Interstate migration and human capital formation in Brazil

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Abstract

Purpose – The purpose of this paper is to analyze the impact of interstate migration of individuals with different qualification levels on human capital formation in the migrant's place of origin.
Design/methodology/approach – A dynamic panel model with data from the National Household Sample Survey (Pesquisa Nacional por Amostra de Domicílios (PNAD)), between 2001 and 2013, is used.
Findings – The results indicate that the migration of high-skilled people boosts school attendance in fifth grade elementary school and first year high school, but it does not affect the levels of those entering first year in higher education. However, the migration of low-skilled workers discourages people from entering higher education, as those living in less developed areas do not need higher education qualifications to get higher incomes. Thus, they migrate to developed areas with the education levels they already have. The brain gain hypothesis is not, therefore, confirmed in the context of higher education attendance.
Originality/value – This paper's contribution is its investigation into the effect of interstate migration on human capital formation in Brazil, through testing the brain gain hypothesis in a national context. In addition, it also analyzes the impact of the migration of people of low and intermediate qualification levels on human capital, with a view to verifying if the mobility of people with other levels of qualification could discourage the formation of human capital.

Keywords Human capital, Brain gain, Education levels and migration, Interstate migration
Paper type Research paper

1. Introduction

The literature on economic growth considers that the accumulation of human capital is a decisive factor in determining growth. The mobility of such capital between regions can affect both human capital accumulation and the economic development of the different locations. Liu and Shen (2014) considered that an influx of people with high education levels can accelerate the accumulation of human capital, facilitate innovative activities and improve the potential for endogenous growth in the receiving areas.

However, earlier studies on internal migration did not deal with migrants' qualification levels, since they only considered the necessary transfer of labor surplus from rural to urban areas (Lewis, 1954; Todaro, 1969; Harris and Todaro, 1970). According to Bildirici *et al.* (2005), in the mid-1960s, when England began losing a significant number of people with high levels of schooling to North America and other countries, an interest in researching the migration of skilled labor was awakened.

From then on, international literature has studied the phenomenon known as the brain drain, the migration of the skilled from developing to developed countries (Beine *et al.*, 2008). Beine *et al.* (2011) considered the skilled to be those with post-secondary education, while Di Maria and Lazarova (2012) considered them as those with higher education.

The authors of this paper have not made the research data set openly available. Any enquiries regarding the data set can be directed to the corresponding author.

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The literature on the brain drain considers that such migration has certain repercussions, especially for the migrant's country of origin. Some authors claim that this migration damages these countries as it reduces the stock of human capital and affects the well-being of the remaining population (Grubel and Scott, 1966; Bhagwati and Hamada, 1974).

However, from the 1990s onwards, authors, such as Mountford (1997), Vidal (1998) and Beine *et al.* (2001, 2008, 2011), proposed new approaches, according to which the migration of the skilled from developing to developed countries stimulates the formation of human capital in their country of origin. This became known as beneficial brain drain or brain gain.

As the returns from education are higher abroad (in the migrant's country of destination), Beine *et al.* (2008) claimed that migration perspectives can induce more people to invest in education at home, with a view to migrating in the future. Such an occurrence would have an incentive effect (called brain gain), which could be superimposed on actual emigration and lead to a net gain for the source country (beneficial brain drain).

In the context of internal migration, where barriers to mobility tend to be lower, people are induced to seek higher remuneration for acquired human capital and can leave their state of origin (Bezerra and Silveira Neto, 2008). When such people have higher education levels and migrate to more developed regions, there can be a brain drain, whose consequences for the source areas could be similar to those of international skilled migration.

Surveys of migration in Brazil have paid little attention to the migrant's qualification levels. Diniz (1993) explained that this is due to the country's pattern of industrial growth, especially until the 1970s, where expansion occurred through basic or durable consumer goods industries and through the advance of the national agricultural frontier, where the demand for labor did not require high education levels.

In this period, only Campino (1973) analyzed the state migratory balances between 1950 and 1970, considering the mobility of the qualified to find out which states presented the greatest losses of human capital and why. However, as levels of schooling were generally low in that period, the author considered the qualified to be those with a minimum of nine years schooling. The results indicated that Maranhão, Piauí, Minas Gerais, Espírito Santo, São Paulo, Paraná, Santa Catarina and Rio Grande do Sul presented net losses of people with this level of qualification.

However, Diniz (1993) claimed that the introduction of technological changes led to the expansion of sectors sustained by science and technology, demanding fewer natural resources. This created locational requirements, such as the presence of educational and research centers and professional labor market (Diniz, 1993). Given the fact that internal migration opportunities can be grasped by a significantly greater number of people because of the less barriers, the lower mobility costs (Natali, 2009), and the increase in demand for more qualified workers, certain national surveys returned to analyzing the relationship between migration and human capital in Brazil.

