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ORIGINAL PAPER

Does the spatial density of employment stimulate inter-firm worker mobility? An analysis of Brazilian municipalities

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Abstract
This study aimed to investigate how the spatial density of employment affects inter-firm worker mobility in the Brazilian job market. For this purpose, evidence was produced through random-effect probit models applied to an employer–employee data panel that captures regional differences and characteristics related to workers and companies, constructed through the Annual Inventory of Social Information (Relação Anual de Informações Sociais—RAIS). The results indicated that individuals working in denser regions are more inclined toward inter-firm mobility. In general, employment density more strongly affects inter-firm mobility if the workers are men, are between the ages of 18 and 29 and have a higher level of schooling. In addition, the analysis by sectors indicates that for the Farming, Industry, Commerce, and Services, the employment density coefficient was positive and statistically significant.

JEL Classification J61 · R12 · C33

1 Introduction

A theoretical and empirical regularity established in economic science is that denser regions tend to be more productive (Duranton and Puga 2004; Puga 2010). However, despite the various evidence gathered to verify the reasons for the high degree of concentration of people and economic activities in limited geographical spaces, studies about the sources of the advantages of the productivity resulting from this pattern are still scarce (Rosenthal and Strange 2004; Combes and Gobillon 2014).

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One of the theoretical arguments put forward infers that the concentration of people and companies in certain geographic spaces would reduce the costs of transactions in the job market, favoring a better matching or interaction between the skills of workers who are unemployed or looking for better job opportunities, and employers (Helsley and Strange 1990; Sato 2001; Wheeler 2008). Additionally, urban job markets—blessed with skilled labor—would be able to generate human capital externalities that would not exist in less densely populated regions (Rauch 1993; Glaeser and Maré 2001; Moretti 2004). Thus, inter-firm labor mobility can be considered a channel for the productivity advantages arising from the spatial density of employment.

For Marshall (1920), the main factors influencing the geographical distribution of economic activities in an area are: (1) the formation of a constant grouping of skilled workers and the production of new ideas; (2) the physical conditions of the region (e.g., the type of climate and soil), and the availability and the ease of access to inputs needed for production and to consumer markets; and (3) the presence of spillovers of knowledge.

Of these three micro-foundations of the agglomeration economies reported by Marshall (1920), the relationship between work mobility and density can be associated with two, which are summarized by Duranton and Puga (2004) as follows: learning or spillover of knowledge, due to being a mechanism of diffusion and production of new ideas, which is stimulated by the greater ease afforded by the geographical proximity to the exchange of technical and organizational information between workers—also known as face-to-face interactions; and matching, given that this facilitates the process of efficient harmonization between workers and employers by offering a constant market for specialized labor, which can also contribute to mitigating the conflicts between them (Andersson and Thulin 2013).

Thus, these arguments suggest that the inter-firm switching of workers—typically performed more frequently in denser regions—can be considered to be a mechanism through which the effects of learning and matching can materialize, thereby boosting the productivity arising from the savings or gains afforded by the agglomeration of economic activities.

Although inter-firm mobility is an important factor in stimulating the relationship between density and productivity, there are still few studies that explore this relationship (Combes and Gobillon 2014). Among the studies that address the relationship between inter-firm mobility and agglomeration economies, the following stand out: Almeida and Kogut (1999), Finney and Kohlhase (2008), Wheeler (2008), Freedman (2008), Bleakley and Lin (2012), and Andersson and Thulin (2013).

In Brazil, most of the works regarding mobility have as a main focus the individual and regional determinants of the geographical migration and spatial mobility of workers; see, for example, Lameira et al. (2012, 2015), Freguglia et al. (2014), Tavares and Almeida (2014), Gonçalves et al. (2015), and Almeida et al. (2016). The exception is Mendes et al. (2012), who specifically addressed the determinants of inter-firm worker mobility.

Given this context, the objective of this study is to analyze how the spatial density of employment in the Brazilian job market affects inter-firm worker mobility. The study of the possible determinants of inter-firm mobility is relevant for Brazil, since the results can guide economic policies aimed at reducing spatial inequalities,

especially in the labor market, as well as guiding more effective economic growth strategies. In addition, research on labor mobility among firms has been the subject of some empirical studies, mainly applied to the regions of the USA and Europe. However, especially in the context of a developing country such as Brazil, the empirical studies on inter-firm mobility are still scarce.

To do so, an employer–employee data panel—that captures regional differences and characteristics related to workers and companies—was considered for the period from 2003 to 2013. It was constructed based on data from the Annual Inventory of Social Information (RAIS). The empirical analysis was performed using the random-effects probit models estimated on a balanced panel data, which the dependent variable is binary, assuming value 0 for workers who remained in the same employment relationship and 0 for those who changed.

The results found were consistent with the findings in the literature for other countries and indicated that individuals working in denser regions are more inclined toward inter-firm mobility. In general, employment density affects inter-firm mobility more intensely if the workers are in the 18-to-29-year-old age-group and are more qualified.

To achieve these objectives, in addition to this introduction, the research is organized as follows. Section 2 contains a review of the related literature. Section 3 describes the empirical strategy, the database, and the construction of variables. In Sect. 4, the empirical results are discussed. Section 5 presents the conclusions.

2 Literature review

The investigation of the possible determinants of inter-firm mobility has become the object of analysis in empirical studies, due to an increase in the number of longitudinal databases available at the individual level, essential for the measurement of this type of mobility. The mobility of workers between companies can be derived from many factors, such as the closure of the plant, termination or a better match between worker skills, and a job with another employer. However, the rate of change of jobs between firms may differ between regions, since dense regions can offer several mobility advantages such as greater access to potential employers, and vice versa, and information facilities on potential jobs and employers. In this context, the relationship between density and job change between companies has been the object of some empirical studies, especially for regions of the USA and Europe.

For example, Almeida and Kogut (1999) investigate the inter-firm mobility of engineers as the source of technological knowledge flows, analyzing the degree of localization of knowledge in the US semiconductor industry. Their results indicate that mobility among firms is an important determinant of the degree of location, intensity, and transfer of knowledge among workers, thus providing positive externalities.

Finney and Kohlhase (2008) empirically examine labor market matching as a source of agglomeration economies in the US urban areas by estimating the relationship between urbanization and the occupational mobility of young men by controlling individual characteristics such as ethnicity and status estimating the probability

of job rotation. Using a panel from the National Longitudinal Survey of Youth, their findings suggest that young men switch jobs more often early in their careers if they live in larger or more educated urban areas.

Freedman (2008) studies the effect of industrial clustering (economies of expertise) in the US software publishing industry on worker mobility. Using longitudinal matched employer–employee dataset, their results demonstrate that industrial clustering facilitates the mobility of workers within the industry by accepting lower wages early in their careers in exchange for higher wages later. The author points out that these results are consistent with theoretical models that suggest that agglomeration improves labor market coordination and facilitates greater learning and human capital formation.

Wheeler (2008) analyzes the hypothesis that workers tend to experiment with different types of employment before choosing what they like best and that this process can present substantial differences depending on the size of the local markets within which the individual resides. To do so, it assesses the effect of the local population, density, and diversity in the mobility between industries, depending on the number of previous labor movements. Using a sample of young male workers from 350 counties and metropolitan areas in the USA over the years 1978–1994, their results suggest that the likelihood of a worker changing industry increases with the size and diversity of the local labor market on his first job change. However, this association gradually decreases as the individual makes more employment changes.

In the same line of research, Bleakley and Lin (2012) analyze the effect of employment density on changes in occupation and industry using the US data, using local historical density at the state level as instrumental variables for current local density. Their results indicate that the rate of change of occupation and industry is lower in the denser markets, a result that is reversed for younger workers.

