)
25–34 years; 1–6 years of schooling	0.587* (0.325)	-0.258 (0.447)	-0.593 (0.446)
25–34 years; 7–12 years of schooling	-1.687*** (0.318)	1.309*** (0.433)	1.361*** (0.429)

25–34 years;	1.630**	-2.047**	-1.196
13+ years of schooling	(0.722)	(1.004)	(1.002)
35–49 years;	0.252	-2.031***	-2.114***
0 years of schooling	(0.537)	(0.755)	(0.745)
35–49 years;	-0.151	-0.371	-0.0302
1–6 years of schooling	(0.293)	(0.401)	(0.399)
35–49 years;	-0.841**	0.795*	0.663
7–12 years of schooling	(0.355)	(0.469)	(0.465)
35–49 years;	4.415***	-3.178***	-2.985***
13+ years of schooling	(0.690)	(0.950)	(0.949)
50–64 years;	0.559	-1.336**	-2.269***
0 years of schooling	(0.452)	(0.631)	(0.624)
50–64 years;	-0.516*	-0.233	-0.0457
1–6 years of schooling	(0.272)	(0.367)	(0.364)
50–64 years;	3.629***	-2.400	-5.520***
7–12 years of schooling	(1.360)	(1.810)	(1.790)
50–64 years;	13.25***	-8.540***	-7.980***
13+ years of schooling	(2.008)	(2.686)	(2.678)
Number of observations	82,604		
Number of groups	7,259		
Fraction of variance due to area-time fixed effects	0.968		
F (93; 75,252): all coefficients=0	577.32***		
F (7,258; 75,252): area-time fixed effects=0	12.21***		

* Significant at p<0.1, ** Significant at p<0.05, *** Significant at p<0.01.
Standard errors are reported in parentheses.
Sources: 1990, 2000, and 2010 Mexican Demographic Censuses (IPUMS-International).

Table 7. Effects of proportion of male working-age population by age-education groups (factor-price elasticities) on mean real monthly earnings from main occupation⁺ (dependent variable), based on Equation (2) (Table 5), using the national age-education distribution (Table 1), Brazil, 1970–2010.

Age-education groups	**Elasticities**				
	1970	**1980**	**1991**	**2000**	**2010**
15–24 years; 0–3 years of schooling	-0.061	-0.040	-0.010	-0.070	-0.066
15–24 years; 4–8 years of schooling	-0.230	-0.059	-0.091	-0.189	-0.111
15–24 years; 9–11 years of schooling	-0.248	-0.284	-0.198	-0.121	-0.006
15–24 years; 12+ years of schooling	-0.147	-0.161	-0.118	-0.031	-0.274
25–34 years; 0–3 years of schooling	-0.099	-0.133	-0.069	-0.080	-0.098
25–34 years; 4–8 years of schooling	-0.197	-0.028	-0.036	-0.003	-0.024
25–34 years; 9–11 years of schooling	-0.165	-0.172	-0.115	-0.064	-0.106
25–34 years; 12+ years of schooling	-0.130	-0.132	-0.143	-0.063	-0.042
35–49 years; 0–3 years of schooling	-0.243	-0.269	-0.144	-0.121	-0.172
35–49 years; 4–8 years of schooling	-0.154	-0.029	-0.084	-0.054	0.057
35–49 years; 9–11 years of schooling	-0.096	-0.047	-0.161	-0.163	-0.272
35–49 years; 12+ years of schooling	-0.055	-0.006	-0.126	-0.033	0.007
50–64 years; 0–3 years of schooling	-0.248	-0.284	-0.143	-0.160	-0.121
50–64 years; 4–8 years of schooling	-0.121	-0.323	-0.070	0.019	-0.050
50–64 years; 9–11 years of schooling	-0.078	-0.037	-0.144	-0.126	-0.321
50–64 years; 12+ years of schooling	0.004	0.034	0.011	0.042	-0.099
Standard deviation	**0.077**	**0.115**	**0.057**	**0.067**	**0.107**

⁺ Nominal earnings were converted to base 1 in January 2002, taking into account changes in currency and inflation (Corseuil and Foguel 2002).
Sources: 1970, 1980, 1991, 2000, and 2010 Brazilian Demographic Censuses (Brazilian Institute of Geography and Statistics – IBGE).

Table 8. Effects of proportion of male working-age population by age-education groups (factor-price elasticities) on mean nominal monthly earnings from main occupation (dependent variable), based on Equation (2) (Table 6), using the national age-education distribution (Table 2), Mexico, 1990–2010.