In these surveys, it can be seen that studies seek to identify the direction of migratory flows of skilled people and the locational attractive characteristics to such migrants, verifying if an interstate brain drain exists in the country.

One such study was undertaken by Rigotti (2006), who investigated the dynamics of migration between Brazilian regions. He divided migrants into two skill levels: those with 15 or more years of schooling and those with up to 4 years of schooling, due to the fact that considerable numbers of people with low levels of schooling still existed. In the former, he noted that 96 percent of migratory flows between 1995 and 2000 originate in metropolitan regions, and that these urban agglomerates are also the favorite destinations of those with most schooling. For the migratory flows of the less skilled, Rigotti (2006) showed that these metropolitan regions and capitals are also highlighted for their attraction and repulsion of such people, although certain hinterland cities (such Campinas) also receive a substantial number of these individuals.

Mata *et al.* (2007) analyzed the characteristics of cities which are attractive to qualified migrants with complete or incomplete higher education. The authors showed that the dynamism of the labor market, a lower level of social inequality and violence, the proximity to the coast and less severe climatic conditions are determinants of the migration of this workforce.

The authors noted that the dynamism of the labor market, a lower level of social inequality and violence, proximity to the coast and less severe climatic conditions are determinants of the migration of this workforce.

Bezerra and Silveira Neto (2008) studied if there was brain drain within Brazil from the migration of other states to the state of São Paulo. Their results pointed out that the migratory movements into São Paulo were not dominated by qualified people (except those originating from the states of Rio de Janeiro or Rio Grande do Sul), but by workers with little or no schooling. In addition, they emphasized that those states with greatest migration to São Paulo did not record losses in productivity as a result of the migration of the skilled.

Taking all of that into consideration, this study sets out to evaluate the impact of the migration of people with different levels of qualification on human capital in their home states. Since internal migration in Brazil involves people with lower educational levels (about 85 percent of migrants have a maximum of 11 years of schooling), this research considers the impact of the mobility of people with different skill levels on human capital: high skilled (more than 11 years of schooling), middle skilled (between 4 and 11 years) and low skilled (less than 4 years).

As pointed out by Ha *et al.* (2016), there are certain benefits from analyzing the effects of migration on human capital in a national context. First, the availability of state data obtained from the same source may avoid statistical inconsistencies that prevail in many cross-country regressions. Second, Brazil, the fifth largest country in the world, has 26 states and the Federal District, with an average population per state of over 7m, making the internal migration a mirror of international migration in many countries. Third, the Brazilian data allowed us to compare the effects of the migration of people with different educational levels on the formation of human capital. Finally, the use of a panel data model allows for the removal of cross-state heterogeneities.

As highlighted by Beine *et al.* (2001, 2008, 2011), the incentive to expand the human capital of those intending to move to another country comes from the fact that they expect to have greater returns in the future on moving abroad as a result of the qualification acquired. However, this decision is made in a context of uncertainty, as migration does not always occur. This study analyzes if such incentive effects really exist in the context of interstate migration in Brazil, or if there is a discouragement effect on obtaining human capital, as a result of the migration of people with lower levels of qualification. This possibility was highlighted by Haas (2007), who warned that there could be negative incentives for an increase in education in systems where the migration of low-skilled workers predominates.

2. Theoretical reference

The theoretical model used in this paper, proposed by Beine *et al.* (2011), presents certain presuppositions. First, each country is populated by heterogeneous individuals living in two periods. In the first, young people work and may invest in human capital at the same time, while in the second, adults dedicate all their time to work. Another hypothesis is that the proportion of skilled workers affects the wage rate in the different localities.

Beine *et al.* (2011) assumed a linear production function with labor in efficiency units as the only input. High-skilled and low-skilled workers are perfect substitutes, but low-skilled workers supply one efficient unit of labor, while high-skilled workers offer $\sigma > 1$ of these units. In each period, the gross domestic product is given by the following:

$$Y_t = w_t L_t, \tag{1}$$

where L_t is the total labor force (in efficiency units) and w_t is the wage rate, since w_t is an increasing function of the proportion of high-skilled adults (H_t) remaining in the country (with $w' = (\partial w_t/\partial H_t) > 0$ and $w'' \neq 0$ to allow for locally increasing returns).

The expected utility of each worker depends on the first-period income and the expected second-period income ($y_{1,t}$ and $y_{2,t+1}$):

$$E[u_t] = \ln(y_{1,t} - \mu) + E[\ln(y_{2,t+1})], \tag{2}$$

where μ is the subsistence level, which is null in the second period.