Andersson and Thulin (2013) use a corresponding employer–employee dataset to estimate the influence of the spatial density of employment on the probability of change in employment for private sector workers in Sweden. The results indicate that the density of employment increases the likelihood of a random worker changing jobs. This result is robust for the inclusion of several control variables and is valid for workers of different ages and levels of schooling.

However, it is possible that there is a temporal dynamic[1] of the mobility because a worker who has changed jobs in a given period may be more or less likely to make a new change. Nevertheless, applications of this model in analyses of inter-firm mobility are still scarce. An example found in the literature is the work of Buchinsky et al. (2010), which investigates the effects of inter-firm mobility, wages, and returns on employment duration and on experience in the USA.

In Brazil, as stated previously, most of the works regarding mobility have as a main focus the individual and regional determinants of the geographical migration and spatial mobility of workers: Lameira et al. (2012, 2015), Freguglia et al. (2014),

[1] In Table 12, in Appendix 2, we present a brief application of the dynamic models of Heckman (1981) and Stewart (2006a, b) to study the relationship between inter-firm mobility and employment density in the Brazilian context.

Tavares and Almeida (2014), Gonçalves et al. (2015), and Almeida et al. (2016). The exception is Mendes et al. (2012), who specifically addressed the determinants of inter-firm worker mobility, analyzing the main factors that determine the mobility of workers in the Brazilian manufacturing industry, with emphasis on the possibility of diffusion of knowledge inter-firms. Their results demonstrate that a higher expectation of wage return, as well as the experience of the worker in the previous link, positively stimulates the propensity to inter-firm mobility. The relationship between stability in the new job and the probability of mobility is negative. In addition, the propensity for mobility varies positively with the educational level, the fact of the individual and the size of the company, and negatively with the age of the worker.

Thus, there is still room to contribute to this literature, especially in the context of a developing country such as Brazil, where empirical studies on inter-firm mobility are still scarce.

3 Empirical strategy, database, and construction of the variables

The influence of the spatial density of employment on the probability of an individual changing employer in Brazilian municipalities will be investigated by considering an employer–employee data panel that captures the regional differences and characteristics related to the individuals and their employment relationship. Thus, based on Finney and Kohlhase (2008) and Andersson and Thulin (2013), the methodology initially assumes the following specification for binary response panel data models:

$$\Pr\left(y_{it}^{*}=1|X_{i,t}\right)=\Phi\left(\alpha+r'\beta+z_{i,t}'\mu+w_{i,t}'\theta+\varepsilon_{i,t}\right)\quad i=1,\ldots,N;\ t=1,\ldots,T \tag{1}$$

in which y_{it}^{*} is a binary-dependent variable that assumes a value equal to 1 if individual i changed employer between years t and $t+1$; $X_{i,t}$ is a vector of exogenous explanatory variables, of which r' is a vector of regional variables; $z_{i,t}'$ is a vector of characteristics of the individual i; and $w_{i,t}'$ is a vector of characteristics of the employer in period t. Additionally, $\varepsilon_{i,t}$ is an a priori random error term without time autocorrelation.

We also conduct separate estimations of the model described by Eq. (1), subdividing the sample for all the individuals for groups of workers with different ages, education levels, and sectors.[2]

The data used in the empirical model come from the Annual Inventory of Social Information (RAIS), which enables monitoring the occupational trajectory of workers through the Registry of Physical Individuals (Cadastro de Pessoas

[2] An issue often discussed in model estimates involving spatial units such as regions or municipalities is the possible existence of spatial dependence that may lead to spatial autocorrelation issues. However, in the present study, the observation unit of our database is individuals randomly chosen (inter-firm worker mobility) and not spatial units. Thus, in a conventional data panel model in which the cross-sectional units (individuals) are independent of each other, the presence of spatial dependence is unlikely.

Table 1 Brazil: Distribution of the employment records (2003–2013). *Source*: Own preparation based on RAIS data

Year	Terminated	Active on 12/31	Total
2003	12,424,235	29,544,927	41,969,162
2004	13,276,334	31,407,576	44,683,910
2005	14,418,482	33,238,617	47,657,099
2006	15,545,778	35,155,249	50,701,027
2007	17,041,703	37,607,430	54,649,133
2008	20,264,853	39,441,566	59,706,419
2009	19,919,350	41,207,546	61,126,896
2010	22,678,947	44,068,355	66,747,302
2011	24,660,494	46,310,631	70,971,125
2012	25,867,773	47,458,712	73,326,485
2013	26,452,077	48,948,433	75,400,510

Físicas—CPF), at the municipal[3] level. From the RAIS, it was possible to construct a data panel that captures characteristics of individuals, regional aspects, and employment relationships. The analysis covers the period from 2003 to 2013. The year 2013 was chosen as the final year because it has the latest information—from the RAIS—available at the time this present study was being conducted. The year 2003 is the first year available in the database that contains all the variables necessary for the econometric estimation of the model. The total number of records in the database varies between 41,969,162 in 2003 and 75,400,510 in 2013, considering the active and terminated jobs on December 31 of each year, as per Table 1.

From this set of original data, some filters were executed. First, the sample was restricted to private sector workers, excluding public and mixed enterprises. Additionally, only individuals aged between 18 and 64 years and those with only one employment relationship were kept in the sample. In relation to the active workers, the criterion of maintaining only one employment relationship in the year took into account the criterion of higher salary and length of employment, assuming that this job is the main source of income of the worker. Workers whose reason for termination was recorded as a result of retirement, death, termination of contract (temporary contract), and transfer were disregarded. Furthermore, relationships arising from temporary or fixed-term contracts, in addition to those registered as apprenticeships, were excluded. To eliminate discrepant observations or outliers, only workers whose real salary in the month of December did not exceed R$ 50,000.00 were kept. In addition to the controls mentioned, the following records were also eliminated: those with declaration errors or omission of data; those identified as having repeated observations for the same worker, missing information, or with an identification code ignored; and those with changes in the value of the variable representative of the worker's gender throughout the data panel.

[3] The municipality is the smallest political-administrative unit existing in Brazil, being the whole national territory divided into municipalities.

Table 2 Brazil: Distribution of the employment records by subperiod after execution of the filters and the calculation of the dependent variable (2003–2013). *Source*: Own preparation based on RAIS data

Subperiods	Employment records
2003–2004	10,471,240
2004–2005	10,972,820
2005–2006	11,259,260
2006–2007	11,055,840
2007–2008	11,848,480
2008–2009	12,263,600
2009–2010	12,147,000
2010–2011	12,399,600
2011–2012	12,428,840
2012–2013	12,403,160

Regarding the measurement of the variables, the dependent variable 'inter-firm mobility' is defined as the change in company of an individual between two consecutive years, the calculation of which took into account ten subperiods: 2003–2004, 2004–2005, 2005–2006, 2006–2007, 2007–2008, 2008–2009, 2009–2010, 2010–2011, 2011–2012, and 2012–2013. The dependent variable was then constructed for each subperiod, assuming a value equal to 1 if the individual i changed employer between years t and $t + 1$ and a value of 0 otherwise. After the calculation of the dependent variable, the information related to the explanatory variables corresponding to the initial year was kept in each subperiod. Table 2 presents the number of observations available in each subperiod after execution of the filters and the calculation of the dependent variable.

For the construction of a balanced data panel, only those individuals whose information was available for all the subperiods of the sample (i.e., 11,937,600 individuals) were maintained. Due to the high number of individual observations and also due to seeking the operationalization of the econometric model, a random sample of 5% was selected. Thus, the final database totaled 596,880 observations, which allowed the behavior of 59,688 individuals to be monitored over ten subperiods. As mentioned previously, the explanatory variables are defined in the initial year of each subperiod, and they highlight information related to the workers and their occupation, attributes of the employer or the companies, and regional characteristics.