Age-education groups	Elasticities		
	1990	2000	2010
15–24 years; 0 years of schooling	0.019	0.014	0.004
15–24 years; 1–6 years of schooling	0.100	0.050	0.010
15–24 years; 7–12 years of schooling	-0.168	0.021	0.038
15–24 years; 13+ years of schooling	0.063	-0.099	-0.043
25–34 years; 0 years of schooling	-0.048	-0.024	-0.016
25–34 years; 1–6 years of schooling	0.060	0.026	0.000
25–34 years; 7–12 years of schooling	-0.145	-0.049	-0.040
25–34 years; 13+ years of schooling	0.069	-0.018	0.023
35–49 years; 0 years of schooling	0.009	-0.030	-0.023
35–49 years; 1–6 years of schooling	-0.019	-0.059	-0.015
35–49 years; 7–12 years of schooling	-0.040	-0.004	-0.024
35–49 years; 13+ years of schooling	0.129	0.062	0.085
50–64 years; 0 years of schooling	0.020	-0.018	-0.032
50–64 years; 1–6 years of schooling	-0.037	-0.058	-0.043
50–64 years; 7–12 years of schooling	0.047	0.028	-0.084
50–64 years; 13+ years of schooling	0.101	0.072	0.171
Standard deviation	**0.084**	**0.048**	**0.060**

Sources: 1990, 2000, and 2010 Mexican Demographic Censuses (IPUMS-International).

Table 9. Coefficients and standard errors estimated with model from Equation (4) for the logarithm of individual earnings as the dependent variable by income quartile, Brazil, 2000 and 2010.

Variables	2000				2010			
	Total	1 quartile	2 quartile	3 quartile	Total	1 quartile	2 quartile	3 quartile
Age	0.1033***	0.0941***	0.0972***	0.1051***	0.0738***	0.0655***	0.0630***	0.0703***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0002)	(0.0003)	(0.0002)	(0.0003)
Age^2	-0.0011***	-0.0011***	-0.0011***	-0.0011***	-0.0007***	-0.0007***	-0.0006***	-0.0007***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Immigrant	0.0868***	0.0749***	0.0781***	0.0942***	0.1415***	0.0982***	0.1164***	0.1487***
	(0.0016)	(0.0021)	(0.0017)	(0.0020)	(0.0016)	(0.0021)	(0.0020)	(0.0025)
Education – reference: less than primary completed								
Primary completed	0.3641***	0.3105***	0.3110***	0.3425***	0.2857***	0.2451***	0.2408***	0.2630***
	(0.0013)	(0.0016)	(0.0014)	(0.0017)	(0.0013)	(0.0013)	(0.0012)	(0.0016)
Secondary completed	0.8213***	0.6645***	0.7536***	0.8808***	0.6069***	0.4783***	0.4862***	0.5892***
	(0.0015)	(0.0018)	(0.0016)	(0.0019)	(0.0015)	(0.0013)	(0.0013)	(0.0017)
University completed	1.6930***	1.5629***	1.7324***	1.8369***	1.4305***	1.1063***	1.3254***	1.5362***
	(0.0023)	(0.0031)	(0.0026)	(0.0030)	(0.0023)	(0.0020)	(0.0019)	(0.0024)
Predicted proportion of	0.0654***	0.0631***	0.0660***	0.0675***	0.0199***	0.0123***	0.0216***	0.0278***
undergraduates (Equation 3)	(0.0003)	(0.0004)	(0.0004)	(0.0004)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Urbanization rate	0.0023***	0.0036***	0.0025***	0.0014***	0.0034***	0.0049***	0.0027***	0.0014***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0001)
Unemployment rate	0.0014***	0.0045***	0.0023***	0.0002	-0.014***	-0.0205***	-0.0096***	-0.0081***
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0001)	(0.0001)	(0.0002)
Regions – reference: Southeast (“Sudeste”)								
	-0.0714***	-0.1345***	-0.0881***	-0.0286***	0.0144***	-0.0169***	-0.0221***	0.0290***
North (“Norte”)	(0.0022)	(0.0028)	(0.0024)	(0.0027)	(0.0021)	(0.0022)	(0.0021)	(0.0027)
	-0.3240***	-0.3641***	-0.3354***	-0.2822***	-0.1811***	-0.2114***	-0.1720***	-0.1526***
Northeast (“Nordeste”)	(0.0017)	(0.0021)	(0.0017)	(0.0020)	(0.0016)	(0.0018)	(0.0017)	(0.0022)
	0.0434***	0.0422***	0.0471***	0.0475***	0.0710***	0.0521***	0.0825***	0.0855***
South (“Sul”)	(0.0016)	(0.0019)	(0.0016)	(0.0019)	(0.0015)	(0.0015)	(0.0014)	(0.0018)
	0.0069***	-0.0250***	-0.0063***	0.0165***	0.0742***	0.0300***	0.0608***	0.0878***
Center-West (“Centro-Oeste”)	(0.0020)	(0.0025)	(0.0021)	(0.0025)	(0.0020)	(0.0019)	(0.0018)	(0.0023)
	2.9749***	2.7289***	3.1090***	3.3765***	4.4119***	4.4210***	4.7119***	4.8401***
Constant	(0.0053)	(0.0065)	(0.0055)	(0.0063)	(0.0063)	(0.0063)	(0.0059)	(0.0076)
Number of observations	2,160,745				2,152,549			
Adjusted R-squared	0.4725				0.4304			
Pseudo R-squared		0.2578	0.2813	0.3065		0.1762	0.2228	0.2601