Young individuals offer a unit of human capital and earn the low-skilled wage w_t. They can accumulate human capital by investing part of their income. The authors assume that people are heterogeneous in their ability to learn and incur heterogeneous education costs (h), expressed as a proportion of the wage rate. For a type-h agent, the cost is $\alpha h w_t$, where α is a parameter capturing technology training and fiscal policy (the higher the subsidy to education, the lower the α). The variable h is distributed on [0, 1]. In adulthood, people dedicate all their time to the labor market. Low-skilled people receive w_t, while high-skilled adults receive σw_t.

In an economy where the possibility of migration exists (subscript m), young people anticipate it (m_{t+1}) if they opt for education. Beine *et al.* (2011) assumed that low-skilled adults have no access to migration. In a probabilistic migration framework, in which $h_{m,t}$ is the proportion of young people who opted for *ex ante* education, the *ex post* proportion of high-skilled adults remaining is as follows:

$$H_{m,t+1} = \frac{(1 - m_{t+1})h_{m,t}}{1 - m_{t+1}h_{m,t}}. \tag{3}$$

Beine *et al.* (2011) considered that the prospect of migration affects the returns expected from schooling and induces an increase in education. They also considered w^* the net-of-migration-costs wage rate in the potential host countries and assumed a constant skill premium across countries.

In high-income countries, where the domestic wage rate is higher or equal to w^*, migration prospects do not affect educational choices. In low-income countries, people who invest in education contemplate the prospect of emigration, making decisions under conditions of uncertainty. *Ex ante*, the expectation of m_{t+1} increases the proportion of young people investing in education, creating the possibility of a net gain for the source countries. If $w^* > w_{m,t+1}$, education is optimal when it maximizes expected utility:

$$\begin{aligned} &\ln(w_{m,t} - \alpha h w_{m,t} - \mu) + m_{t+1}\ln(w^*\sigma) + (1 - m_{t+1})\ln(w_{m,t+1}\sigma) \\ &\quad > \ln(w_{m,t} - \mu) + \ln(w_{m,t+1}). \end{aligned} \tag{4}$$

The *ex ante* proportion of young people educated is given by the following equation:

$$h_{m,t} \equiv \frac{w_{m,t} - \mu}{\alpha w_{m,t}} \frac{\sigma(w^*/w_{m,t+1})^{m_{t+1}} - 1}{\sigma(w^*/w_{m,t+1})^{m_{t+1}}}. \tag{5}$$

If $(w^*/w_{m,t+1})^{m_{t+1}} > 1$, the critical level of qualification increases with m_{t+1} and more people invest in education.

When $w^* > w_{m,t+1}$, the migration incentive mechanism is given by the following equation:

$$\frac{\partial h_{m,t}}{\partial m_{t+1}} = \frac{w_{m,t} - \mu}{\alpha w_{m,t}} \frac{\ln(w^*/w_{m,t+1})}{\sigma(w^*/w_{m,t+1})^{m_{t+1}}} > 0. \tag{6}$$

Beine *et al.* (2011) stressed that there is a close link between the size of the incentive effect and the level of development at origin. In less developed countries, liquidity constraints limit people's response to incentives because the wage rate is close to subsistence level. However, the lower the level of development, the stronger the expected migration premium and the impact of migration prospects on the expected return to schooling.

Although qualified people form expectations about the possibility of migration, the authors warn that this probability must be considered potentially endogenous. Batista *et al.* (2012) observed that two factors could be responsible for this endogeneity. First, there may be unobserved individual characteristics which simultaneously affect migration prospects in the future and the propensity to get a higher level of education. Second, there is a likelihood of reverse causality, in which there is a greater probability that this person could emigrate if they are better educated.

Beine *et al.* (2011) stressed that the difference between this model and those proposed in the literature is the emphasis on the way the level of development at origin affects the magnitude of the *ex ante* incentive mechanism. Thus, the Beine *et al.* (2011) model counters the criticism of Commander *et al.* (2004) that the brain drain models pay no attention to the heterogeneity of the migrants' countries of origin.

One limitation of the model is that it only considers the relation between the migration of skilled individuals and the formation of human capital, and does not evaluate the impact of low-skill emigration on human capital. As there is no other model in the literature addressing this relationship, we adopted it as it considers the heterogeneity of the migrants' origins, a crucial factor in the analysis of mobility in Brazil.

3. Methodology

Regarding to the relationship between migration and human capital, a variable had first to be selected to represent human capital. Economic theory considers that it is determined by variables such as schooling, experience and ability. However, Lucas (1988) emphasized that schooling is one of the main factors that determine the individual's productivity and human capital. Therefore, schooling (defined by the number of years of study) is used here as a measure of human capital as widely used in the literature (Beine *et al.*, 2001, 2008, 2011; Ritsilä and Haapanen, 2003; Mackenzie and Rapoport, 2006; Batista *et al.*, 2012).