Among the explanatory variables, those that measure the regional characteristics are of greatest interest in this article, especially regarding the employment density, which is used as a proxy for agglomeration economies. In the present study, we used the logarithm of the ratio between the total number of workers and the urban area (in km^2) to obtain the variable employment density. The data related to the municipal urban area result from measurements and estimates of urban areas in Brazil, published by the Embrapa Satellite Monitoring of the Ministry of Agriculture, Livestock, and Supply (Ministério da Agricultura, Pecuária e Abastecimento—MAPA).

The methodology used by Embrapa to estimate the urbanized area involved an evaluation of census data of the urban population in Brazil, satellite images, statistical procedures, and geoprocessing (Miranda et al. 2005). The variable 'employment density' is related to the size of the cities and their capacity to generate positive externalities resulting, for example, from a greater availability of services and

employment.[4] Furthermore, as emphasized by Jacobs (1969), the specific characteristics of a diverse urban center favor the exchange of information and experiences, thus boosting innovation and economic growth. Thus, it is expected that the employment density will have a positive influence on the probability of inter-firm changes in employment, that is, individuals are more likely to move to more urbanized regions. The five macro-regions of Brazil—North (category omitted), Northeast, South, Southeast, and Center-west—were used as geographical units for the construction of control dummy variables for regions.[5]

For the characteristics of the workers and their occupations, the following control variables were included: age (in years), gender, length of employment, and education level. In general, it is expected that younger individuals, in addition to men, are more likely to be mobile (Johansson et al. 2002; Faggian et al. 2007). The variable 'length of employment' represents a proxy for the experience of the worker and refers to the length of employment, in months, in the same employment relationship. The longer the employment, the lower the probability of mobility (Farber 1994). A set of binary variables subdivided into three categories is used as control for the length of employment: from 0 to 11.9 months (category omitted), from 12.0 to 59.9 months, and 60.0 months or more.

With respect to education levels, the literature indicates that more educated individuals tend to be more mobile (Machin et al. 2008). To measure the education level of the workers, we used dummies constructed from the variable 'Education levels' available in the RAIS, which was adjusted into seven divisions that are part of the stages of the education cycle: no education (category omitted), elementary incomplete, elementary completed, high school incomplete, high school completed, higher education incomplete, and higher education completed.

For firm characteristics, dummy variables were included for different size classes of the establishment. The construction of this variable follows the classification of the Service for Support to Micro and Small Enterprises (Serviço de Apoio às Micro e Pequenas Empresas—SEBRAE), which divides the size of a company by number of workers, as follows: from 0 to 19 workers, from 20 to 99 workers, from 100 to 499 workers, and 500 or more workers. In this case, a higher likelihood of changing jobs is expected the smaller the size of the company (Baltzopoulos et al. 2012). Another feature of the employer included as control is the economic sector of the company. The sectors of activity were defined according to the classification of economic activities in large sectors, from the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística—IBGE), and subsequently, dummy variables were constructed to represent the following sectors: Farming (category omitted), Industry, Civil Construction, Commerce, and Services.

[4] Despite the positive association between employment density and the diversity highlighted in the literature, it is possible to combine a diversified economy with a low employment density. However, we believe that this theoretical association is more plausible for a country with continental dimensions and large urban areas such as Brazil, since the density can be used as a measure of the degree of urbanization.

[5] The regions of Brazil are groupings of the units of the federation (states) in five regions. As defined by the Brazilian Institute of Geography and Statistics, currently in Brazil, there are five official regions: Center-West, Northeast, North, Southeast, and South.

4 Results

4.1 Descriptive analysis of the sample

The descriptive statistics of the variables used in the estimation of the empirical model of this article are summarized in Table 3. The database includes 596,880 observations, which enables the behavior of 59,688 individuals in the Brazilian formal job market to be followed over ten periods (2003–2013). This sample is composed of workers with an average age of 36 years old, the majority of whom are men (approximately 78%) who have a high level of education and long period of employment, and they work in the industrial sector (approximately 41%) in the Southeast region (approximately 72%).

As stated earlier, in a regional economy, one of the determinants of inter-firm mobility is employment density. Specifically, the inter-firm mobility of workers would occur more frequently in regions that are denser in terms of economic activities and the job market. Taking this into account, Fig. 1 provides another analysis of the data, describing the mean of the employment density in the municipalities where the companies from which workers changed jobs are located, for the period of time considered in this present study. It is possible to observe that the mean employment density is relatively increasing over time, varying from 6.74 (2003–2004) to 6.96 (2012–2013).

Complementing the analysis presented in Figs. 1 and 2 highlights the distribution of the employment density in Brazilian municipalities in the initial (2003) and final (2012) years.

Individual characteristics can determine inter-firm mobility in dense regions. Figures 3, 4, and 5 highlight the mobility rate (quadrant a) and the average employment density (quadrant b), considering different age-groups, levels of education, and sectors.

The mobility rate was computed based on total number of job changes, normalized by the total number of workers in each category. From Fig. 3, it can initially be observed that the youngest individuals (the 18–29-year age-group) are those with the highest mobility rate—21%. The workers in the 30–49-year age-group are the ones that had the highest average employment density (6.97).

Considering the different education levels, Fig. 4 shows that the mobility rate (quadrant a) varies from 15%—for individuals no education—to 16% for workers with high school incomplete. Additionally, it can be observed that the graph for the mobility rate according to education levels has a nonlinear format, in which the mobility rate is higher for workers with intermediate education levels—from elementary schooling completed to higher education incomplete—and lower for workers located at the extremes of this subdivision—elementary incomplete and higher education completed. As for the mean employment density in the municipalities where the company is located (quadrant b), this increases as the education level of the workers increases, reaching an average of 7.05 for individuals with higher education completed.

Analyzing the composition of the sample by economic activity, from Fig. 5, it can be observed that the highest mobility rate (quadrant a) is in the Civil

Table 3 Brazil: Descriptive statistics of the sample (2003–2013). *Source*: Own preparation based on RAIS data

Variable	Mean	Proportion	Minimum	Maximum
Mobility			0	1
Remained in the same job		85.84		
Changed job		14.16		
Employment density[a]	6.90		− 0.61	11.80
Male		77.98		
Female		22.02		
Age	36.22		18	64
Education level				
No education		0.39	0	1
Elementary incomplete		20.51	0	1
Elementary completed		17.59	0	1
High school incomplete		8.93	0	1
High school completed		36.93	0	1
Higher education incomplete		4.07	0	1
Higher education completed		11.58	0	1
Length of employment				
From 0 to 11.9 months		17.32	0	1
From 12.0 to 59.9 months		38.71	0	1
60.0 months or more		43.98	0	1
Sectors				
Farming		1.40	0	1
Industry		40.92	0	1
Construction		4.63	0	1
Commerce		23.29	0	1
Services		29.76	0	1
Size of the establishment				
From 0 to 19 workers		25.53	0	1
From 20 to 99 workers		24.29	0	1
From 100 to 499 workers		22.44	0	1
500 or more workers		27.73	0	1
Regional variables				
North		0.74	0	1
Northeast		7.68	0	1
Southeast		71.84	0	1
South		17.56	0	1
Center-west		2.18	0	1
Total number of observations		596,880		
Total number of individuals in each subperiod		59,688		