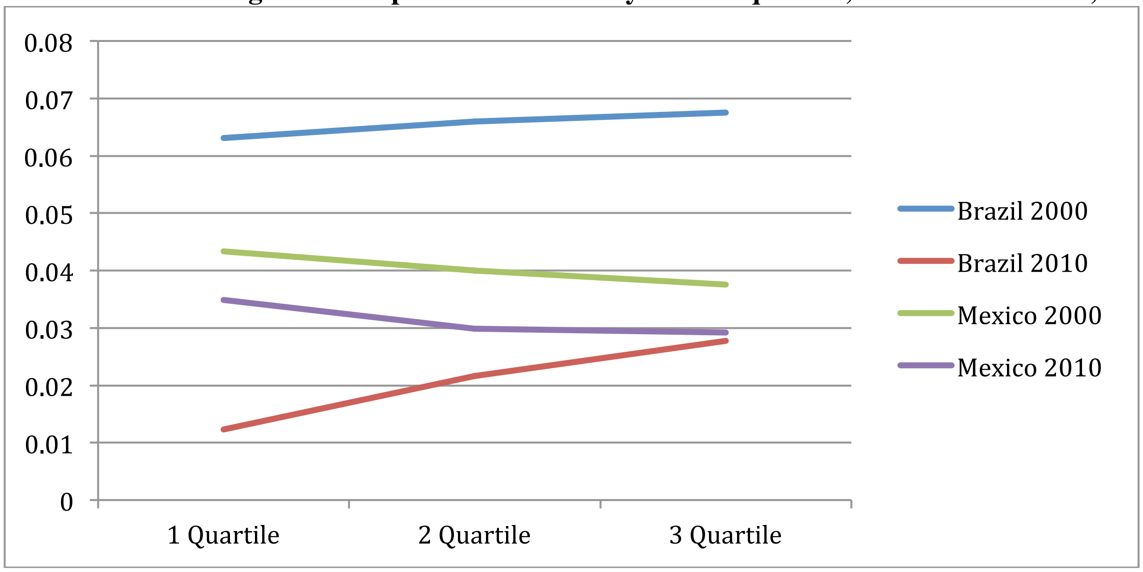
* Significant at p<0.1, ** Significant at p<0.05, *** Significant at p<0.01.
Standard errors are reported in parentheses.
Sources: 1991, 2000, and 2010 Brazilian Demographic Censuses (IPUMS-International).

Table 10. Coefficients and standard errors estimated with model from Equation (4) for the logarithm of individual earnings as the dependent variable by income quartile, Mexico, 2000 and 2010.