Papers analyzing the impact of migration on human capital, such as those of Beine *et al.* (2001, 2008, 2011), Di Maria and Lazarova (2012) and Batista *et al.* (2012), generally consider one level of education only to represent human capital. In this study, the effects of migration are evaluated on three educational levels, namely, fifth grade elementary school, first year high school and first year in higher education. These levels represent the first year of the final three educational levels in the Brazilian Education System with an elementary school regime of eight years[1].

The option to divide human capital into levels is justified by certain factors. First, education is the result of a series of discrete choices, in which people decide to go on to the next grade or leave school Glick and Sahn (2000). De Leon and Menezes Filho (2002) showed that a similar percentage of Brazilian students leave the middle grades of a same school cycle (first stage of elementary education, second stage of elementary education, secondary education and tertiary education), and that there is a more pronounced decline in school dropout when students complete the last year of each cycle. Gonçalves (2008) also showed that there is a greater dropout in studies at fifth grade, the stage at which students begin the second stage of primary education.

Since the rate of school dropout is higher on completing a certain cycle, students need to be motivated to complete their studies and start a new school cycle. The migration and professional success of a high-skill person can have a positive effect on an individual decision to continue in education, especially to start a new school cycle.

Therefore, the models are estimated according to the following equation:

$$\ln\left(\frac{h^{s}_{i,t}}{h^{s}_{i,t-1}}\right) = \alpha_{1p}\sum_{p=1}^{T-1} mhq_{i,t-p} + \alpha_{2p}\sum_{p=1}^{T-1} mmq_{i,t-p} + \alpha_{3p}\sum_{p=1}^{T-1} mlq_{i,t-p} + \beta \ln\left(\frac{h^{s}_{i,t-1}}{h^{s}_{i,t-2}}\right) + \eta_i + \varepsilon_{i,t}, \quad (7)$$

where $\ln(h^{s}_{i,t}/h^{s}_{i,t-1})$ denotes the growth rate of the proportion of individuals who attend grade s between the periods t and $t-1$, with $t = 2001, \ldots, 2013$; s is the first grade of each cycle (fifth grade elementary school, first year high school and first year in higher education); η_i are the specific fixed effects of each state, which capture the influence on the long-term level of attendance at that grade and that are constant over time; $mhq_{i,t-p}$ represents the migration rate of high-skilled workers of state i, lagged in up to p periods, with $p = 1, \ldots, T-1$; $mmq_{i,t-p}$ represents the migration rate of middle-skilled workers of state i in period $t-p$; $mlq_{i,t-p}$ represents the migration rate of low-skilled workers of state i in period $t-p$; β is the parameter that measures the influence of the attendance level in the respective grade in the previous year; and $\varepsilon_{i,t}$ is the error term of the equation.

The variable $h^{s}_{i,t}$ represents the ratio between individuals from the state i who are attending school grade s in period t and individuals of the same state able to attend the same school grade in $t+1$. To select these individuals, those with any characteristic which could render them ineligible to attend this grade are excluded from the sample, as shown in Table I.

As in Beine *et al.* (2011), the migration rate of high-skilled workers ($mhq_{i,\,t-p}$) is defined as the ratio of the stock of high-skilled emigrants to the whole stock of high-skilled people born in the state (the sum of residents and emigrants). A similar analysis can be done to define the variables $mmq_{i,t-p}$ and $mlq_{i,t-p}$, which represent the relationship between the middle- and low-skill emigrant stocks of the state and the total number of people with the same educational levels born in this state.

Beine *et al.* (2007) pointed out that a failure to control the factors which influence the human capital accumulation process leads to omitted-variable biases, since such factors can be correlated with the initial level of human capital. To solve this problem, they assumed that these factors are constant over time[2]. Thus, a panel data analysis can take that into account through the introduction of country-specific effects, capturing part of the

S	Characteristics
5th grade elementary school	Under 11 years old
	Not attending school, but have completed 5th grade
	Attending school, and are in 6th grade or higher
	More than 11 years old, whose last grade attended was lower than 4th
1st year high school	Under 15 years old
	Not attending school, but have completed 1st year high school
	Attending school, and are in 2nd year high school or higher
	More than 15 years old, whose last grade attended was inferior to 8th grade elementary school
1st year in higher education	Under 18 years old
	Not attending university, but have completed 1st year in higher education
	Attending university, and are in 2nd year in higher education or a year higher than 2nd
	Over 18 years old, whose last grade attended was lower than 3rd year high school

Source: Drawn up by the author

Table I.
Individuals ineligible to attend grade *s*

unobserved heterogeneity. Other studies also use panel analysis to circumvent this (Boucher *et al.*, 2009; Beine *et al.*, 2011; Ha *et al.*, 2016).