[a]Variable in logarithm

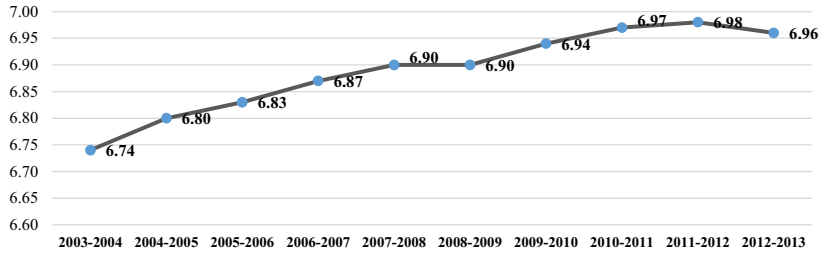

Fig. 1 Brazil: Mean of the employment density for the workers who changed jobs (2003–2012). *Source*: Own preparation based on RAIS data. *Note* For the construction of this graph, the characteristics of the employees in the initial year of each subperiod were considered

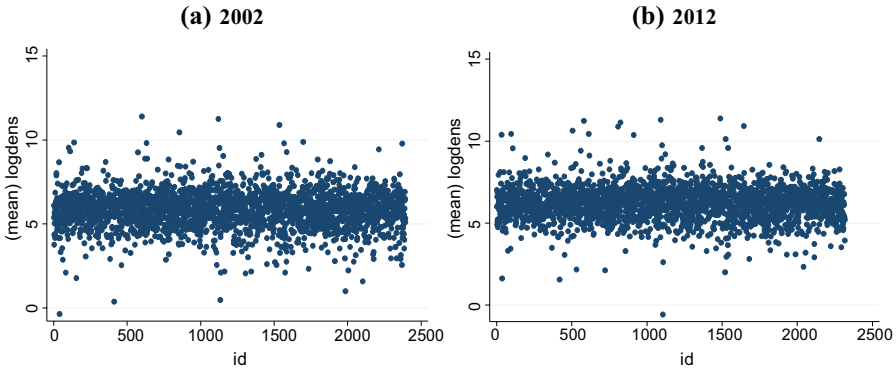

Fig. 2 Brazil: Distribution of employment density in municipalities in the years 2003 and 2012. *Source*: Own preparation based on RAIS data

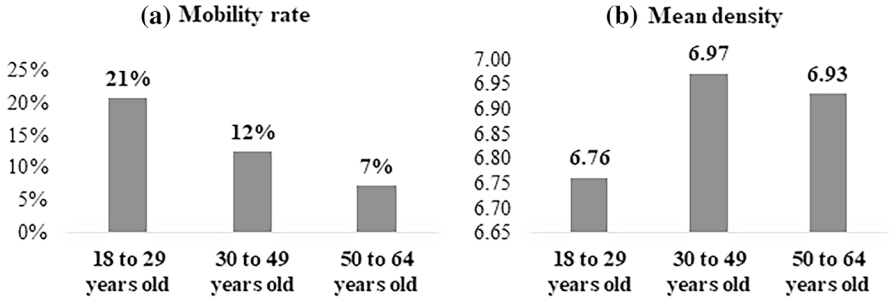

Fig. 3 Brazil: Mobility rate and mean employment density for the workers who changed jobs according to age-group (2003–2012). *Source*: Own preparation based on RAIS data

Construction sector (27%), whereas the lowest is in Industry (10%). Also from Fig. 5, it can be observed that the mean density, in the municipalities in which the companies from which workers changed jobs are located, was greater for the individuals employed in the Construction and Services sectors; however, in terms of magnitude, this value is not much greater than those for the other sectors are.

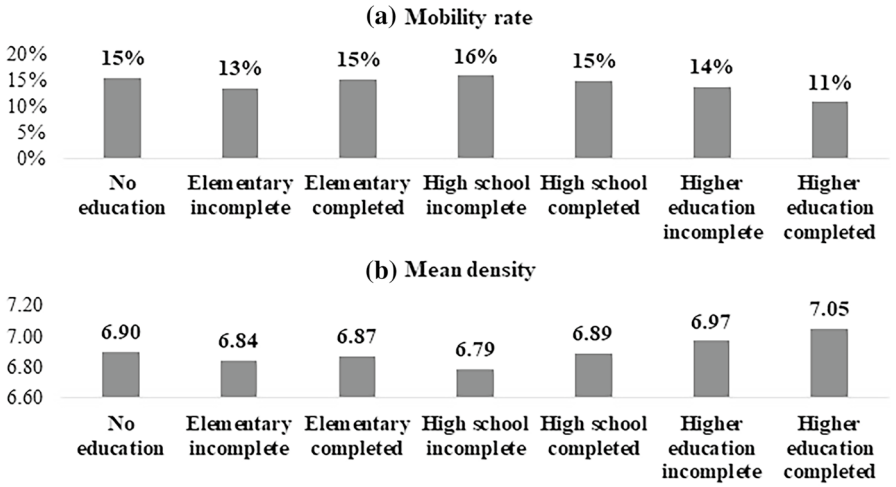

Fig. 4 Brazil: Mobility rate and mean employment density for the workers who changed jobs according to level of education (2003–2012). *Source*: Own preparation based on RAIS data

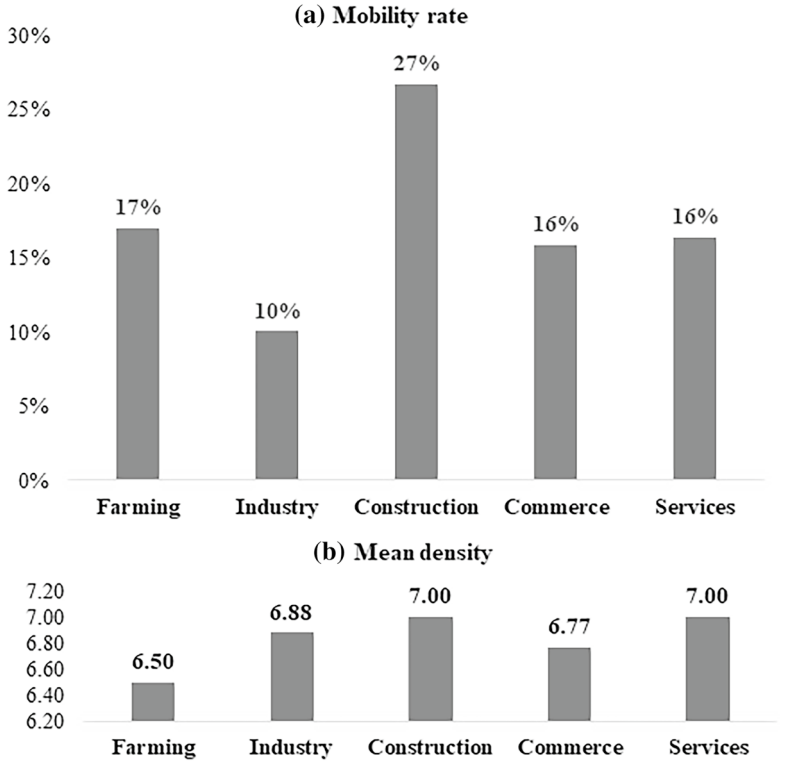

Fig. 5 Brazil: Mobility rate and mean employment density for the workers who changed jobs, according to sector (2003–2012). *Source*: Own preparation based on RAIS data

Table 4 Brazil: Marginal effects of employment density on the likelihood of inter-firm mobility by subperiods used in the balanced panel assembly (2003–2013). *Source*: Own preparation based on RAIS data

Subperiods	Employment density	
	Coefficients	SD
2003–2004	0.96***	(0.0007)
2004–2005	0.83***	(0.0007)
2005–2006	1.00***	(0.0007)
2006–2007	1.00***	(0.0007)
2007–2008	1.00***	(0.0007)
2008–2009	0.79***	(0.0007)
2009–2010	1.29***	(0.0007)
2010–2011	1.19***	(0.0007)
2011–2012	1.04***	(0.0006)
2012–2013	1.24***	(0.0006)

1. Heteroscedastic-robust standard deviations are in parentheses. 2. ***Statistically significant at 1%. 3. For the estimation by subperiods uses the same control variables of Table 5, except the year dummies. 4. Estimated marginal effects (100×)

4.2 Inter-firm worker mobility

Initially, a first block of evidence is presented in which it is sought to explore the effect of employment density on the likelihood of inter-firm mobility, considering each of the subperiods used in the data panel assembly, still with the data structure cross-sectional. The purpose is to verify the sensitivity of the results over time, in addition to the behavior of the employment density in relation to the magnitude and significance of the estimated coefficients. Accordingly, Table 4 highlights the marginal effects obtained through standard probit estimates for the main regressor of this study—the variable 'employment density'—for each subperiod. The control variables used are sex, age, education, length of employment, size of the establishment, sector, and regions.