Variables	2000				2010			
	Total	1 quartile	2 quartile	3 quartile	Total	1 quartile	2 quartile	3 quartile
Age	0.0644***	0.0530***	0.0530***	0.0585***	0.0613***	0.0575***	0.0495***	0.0497***
	(0.0003)	(0.0003)	(0.0002)	(0.0003)	(0.0003)	(0.0003)	(0.0002)	(0.0003)
Age2	-0.0007***	-0.0006***	-0.0006***	-0.0007***	-0.0007***	-0.0007***	-0.0006***	-0.0005***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Immigrant	0.1322***	0.1138***	0.1133***	0.1323***	0.1333***	0.1213***	0.1183***	0.1285***
	(0.0017)	(0.0019)	(0.0016)	(0.0018)	(0.0017)	(0.0022)	(0.0017)	(0.0018)
Education – reference: less than primary completed								
Primary completed	0.2696***	0.2149***	0.2220***	0.2563***	0.2606***	0.2778***	0.2338***	0.2292***
	(0.0014)	(0.0014)	(0.0012)	(0.0015)	(0.0016)	(0.0017)	(0.0013)	(0.0015)
Secondary completed	0.6527***	0.5084***	0.6027***	0.7550***	0.5453***	0.4966***	0.4751***	0.5323***
	(0.0018)	(0.0020)	(0.0017)	(0.0020)	(0.0019)	(0.0022)	(0.0017)	(0.0019)
University completed	1.2598***	1.1315***	1.2820***	1.4318***	1.0709***	0.9728***	1.0231***	1.1503***
	(0.0020)	(0.0022)	(0.0019)	(0.0022)	(0.0021)	(0.0027)	(0.0021)	(0.0023)
Predicted proportion of undergraduates (from Equation 3)	0.0511***	0.0433***	0.0400***	0.0375***	0.0307***	0.0349***	0.0299***	0.0292***
	(0.0004)	(0.0004)	(0.0003)	(0.0004)	(0.0001)	(0.0002)	(0.0001)	(0.0001)
Urbanization rate	0.0021***	0.0024***	0.0019***	0.0018***				
	(0.0000)	(0.0000)	(0.0000)	(0.0000)				
Unemployment rate	-0.0124***	0.0007	0.0021***	0.0016	-0.0013***	0.0049***	0.0038***	0.0036***
	(0.0009)	(0.0008)	(0.0007)	(0.0008)	(0.0003)	(0.0003)	(0.0002)	(0.0002)
Regions – reference: Northeast ("Nordeste")								
Northwest ("Noroeste")	0.0143***	-0.0084***	0.0082***	0.0261***	0.0646***	-0.0137***	0.0023	0.0169***
	(0.0021)	(0.0025)	(0.0021)	(0.0024)	(0.0021)	(0.0031)	(0.0024)	(0.0026)
West ("Ocidente")	-0.0198***	-0.0071***	0.0036*	-0.0089***	0.1565***	0.1085***	0.1191***	0.1083***
	(0.0020)	(0.0022)	(0.0019)	(0.0022)	(0.0021)	(0.0027)	(0.0021)	(0.0023)
East ("Oriente")	-0.3259***	-0.3670***	-0.3414***	-0.3223***	-0.0963***	-0.2148***	-0.1666***	-0.1334***
	(0.0019)	(0.0021)	(0.0017)	(0.0021)	(0.0020)	(0.0025)	(0.0019)	(0.0021)
Center-North ("Centro-Norte")	-0.0129***	-0.0523***	-0.0363***	-0.0428***	0.0686***	-0.0041	0.0122***	0.0087***
	(0.0021)	(0.0024)	(0.0020)	(0.0024)	(0.0021)	(0.0029)	(0.0023)	(0.0025)
Center-South ("Centro-Sul")	-0.1978***	-0.2051***	-0.1997***	-0.1943***	-0.0209**	-0.0892***	-0.0493***	-0.0310***
	(0.0017)	(0.0020)	(0.0016)	(0.0019)	(0.0017)	(0.0026)	(0.0020)	(0.0022)
Southeast ("Sudeste")	-0.3230***	-0.4305***	-0.3553***	-0.3092***	-0.0453***	-0.2154***	-0.1675***	-0.1235***
	(0.0025)	(0.0027)	(0.0023)	(0.0027)	(0.0026)	(0.0032)	(0.0025)	(0.0027)
Southwest ("Sudoeste")	-0.3937***	-0.4285***	-0.3511***	-0.3036***	-0.1909***	-0.3178***	-0.1909***	-0.1099***
	(0.0024)	(0.0025)	(0.0021)	(0.0025)	(0.0025)	(0.0027)	(0.0021)	(0.0023)
Constant	5.7328***	5.7694***	6.0856***	6.2589***	6.4723***	6.2892***	6.8100***	7.0816***
	(0.0050)	(0.0053)	(0.0044)	(0.0053)	(0.0055)	(0.0064)	(0.0049)	(0.0053)
Number of observations	1,733,425				1,900,108			
Adjusted R-squared	0.3928				0.2807			
Pseudo R-squared		0.2174	0.2452	0.2763		0.1511	0.1590	0.1890

* Significant at p<0.1, ** Significant at p<0.05, *** Significant at p<0.01.
Standard errors are reported in parentheses.
Sources: 1990, 2000, and 2010 Mexican Demographic Censuses (IPUMS-International).

Figure 1. Coefficients of predicted proportion of undergraduates (from Tables 9 and 10) for the logarithm of individual earnings as the dependent variable by income quartile, Brazil and Mexico, 2000 and 2010.



Source: Brazilian and Mexican Demographic Censuses (IPUMS-International).