Existing data do not allow us to distinguish the state where the individuals were educated. Those who migrated in childhood and qualified at destination are treated in the same way as those who moved when they had already qualified. The migrants of high, middle or low skills are those with the educational levels defined in Section 3.1, who were born in state i, but moved to state j. Hence, our definition of the brain drain is partly determined by data availability Docquier and Marfouk (2006).

According to Beine *et al.* (2011), the estimation of Equation (7) must be made taking two issues into consideration. The first is related to the dynamic structure of the equation, because the empirical analysis of human capital accumulation should allow long-term disparities in this variable between regions. The second relates to the possible endogeneity of $mhq_{i,t-p}$, $mmq_{i,t-p}$ and $mhq_{i,t-p}$. The tests of Durbin (1954), Wu (1974) and Hausman (1978)[3] were undertaken to check whether the variables are actually endogenous.

The present study uses the dynamic panel method proposed by Arellano and Bond (1991), which can handle both issues by estimating the results. This method eliminates the fixed effects when differentiating Equation (7):

$$\Delta \ln\left(\frac{h^{s}_{i,t}}{h^{s}_{i,t-1}}\right) = \alpha_{1p}\sum_{p=1}^{T-1}\Delta mhq_{i,t-p} + \alpha_{2p}\sum_{p=1}^{T-1}\Delta mmq_{i,t-p} + \alpha_{3p}\sum_{p=1}^{T-1}\Delta mlq_{i,t-p} + \beta\Delta \ln\left(\frac{h^{s}_{i,t-1}}{h^{s}_{i,t-2}}\right) + \Delta\varepsilon_{i,t} \quad (8)$$

Differentiating Equation (7) eliminates the fixed effect, but does not prevent the correlation between $\Delta \ln(h^{s}_{i,t-1}/h^{s}_{i,t-2})$ and $\Delta\varepsilon_{i,t}$. Then, it is necessary to use instrumental variables for the differentiated dependent variable, and Arellano and Bond (1991) suggested that values of $\ln(h^{s}_{i,t-1}/h^{s}_{i,t-2})$ lagged in two periods or more are effective instruments for Equation (8).

The Arellano and Bond (1991) estimator was subsequently enhanced by Arellano and Bover (1995) and Blundell and Bond (1998), when they identified that the variables lagged in level are weak instruments when the present values of the dependent and independent variables are strongly correlated with their past values. To solve this problem, the authors proposed the use of lagged values of the predetermined variables as the instruments for the equations in first differences and instruments in level for the equations in first differences. This estimator became known as the system GMM. Blundell and Bond (1998) stated that the use of restrictions of the additional moments provides gains in precision for the system GMM coefficients, and this estimator performs better when the autoregressive parameter is moderately high and the number of temporal series is small. This study also uses the technique of correction of the estimated variance for finite samples, proposed by Windmeijer (2005), to correct the possible bias of the GMM system when applied to samples with few cross-section units.

3.1 Data and variables

The empirical analysis of this study is based on data from the National Household Sample Survey (PNAD) of the Brazilian Institute of Geography and Statistics, for the 2001–2013[4] period, totaling 12 time series. According to Silva *et al.* (2002), certain aspects of the PNAD sampling design define it as a "complex sampling plan." These include the stratification of the sampling units, conglomeration[5] and sample weight adjustments for calibration with known population totals and unequal probabilities of selection in one or more stages. Thus, these data cannot be presumed to have originated from simple random samplings with

replacement, because the descriptive measures of the population are influenced by the weights of the observations. Therefore, the sample weights of PNAD are considered in the calculation of population totals used in the construction of the aggregated data of the estimated model.

The empirical model estimated in this study contains a sample composed of 324 observations constituted by the 27 states and 12 temporal series of the PNADs (2001–2013). A description of the variables used in this model is presented in Table II.

4. Results and discussion

This section presents an analysis of the impact of interstate migration of individuals with different qualification levels on human capital formation, whose results are based on the estimation of Equation (7). More specifically, the relationship between the migration of these individuals and the growth rate of school attendance in fifth grade elementary school, first year high school and first year in higher education are estimated. Migration variables are considered strictly exogenous because they are already included in the empirical model with at least one lag, and the endogeneity tests of Durbin and Wu and Hausman did not reject the null hypothesis of exogeneity.

Despite the Durbin and Wu and Hausman tests, Equation (7) still has an endogenous component because of the use of the lagged dependent variable as explanatory variable. Therefore, Arellano and Bover (1995) proposed the use of instruments in level for equations in first differences and instruments in first differences for equations in levels. Thus, in all the models the instrument used for the equation in level is the first difference lagged in the growth rate of school attendance (ΔGr_attend$_{t-1}$), and the instruments of the equation in difference are the second, third and fourth lags of the dependent variable (Gr_attend$_{t-2}$, Gr_attend$_{t-3}$ and Gr_attend$_{t-4}$).