In general, the values of the estimated coefficients are quite similar, varying little between the different subperiods. Moreover, they do not exhibit differences in terms of the sign and level of statistical significance.

Table 5 presents the panel structure of the data. In this case, the estimates[6] of the determinants of the inter-firm mobility presented were obtained through pooling probit and random-effects probit regression, based on attributes of the workers, the companies, and locational or regional factors. In general, the estimates of the parameters obtained for the influence that observable characteristics of the workers and

[6] To verify the robustness of our results for different samples, we performed the random-effects probit regression again for two different random samples, a new sample of 5% and another one of 1%. Estimates change relatively little, especially for the main explanatory variable of the study, the density of employment. For the new random sample of 5%, the marginal effect value for the variable employment density was 0.523063; already for the sample of 1%, the marginal effect was 0.5460484. Complete robustness tests are available upon request.

Table 5 Brazil: Estimated marginal effects of employment density on the likelihood of inter-firm mobility (probit and random-effects probit regression) for 2003–2013. *Source*: Own preparation based on RAIS data

	(1) Pooling probit	(2) Random-effect probit
Employment density	0.58*** (0.0006)	0.52*** (0.0007)
Characteristics of the individual		
Gender	2.36*** (0.0011)	2.6*** (0.0013)
Age	− 0.36*** (0.0001)	− 0.43*** (0.0001)
Elementary incomplete	− 2.31*** (0.0068)	− 2.46*** (0.0081)
Elementary completed	− 1.89*** (0.0068)	− 2.13*** (0.0082)
High school incomplete	− 1.98*** (0.0069)	− 2.33*** (0.0082)
High school completed	− 2.83*** (0.0068)	− 3.42*** (0.0082)
Higher education incomplete	− 2.98*** (0.0071)	− 3.78*** (0.0085)
Higher education completed	− 2.62*** (0.0069)	− 3.96*** (0.0083)
From 12.0 to 59.9 months	− 6.66*** (0.0011)	− 3.3*** (0.0011)
60.0 months or more	− 16.05*** (0.0012)	− 9.07*** (0.0018)
Characteristic of the company		
Industry	− 4.71*** (0.0035)	− 4.99*** (0.0041)
Construction	5.16*** (0.0039)	4.76*** (0.0045)
Commerce	− 2.46*** (0.0036)	− 2.53*** (0.0041)
Services	0.38 (0.0036)	0.17 (0.0041)
From 20 to 99 workers	− 1.71*** (0.0012)	− 2.6*** (0.0013)
From 100 to 499 workers	− 2.39*** (0.0013)	− 3.71*** (0.0015)
500 or more workers	− 4.41*** (0.0014)	− 5.87*** (0.0015)
Regional factors		
Northeast	− 3.01*** (0.0055)	− 2.9*** (0.0064)
Southeast	− 1.43*** (0.0053)	− 1.4** (0.0062)
South	− 0.98* (0.0054)	− 0.96 (0.0063)
Center-west	0.84 (0.0059)	1.11 (0.0069)
Time dummies	Yes	Yes
Number of observations	596,880	596, 880
Number of individuals	59,688	59,688

1. Heteroscedastic-robust standard deviations are in parentheses. 2. ***Statistically significant at 1%. **Statistically significant at 5%. *Statistically significant at 10%. 3. Estimated marginal effects (100×)

the companies have on mobility are employed as controls for the evaluation of the impact that regional characteristics—specifically urban density—have on the mobility of workers. Initially, the signs and statistical significance of the explanatory variables exhibit the same pattern for all the specifications, varying only in magnitude.

The results found were consistent with the findings in the literature for other countries. The employment density exhibited an expected sign and a statistically significant coefficient at 1%. Specifically, it can be observed that when mobility is controlled by the observable characteristics of the workers and of the companies, the

individuals who work in denser regions (i.e., with higher employment density) are more inclined toward inter-firm mobility. In terms of the economic significance of the effect of density on the probability of inter-firm mobility, we find that a doubling of spatial employment density yields about 0.5% points increase in the probability of inter-firm mobility for a randomly chosen individual.

Thus, the marginal effects reported in Table 5 suggest that the density of employment is an important determinant of the worker's mobility interferes. This result is in agreement with the findings in the theoretical and empirical literature. For example, a similar result was found in the study by Finney and Kohlhase (2008), which suggested that urban areas are associated with greater work mobility at the beginning of careers, and in Andersson and Thulin (2013), who found a positive significant effect of the spatial density of employment on the likelihood of a worker changing companies in the Industrial and Services sectors of Sweden.

This trend exists because, as theoretically highlighted, the advantages arising from the agglomerative process—such as the greater supply of services and sources of raw materials and jobs—stimulate increased productivity through exchange of information and knowledge (Marshall 1920). Moreover, workers and companies located in dense regions have high accessibility to a large pool of potential employees and employers, which can reduce the costs associated with the search for new jobs and with the hiring of new employees.

In terms of control variables, the results were generally similar to those in the literature regarding this topic, which reinforces the importance of variables such as age, education level, length of employment, economic sector, and region for the determination of inter-firm mobility (Finney and Kohlhase 2008; Wheeler 2008; Andersson and Thulin 2013). Regarding the first group of variables (general attributes of workers), it is noted that the effect of age indicates that older workers tend to have lower inter-firm mobility.

In fact, as Borjas (2012) notes, considering mobility to be an investment in human capital, older workers will have a shorter period of time to benefit from the possible returns resulting from investments made in the transfer of firm, thus reducing the likelihood of mobility. The same is true for those who have a longer length of employment, which indicates that inter-firm mobility is greater the shorter the length of employment. The effect of age and length of employment can be explained jointly by the trend of greater stability in employment (professional career) and, consequently, less need to seek another job the greater the age and the length of employment. With regard to the relationship between the 'gender' variable and mobility, a direct and significant relationship is identified: Men are, on average, more likely than women to change jobs.

Regarding education levels, all the dummy variables are negative, which indicates that for the Brazilian case, greater inter-firm mobility would tend to be found in workers with lower levels of education. The fact that workers with a higher education level are more inclined toward inter-firm mobility may be associated with the increased opportunities in the job market for individuals with higher qualifications. On the other hand, lack of information, lower skills, credit restriction, or other unobserved characteristics correlated with a lower

qualification may be indicated as possible limitations to the inter-firm mobility of less educated individuals (Machin et al. 2008).