In using the instruments, however, the Sargan (1958) test must be applied to verify their validity. Table III shows that the null hypothesis of the Sargan test was not rejected in any equation, which indicates that the conditions of the moments are correct. Table III also presents the results of the Arellano and Bond (1991) autocorrelation test, which rejected the null hypothesis of absence of autocorrelation of first-order errors and did not reject this hypothesis for second-order errors, which indicates that there is no serial correlation in the models.

The results show that equations estimated for the growth rate of school attendance in fifth grade and first year elementary school were similar. However, the equation estimated for the growth rate of the attendance at first year in higher education presented a different functional form. This occurred because when estimating the model with only one lag for the

Variable	Description
Growth rate of the proportion of people who attend grade *s*	Natural logarithm of the difference between the ratio of the number of people attending grade *s* in year *t* and the number of people able to attend the same grade in *t*+1
High-skilled migration rate	Natural logarithm of the number of migrants of state *i* with more than 11 years of schooling and the total number of people born in *i* with the same level of education
Middle-skilled migration rate	Natural logarithm of the number of migrants of state i with between 4 and 11 years of schooling and the total number of people born in *i* with the same level of education
Low-skilled migration rate	Natural logarithm of the number of migrants of state i with less than 4 years of schooling and the total number of people born in *i* with the same level of education

Source: PNAD (2001–2013)

Table II.
Description of the variables used in the analysis model of the impact of migration on human capital

Variables	5th grade elementary school	1st year high school	1st year in higher education
Intercept	3.245733*** (1.173122)	3.829274** (1.925089)	−1.212013* (0.686414)
Gr_attend($t-1$)	−0.416829*** (0.017090)	−0.514578*** (0.033619)	−0.6765536*** (0.140785)
Gr_attend($t-2$)			−0.6034779*** (0.148154)
Gr_attend($t-3$)			−0.2182734** (−0.218273)
Ln_mhq($t-1$)	1.355366*** (0.401664)	1.383037*** (0.484975)	−0.207072ns (0.249081)
Ln_mhq($t-2$)	0.984274*** (0.311133)	0.716438* (0.399964)	
Ln_mmq($t-1$)	0.339277ns (0.360747)	0.611464ns (0.606539)	−0.074216ns (0.261534)
Ln_mlq($t-1$)	−0.5262778ns (0.349394)	−0.247126ns (0.6476091)	−0.007257ns (0.174277)
Ln_mlq($t-2$)			−0.500473* (0.259886)
Wald p-value	615.82	553.01	69.94
	0.0000	0.0000	0.0000
Arellano_Bond (AR1)	−4.0025	−3.9930	−2.3530
p-value	0.0001	0.0001	0.0186
Arellano_Bond (AR2)	−0.8627	0.1224	0.2067
p-value	0.3883	0.9026	0.8362
Sargan p-value	23.9170	24.3855	12.2992
	0.4084	0.3827	0.5823

Notes: Values in parentheses refer to standard errors. [a]In 2010, there was no PNAD because it was the year of the National Demographic Census. *,**,***Significant at the 10, 5 and 1 percent levels, respectively
Source: Survey results

Table III.
Impact of interstate migration of individuals with different levels of qualification on the growth rate of attendance in 5th grade elementary school, 1st year high school and 1st year in higher education (2001–2013)[a]

dependent variable, the Arellano and Bond test pointed to the existence of autocorrelation, which was corrected by increasing the number of lags and estimating Equation (7) using this functional form.

In all the equations, the results presented in Table III also indicate that the dependent variable lags were statistically significant, which indicates that there is a temporal dependence of the school attendance rate in all the levels investigated. This corroborates the use of a dynamic model.

In literature, only Beine *et al.* (2011) considered the lagged dependent variable. The estimate of this parameter was −0.074, a value statistically significant at 1 percent, which they attributed to a convergence process of the level of education between the countries.

Considering the high-skilled migration rate, it was seen that it has a positive and significant impact on the growth of school attendance at fifth grade elementary school and first year high school, but it did not significantly affect the attendance at first year in higher education.

Such results provide evidence that the hypothesis of brain gain is valid in these contexts, that is, high-skilled migration works as an incentive for over 17 years old to invest in human capital by returning to school or continuing their studies in fifth grade and first year high school. The professional success achieved by skilled migrants incentives the people that remained in the state of origin to invest in education to achieve a similar success in the future.

Despite the incentive effect, it is important to emphasize that the individuals with lower levels of education not only need to return to their studies but to complete them. That is, unless persons complete lower education levels, they will not generally be able to attend higher education.