For Sahota (1968), in a seminal article about internal migration in Brazil, a priori, it is not possible to directly predict the influence of education. Thus, mobility will not necessarily be higher among individuals who are more educated because other factors may influence this decision (e.g., the number of educated individuals in the destination region), taking into consideration the degree of competition for new jobs and the comparison between the financial returns offered by the regions of origin and destination. However, holding the other factors constant, the marginal effects of education could still exist. This result can also be supported by studies that found different results regarding the determinants of inter-firm mobility when different samples by education level were considered in the analysis, such as Finney and Kohlhase (2008) and Andersson and Thulin (2013).

Regarding company characteristics, the results suggest that workers more likely change employers if they work in smaller (in terms of number of employees) companies. Regarding mobility between different economic sectors, the results suggest that being employed in sectors such as Industry and Commerce reduces mobility when compared to the primary sector category (Farming), while working in Civil Construction increases the likelihood of changing jobs. Concerning Commerce, the coefficients are not statistically significant. Additionally, because inter-firm mobility can be affected differently, given the characteristics of the job market among the different Brazilian regions, control dummy variables were included for the North (omitted category), Northeast, South, Southeast, and Center-west regions, which were all shown to be statistically significant, except for the South region.

Once the initial evidence was discussed, we also conduct separate estimations, subdividing the sample for all the individuals used in the estimation of the results verified in Table 5 for groups of workers with different ages, education levels, and sectors. These reductions allowed us to analyze how the effect of the employment density on mobility may be different, given the characteristics of each group analyzed individually. In fact, one of the issues considered in the identification of the effect of density on labor mobility is the selection of the sample, which arises from the possibility of non-random spatial classification of workers in relation to the individual characteristics associated with their mobility (Andersson and Thulin 2013). In this way, denser regions can attract inherently mobile workers; making the higher mobility in these locations reflects a classification effect, rather than an effect of density on workers' mobility (Combes et al. 2012).

Thus, the identification of the influence of the density of cities on worker mobility performed to date does not let the nature of these influences be verified, given that there may be the possibility that the advantages resulting from the agglomeration of people and economic activities in an area—measured through employment density—result from the greater stimulus toward learning, through the diffusion of knowledge and ideas, which happens owing to greater contact between different individuals. Hence, if this learning is conditioned to individual characteristics, such as age and education level, it is possible that the effects of employment density are distributed differently among the individuals.

Table 6 Brazil: Estimated marginal effects of employment density on the likelihood of inter-firm mobility according to age-group (2003–2013). *Source*: Own preparation based on RAIS data

	From 18 to 29 years	From 30 to 49 years	From 49 to 64 years
Employment density	0.92***	0.25***	−0.41
Time dummies	(0.0011)	(0.0008)	(0.0026)
Number of observations	163,098	379,510	54,272
Number of individuals	16,310	37,951	5427

1. Heteroscedastic-robust standard deviations are in parentheses. 2. ***Statistically significant at 1%. **Statistically significant at 5%. *Statistically significant at 10%. 3. Estimated marginal effects (100×)

To investigate such possibilities, Tables 6, 7, and 8 present the results of the random-effects probit model, in which the dependent variable[7]—inter-firm mobility—was computed considering different age ranges, education levels, and sectors, respectively. In Table 6, in general, the findings indicate that employment density affects inter-firm mobility more intensely if the workers are in the 18-to-29-year-old age-group. In particular, the relationship between employment density and inter-firm mobility of workers in this age-group is positive and statistically significant, suggesting that density is a more important factor for mobility if the workers are younger. For the 30-to-49-year-old age-group, the employment density coefficient is also positive and statistically significant but smaller in magnitude than the younger age-group. In terms of economic significance, for individuals in the 18-to-29-year-old age-group, doubling the spatial density increases the probability of inter-firm mobility by about 0.9%, while for individuals in the 30-to-49-year-old age-group, this increase is only 0.2%. For workers between 49 and 64 years of age, the coefficient obtained for the employment density was not statistically significant. The variation in the effect of density on inter-firm mobility for different age-groups is a well-established result in the literature—for example; it was verified in the study by Bleakley and Lin (2012).

When comparing the regressions performed by education level, in Table 7, it can be observed that the magnitude of the employment density coefficients increases as the estimations are made for individuals that are more educated. However, the coefficient of the explanatory variable employment density is not statistically significant for workers with incomplete and complete higher education. Such evidence suggests that despite the less urbanized regions, municipalities with a higher employment density can produce positive advantages or externalities for more skilled workers, such as greater access to services and job opportunities.

Finally, in Table 8, the results obtained for economic activity are highlighted, considering the sectors Agriculture and Livestock, Industry, Construction, Commerce, and Services. For the Farming, Industry, Commerce, and Services, the employment density coefficient was positive and statistically significant. It can also be observed that the magnitude of the employment density coefficients for Farming

[7] The complete tables of the estimated coefficients are shown in Tables 9, 10, and 11, in Appendix 1.

Table 7 Brazil: Estimated marginal effects of employment density on the likelihood of inter-firm mobility according to education level (2003–2013). *Source*: Own preparation based on RAIS data

	No education	Elementary incomplete	Elementary completed	High school incomplete	High school completed	Higher education incomplete	Higher education completed
Employment density	−2.21**	0.41***	0.46***	0.43*	0.80***	0.34	−0.05
	(0.0102)	(0.0013)	(0.0016)	(0.0023)	(0.0012)	(0.0040)	(0.0022)
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	3120	152,080	118,500	65,280	181,770	22,450	53,680
Number of individuals	312	15,208	11,850	6528	18,177	2245	5368

1. Heteroscedastic-robust standard deviations are in parentheses. 2. ***Statistically significant at 1%. **Statistically significant at 5%. *Statistically significant at 10%. 3. Estimated marginal effects (100×)

Table 8 Brazil: Estimated marginal effects of employment density on the likelihood of inter-firm mobility to sectors (2003–2013). *Source*: Own preparation based on RAIS data

	Farming	Industry	Construction	Commerce	Services
Employment density	0.92*	0.48***	−0.58	0.87***	0.59***
	(0.0049)	(0.0009)	(0.0037)	(0.0014)	(0.0014)
Time dummies	Yes	Yes	Yes	Yes	Yes
Number of observations	9610	237,780	25,810	146,260	177,420
Number of individuals	961	23,778	2581	14,626	17,742

1. Heteroscedastic-robust standard deviations are in parentheses. 2. ***Statistically significant at 1%. **Statistically significant at 5%. *Statistically significant at 10%. 3. Estimated marginal effects (100×)

and Commerce and Services is relatively higher in relation to the Industry sector. In terms of economic significance, for individuals operating in the Farming, Manufacturing Industry and the Commerce sector, doubling the spatial employment density increases by about, 0.9%, 0.4% and 0.8%, respectively, the probability of mobility inter-firm, while for individuals employed in the Service sector, this increase is 0.5%. For the construction sector, the coefficient of the variable employment density is not significant.

Thus, it can be inferred that the results indicate significant differences between the coefficients estimated for employment density by age-group, education level, and sector, which indicates that more robust evidence about the determinants of inter-firm mobility should consider the effects of the sample selectivity between different groups.

5 Final considerations

The study aimed to investigate how the spatial density of employment affected the inter-firm mobility of workers in the Brazilian job market between 2003 and 2013. Analyzing the determinants of inter-firm mobility is relevant for Brazil, since a better understanding of such determinants may become useful for economic policy intended to reduce spatial inequalities, as well as for determining economic growth strategies. In addition, most of the empirical studies that address this issue have focused on the developed countries, but we are evaluating the effects of the spatial density of employment on inter-firm mobility in the context of a developing economy, that of Brazil, which is an important contribution of the present study.

For this purpose, evidence was produced via random-effects probit model applied to an employer–employee data panel that captured regional differences, in addition to characteristics related to the workers and the companies, constructed via the annual RAIS.

Initially considering the general sample of workers, the evidence supports some stylized results in the specialized literature and was consistent with the findings for other countries. Inter-firm mobility is associated with characteristics such as age, education level, length of employment, economic sector, and region. In general,

the empirical results suggest the following: (1) Older workers with a greater length of employment tend to be less inclined toward inter-firm mobility; (2) compared to women, men are, on average, more likely to change jobs; (3) greater inter-firm mobility tends to be observed for workers with lower levels of education; (4) workers tend to be more likely to change employers if they work in smaller (in terms of number of employees) companies and in the Civil Construction sector; and (5) individuals working in denser regions (i.e., with greater employment density) are more inclined toward inter-firm mobility.

Econometric estimations considering different age-groups, education levels, and sectors revealed quite different coefficients among the analyzed groups, indicating that more robust evidence about the determinants of inter-firm mobility should consider the effects among different groups. In general, employment density affects inter-firm mobility more intensely if the workers are in the 18-to-29-year-old age-group. This relationship is positive and statistically significant, which suggests that density is a more important factor for mobility if workers are younger. In turn, when comparing the regressions performed by education level, it can be observed that the magnitude of the employment density coefficients increases as the estimations are made for more educated individuals. However, the density coefficient is not statistically significant for workers with incomplete and completed higher education. Such evidence suggests that despite the less urbanized regions, municipalities with a higher employment density can produce positive advantages or externalities for more skilled workers, such as greater access to services and job opportunities. Moreover, the magnitude of the employment density coefficients for Farming, Commerce, and Services is relatively higher in relation to the Industry sector. In terms of economic significance, for individuals operating in the Farming, Manufacturing Industry, and the Commerce sectors, doubling the spatial employment density increases by about, 0.9%, 0.4% and 0.8%, respectively, the probability of mobility inter-firm, while for individuals employed in the Service sector, this increase is 0.5%.

Thus, in general, the results demonstrate that the dynamics of the job market of a region is closely related to its internal geography and the peculiar characteristics of its economic agents, i.e., companies and workers. Therefore, the finding of higher rates of job mobility between companies in denser geographical spaces would be an empirically relevant determinant of the productivity advantages in these regions. However, as indicated by Andersson and Thulin (2013), the indirect effects of mobility on productivity can be affected by how transaction costs depend on changes in employment. In other words, if job mobility is an important source of productivity resulting from the density, the spatial extent of these benefits must be sensitive to the travel distance and travel time of the workers. There is thus a need for investments in transport infrastructure that can positively intervene in workers' choices in terms of potential employers, which would subsequently stimulate improvements in efficiency in terms of job matching and the flow of knowledge.

One limitation of this study is to consider in the analysis only the formal labor market. Future studies may include a database containing both informal and formal job market information. In addition, alternative econometric techniques such as

multilevel modeling could be employed to verify the possible interactions between different levels (e.g., region, employers, sectors, and workers) in determining the effect of spatial density of employment on inter-firm mobility. Another way forward for future research would be to associate job change with different levels of geographical mobility, that is, to verify if, in addition to changing employers, the worker also moved to another location.

Appendix 1

See Tables 9, 10, and 11.

Table 9 Brazil: Estimated marginal effects of employment density on the likelihood of inter-firm mobility according to age-group (2003–2013). *Source*: Own preparation based on RAIS data

	From 18 to 29 years	From 30 to 49 years	From 49 to 64 years
Employment density	0.92***	0.25***	− 0.41
	(0.0011)	(0.0008)	(0.0026)
Gender	2.17***	2.78***	1.87***
	(0.0022)	(0.0016)	(0.0060)
Age	− 0.70***	− 0.30***	− 0.20**
	(0.0003)	(0.0001)	(0.0009)
Elementary incomplete	− 4.96***	− 1.05	2.63
	(0.0141)	(0.0101)	(0.0212)
Elementary completed	− 5.10***	− 0.56	2.92
	(0.0142)	(0.0101)	(0.0215)
High school incomplete	− 5.35***	− 0.92	2.13
	(0.0142)	(0.0102)	(0.0223)
High school completed	− 7.27***	− 1.16	2.24
	(0.0141)	(0.0101)	(0.0215)
Higher education incomplete	− 8.50***	− 0.69	1.10
	(0.0146)	(0.0105)	(0.0258)
Higher education completed	− 8.97***	− 1.21	1.95
	(0.0145)	(0.0102)	(0.0218)
From 12.0 to 59.9 months	− 4.35***	− 2.52***	− 1.93***
	(0.0019)	(0.0014)	(0.0054)
60.0 months or more	− 10.94***	− 7.03***	− 5.50***
	(0.0030)	(0.0021)	(0.0082)
Industry	− 6.73***	− 3.39***	− 1.80
	(0.0066)	(0.0053)	(0.0123)
Construction	5.19***	4.29***	3.61***
	(0.0075)	(0.0057)	(0.0134)
Commerce	− 4.14***	− 1.12**	− 1.42
	(0.0068)	(0.0054)	(0.0127)

Table 9 (continued)

	From 18 to 29 years	From 30 to 49 years	From 49 to 64 years
Services	− 1.28*	1.41***	0.95
	(0.0067)	(0.0053)	(0.0124)
From 20 to 99 workers	− 2.98***	− 2.27***	− 1.97***
	(0.0022)	(0.0016)	(0.0053)
From 100 to 499 workers	− 4.19***	− 3.23***	− 2.73***
	(0.0025)	(0.0018)	(0.0057)
500 or more workers	− 7.67***	− 4.62***	− 2.12***
	(0.0026)	(0.0018)	(0.0059)
Northeast	− 4.98***	− 0.76	− 0.54
	(0.0143)	(0.0066)	(0.0119)
Southeast	− 2.28	− 0.31	− 0.63
	(0.0141)	(0.0060)	(0.0113)
South	− 1.59	− 1.11*	− 1.76
	(0.0142)	(0.0064)	(0.0123)
Center-west	0.45	1.51**	-0.22
	(0.0150)	(0.0074)	(0.0130)
Time dummies	Yes	Yes	Yes
Number of observations	163,098	379,510	54,272
Number of individuals	16,310	37,951	5427

1. Heteroscedastic-robust standard deviations are in parentheses. 2. ***Statistically significant at 1%. **Statistically significant at 5%. *Statistically significant at 10%. 3. Estimated marginal effects (100×)

Table 10 Estimated marginal effects of employment density on the likelihood of inter-firm mobility according to education level (2003–2013). *Source*: Own preparation based on RAIS data

	No education	Elementary incomplete	Elementary completed	High school incomplete	High school completed	Higher education incomplete	Higher education completed
Employment density	−2.21**	0.41***	0.46***	0.43*	0.80***	0.34	−0.05
	(0.0102)	(0.0013)	(0.0016)	(0.0023)	(0.0012)	(0.0040)	(0.0022)
Gender	7.93***	2.42***	3.66***	3.32***	2.76***	1.89***	1.46***
	(0.0251)	(0.0031)	(0.0034)	(0.0044)	(0.0021)	(0.0058)	(0.0034)
Age	−0.51***	−0.46***	−0.46***	−0.47***	−0.40***	−0.33***	−0.35***
	(0.0010)	(0.0001)	(0.0002)	(0.0002)	(0.0001)	(0.0004)	(0.0002)
Elementary incomplete	–	–	–	–	–	–	–
	–	–	–	–	–	–	–
Elementary completed	–	–	–	–	–	–	–
	–	–	–	–	–	–	–
High school incomplete	–	–	–	–	–	–	–
	–	–	–	–	–	–	–
High school completed	–	–	–	–	–	–	–
	–	–	–	–	–	–	–
Higher education incomplete	–	–	–	–	–	–	–
	–	–	–	–	–	–	–
Higher education completed	–	–	–	–	–	–	–
	–	–	–	–	–	–	–
From 12.0 to 59.9 months	−6.38***	−3.37***	−3.90***	−3.37***	−3.78***	−1.84***	−1.06***
	(0.0173)	(0.0023)	(0.0026)	(0.0036)	(0.0021)	(0.0056)	(0.0034)
60.0 months or more	−15.99***	−8.85***	−10.43***	−10.42***	−10.45***	−6.25***	−3.38***
	(0.0254)	(0.0035)	(0.0042)	(0.0058)	(0.0032)	(0.0080)	(0.0043)