According to the brain drain theory, the migration of skilled individuals works as an incentive to the expansion of education only when such flows originate in developing areas and move toward developed areas. Thus, an analysis of data from the 2013 PNAD shows that 44.5 percent of high-skilled migrants from the North and Northeast of the country reside in São Paulo, Rio de Janeiro and Federal District, all states noted for their high levels of family income. Therefore, the professional success achieved by these individuals encourages those who remained on in the states of origin of these migrants to continue studying.

However, migrants from the South and Southeast regions also move to other states with high incomes, often within the region itself, and can also encourage other inhabitants to expand their levels of human capital.

When such evidence was confronted with the international literature, it was seen that Beine *et al.* (2001) and Di Maria and Lazarova (2012) obtained positive and significant coefficients for the high-skilled migration rate, whose levels vary from 0.05 to 0.08, using others methods. Beine *et al.* (2011) divided skilled migrants on the basis of income in their place of origin and noted that only the migration of high-skilled workers from countries with lower levels of income impacts investment in human capital, with a coefficient of 0.11. Batista *et al.* (2012) also obtained significant estimates which vary from 0.39 to 1.12 when they analyzed the impact of the likelihood of future migration itself on the probability of completing high school.

The results estimated here indicate that high-skilled migration encourages those who did not migrate to expand their levels of human capital, raising the growth rate of school attendance in fifth grade and first year elementary school. In addition, as migratory flows within the national territory are higher because of an absence of barriers to internal mobility, the incentive to expand education in view of the possibility of migrating in the future should also be greater.

As regards the coefficient of this variable in the model of growth rate in relation to the growth rate in attendance in first year in higher education, the results presented in Table III shows that it was not significant. In this case, the brain gain theory is not confirmed for interstate migration in Brazil. One possible explanation for this result is that as individuals with higher levels of education tend to be concentrated in states of higher income, these individuals have no incentive to migrate to another location and earn a similar or slightly higher income[6].

Beine *et al.* (2011) carried out a similar analysis that could justify such results. They divided the sample of migrants based in the country of origin into high-skilled migrants from rich countries and from developing countries, according to the classification of the World Bank[7]. They showed that the rate of migration of skilled workers from rich countries does not impact the proportion of people with 13 or more years of schooling in the country of origin of those migrants because the income of the latter in rich countries is greater than or equal to that of skilled migrants.

When data from the 2013 PNAD were analyzed, it was seen that about 68.7 percent of skilled non-migrant individuals live in the South and Southeast regions. As these are the most developed regions of the country, they also offer a greater number of jobs which allow people to earn higher wages, and can thus reside in the same city or in another in the same state, but which is close to their relatives' place of residence.

In addition, according to the brain gain theory, residents of less developed areas who have not migrated will feel encouraged to study only when the high-skilled migrants moved to more developed areas. However, when analyzing data from the 2013 PNAD, it was also seen that about 90 percent of migrants born in the Northeast and North, regions with lower levels of income, have less than 11 years of schooling. The remaining 10 percent, made up of highly qualified migrants (about 951,240 people), are spread throughout the territory formed by these two regions. Thus, the number of people with high-skill levels that migrated is small in relation to the others and does not lead to incentivizing the expansion of education for those who remained in their place of origin, since the migrant reference that these people have is associated with people of low education levels.

Finally, it is worth noting that, differently from the previously analyzed levels of education, where public access is free and guaranteed by Law 9.394/96, attendance in higher education depends on passing a university entrance examination and involves a series of expenses on things, such as material, housing, food, transportation and monthly

fees (especially if private). Then, although those who aim to migrate in the future may be incentivized to expand their education, the financial constraints of those living in less developed areas (and even in developed areas) may prevent them from attending university. This might explain the lack of significance of the migration rate coefficient of highly qualified people.

As highlighted in the Introduction, interstate migration in the country has historically involved people with low levels of education. Then, the empirical model estimated in this study also considers how middle- or low-skilled migration could affect investment in human capital.

Thus, when the impact of the migration rates of people with such education levels on the rate of growth in attendance at fifth grade and first year high school was identified, it was seen in Table III that these coefficients were not significant. This indicates that over 17 years old are indifferent to increasing their stock of human capital by going on to fifth grade elementary school when they see the economic results achieved by migrants whose maximum education level is a high school diploma.

The difference of income which represents a kind of "premium" for migration could be insufficient to encourage such people to migrate, since migration involves costs. Even if this increase in income is attractive, as highlighted by Beine *et al.* (2011), the existence of liquidity constraints in less developed places may limit people's responses to incentives. In this sense, Ramalho *et al.* (2016) observed that costs related to distances between states and social networks are factors that reduce interstate migration in Brazil. Another factor that restricts the response to the incentive is the increased risk of unemployment faced by individuals with lower qualification levels, a fact observed by Justo and Silveira Neto (2008) and Ramalho *et al.* (2016).

Analyzing the impact of middle-skilled migration on the growth rate of the attendance at first year in higher education, this variable was not statistically significant. For reasons similar to those previously described, this result may indicate that the "premium" for migration is not high enough to stimulate an increase in human capital.

On analyzing low-skilled migration in Table III, it can be seen that this variable negatively impacts the growth rate of attendance at first year in higher education. However, this effect occurs only in the second lag of the variable, which indicates that a period of time is needed for the migration of low-skilled people to discourage human capital acquisition. Such evidence confirms the hypothesis raised by Haas (2007), that in countries characterized by low-skilled migration, as it is the case of Brazil, there may be negative incentives for an increase in education because the economic results achieved by low-skilled migrants could be considered satisfactory by those aiming to migrate in the future, without any need to invest in human capital accumulation.

However, it is important to stress that although the theoretical model used in this research considers that migration is a crucial variable in determining education, Barros *et al.* (2001) considered that low levels of investment in human capital in Brazil are related to the availability and quality of educational services, family environment, attractiveness of the labor market and availability of resources in the family. Such variables could also affect people's responses to the incentive effect given by migration. If access to schools and universities is difficult or if financial constraints require people to join the labor market prematurely in the place where they reside, these variables limit their prospects for improvement resulting from increased qualification undertaken with a view to migrating in the future.

5. Conclusion

Given the results presented in this research, it can be seen that the migration of high-skilled people has encouraged the expansion of school attendance of those eligible to attend fifth grade elementary school and first year high school. This is consistent with the model's presuppositions and it may be explained because people realize that there is a possibility of

gaining considerably higher incomes if they continue studying until they reach the qualification level of those migrants, when they are able to move to the same destination. However, because the premium that these people could receive when they compare their current earnings to those obtained by middle- or low-skilled migrants is small or even negative, this leads to indifference on their part in terms of increasing their level of human capital.

However, the results indicated that the rate of growth in entrance to first year higher education is not influenced by the migration of people with a high qualification level. It may be due to the fact that those people who did not migrate and have a high school diploma are more concentrated in states which already have higher average incomes and, therefore, they do not need to migrate to earn such incomes. In addition, the migration rates of high-skilled people from less developed regions are low and unable to influence the remaining population to expand their education. These rates may motivate people to expand their qualification levels on considering that the increase in income at the destination is attractive. However, if the family income is close to survival levels, financial constraints may limit their response to incentives because the access to higher education involves a series of expenses, even when university education is free.

The results also indicated that the mobility of low-skilled workers is a discouraging factor for the enhancement of the human capital of residents of the source state who have a high school diploma. This is evident from the fact that the incomes earned by people with this level of education and living in less developed regions (such as the North and Northeast) are very close to those earned by low-skilled migrants who moved to the South and Southeast regions. This means that the migration of the latter in the present can substantially increase their income without needing to improve their education levels with a view to moving in the future.

This study has certain limitations, especially with regard to the data used. As the PNAD is a survey which provides a picture of the population at the moment of interview, it is not possible to identify their economic situation before migration or the location in which they acquired their present level of education. In addition, PNAD does not follow up the same individual through time. Hence, aggregate data from this source have to be used. However, it was decided to use it as it is one of the major sources of data on migration, containing additional information about people's social and economic status.

Another limitation concerns the use of an international migration model in a context of internal migration, which was done due to the unavailability of another theoretical model more appropriate to this investigation. However, there is a need to develop a new theoretical model that can be applied both in the context of internal and external migration, presenting the characteristics and limitations of each type of migration, and combining quantitative and qualitative approaches. This model can be developed in a future research.

Notes

1. The delimitation of the sample to over 17 years old excludes those who are attending or have completed primary education in the 9-year regime.
2. Beine *et al.* (2007) explained that this assumption is not very restrictive, since a set of factors which can influence the accumulation of human capital (such as ethnic diversity, urbanization, cost of education and institutional quality) are relatively stable over time. On the other hand, using cross-section analysis, and considering the rate of skilled emigration constant over time, would be a very strong assumption.
3. Endogeneity tests whose null hypothesis is that the variable considered can be treated as exogenous.
4. In 2010, the PNAD survey was not carried out, because it was also the year of the National Demographic Census.

5. Consists of the selection of samples at various stages, with compound sampling units (Silva *et al.*, 2002).
6. The national literature on the determinants of mobility considers income as one of the main factors responsible for the internal migration (Justo and Silveira Neto, 2008; Ramalho *et al.*, 2016).
7. Beine *et al.* (2011) used the 2000 classification of the World Bank, which divided the countries on the basis of income. Countries whose gross domestic product was equal to or higher than $9,666.00 were considered rich, while the others were called developing countries.

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