Table 10 (continued)

	No education	Elementary incomplete	Elementary completed	High school incomplete	High school completed	Higher education incomplete	Higher education completed
Industry	−2.25	−5.58***	−6.79***	−4.31**	−3.39***	1.78	3.46*
	(0.0238)	(0.0054)	(0.0109)	(0.0191)	(0.0109)	(0.0336)	(0.0194)
Construction	4.98*	4.61***	4.60***	5.69***	5.64***	8.10**	7.82***
	(0.0294)	(0.0062)	(0.0118)	(0.0207)	(0.0116)	(0.0366)	(0.0214)
Commerce	−7.52**	−4.89***	−4.29***	−2.42	0.57	5.49	5.05**
	(0.0306)	(0.0057)	(0.0110)	(0.0193)	(0.0109)	(0.0339)	(0.0196)
Services	3.69	−0.63	−1.24	0.09	2.17**	5.70*	7.20***
	(0.0293)	(0.0055)	(0.0109)	(0.0192)	(0.0109)	(0.0340)	(0.0194)
From 20 to 99 workers	−1.38	−3.63***	−2.63***	−2.69***	−1.85***	−1.73***	−2.37***
	(0.0236)	(0.0027)	(0.0030)	(0.0042)	(0.0024)	(0.0065)	(0.0038)
From 100 to 499 workers	−3.43	−4.74***	−3.23***	−4.03***	−2.53***	−4.03***	−4.42***
	(0.0220)	(0.0029)	(0.0034)	(0.0047)	(0.0026)	(0.0071)	(0.0043)
500 or more workers	−4.87**	−5.80***	−5.57***	−6.84***	−5.76***	−5.88***	−5.22***
	(0.0228)	(0.0030)	(0.0035)	(0.0050)	(0.0027)	(0.0075)	(0.0043)
Northeast	1.50	−5.35***	−2.60	−3.22	−1.83*	6.92*	−1.44
	(0.0432)	(0.0111)	(0.0172)	(0.0272)	(0.0109)	(0.0377)	(0.0169)
Southeast	0.69	−3.90***	−0.82	−1.17	0.14	9.77***	−2.21
	(0.0413)	(0.0108)	(0.0166)	(0.0268)	(0.0106)	(0.0355)	(0.0150)
South	1.28	−2.28**	0.03	−0.26	0.05	8.45**	−4.14***
	(0.0451)	(0.0111)	(0.0168)	(0.0270)	(0.0107)	(0.0357)	(0.0155)
Center-west	−6.29	0.03	2.82	1.76	1.31	9.12**	−0.37
	(0.0525)	(0.0125)	(0.0179)	(0.0284)	(0.0120)	(0.0392)	(0.0177)
Time dummies		Yes	Yes	Yes	Yes	Yes	Yes

Table 10 (continued)

	No education	Elementary incomplete	Elementary completed	High school incomplete	High school completed	Higher education incomplete	Higher education completed
Number of observations	3120	152,080	118,500	65,280	181,770	22,450	53,680
Number of individuals	312	15,208	11,850	6528	18,177	2245	5368

1. Heteroscedastic-robust standard deviations are in parentheses. 2. ***Statistically significant at 1%. **Statistically significant at 5%. *Statistically significant at 10%. 3. Estimated marginal effects (100×)

Table 11 Brazil: Estimated marginal effects of employment density on the likelihood of inter-firm mobility to sectors (2003–2013). *Source*: Own preparation based on RAIS data

	Farming	Industry	Construction	Commerce	Services
Employment density	0.92*	0.48***	−0.58	0.87***	0.59***
	(0.0049)	(0.0009)	(0.0037)	(0.0014)	(0.0014)
Gender	5.70**	1.59***	13.32***	2.22***	3.80***
	(0.0227)	(0.0019)	(0.0182)	(0.0026)	(0.0026)
Age	−0.50***	−0.38***	−0.44***	−0.51***	−0.43***
	(0.0006)	(0.0001)	(0.0004)	(0.0002)	(0.0001)
Elementary incomplete	−1.88	−2.76***	4.55	−1.51	−3.20*
	(0.0210)	(0.0095)	(0.0424)	(0.0297)	(0.0192)
Elementary completed	−1.60	−2.61***	5.54	−0.51	−3.00
	(0.0235)	(0.0095)	(0.0426)	(0.0297)	(0.0192)
High school incomplete	−3.70	−2.54***	1.45	−0.26	−3.47*
	(0.0257)	(0.0096)	(0.0435)	(0.0298)	(0.0193)
High school completed	−6.58***	−3.94***	1.36	−0.90	−4.04**
	(0.0235)	(0.0095)	(0.0428)	(0.0297)	(0.0191)
Higher education incomplete	−9.48	−3.99***	4.58	−1.49	−4.31**
	(0.0674)	(0.0100)	(0.0483)	(0.0301)	(0.0196)
Higher education completed	−11.09***	−3.79***	−2.87	−2.05	−4.52**
	(0.0344)	(0.0097)	(0.0455)	(0.0300)	(0.0193)
From 12.0 to 59.9 months	−6.12***	−3.12***	−7.72***	−2.83***	−3.33***
	(0.0097)	(0.0017)	(0.0069)	(0.0024)	(0.0022)
60.0 months or more	−14.99***	−8.07***	−17.55***	−9.17***	−8.36***
	(0.0146)	(0.0025)	(0.0123)	(0.0038)	(0.0033)
Industry	–	–	–	–	–
	–	–	–	–	–
Construction	–	–	–	–	–
	–	–	–	–	–
Commerce	–	–	–	–	–
	–	–	–	–	–
Services	–	–	–	–	–
	–	–	–	–	–
From 20 to 99 workers	−4.67***	−3.10***	−8.50***	−2.43***	−2.46***
	(0.0126)	(0.0020)	(0.0092)	(0.0025)	(0.0026)
From 100 to 499 workers	−6.05***	−4.68***	−9.29***	−2.49***	−3.46***
	(0.0123)	(0.0020)	(0.0095)	(0.0032)	(0.0028)
500 or more workers	−8.31***	−7.69***	−9.85***	−3.19***	−4.61***
	(0.0131)	(0.0021)	(0.0100)	(0.0039)	(0.2008)
Northeast	−3.97	−2.64**	−2.45	−3.04**	−2.60*
	(0.0412)	(0.0107)	(0.0205)	(0.0144)	(0.0135)
Southeast	−2.36	−1.60	−1.82	−0.85	−0.78
	(0.0402)	(0.0104)	(0.0192)	(0.0140)	(0.0130)

Table 11 (continued)

	Farming	Industry	Construction	Commerce	Services
South	−1.36	−0.55	−2.98	−1.32	−1.96
	(0.0413)	(0.0105)	(0.0213)	(0.0142)	(0.0133)
Center-west	−1.93	0.90	1.17	1.85	2.29
	(0.0446)	(0.0116)	(0.0238)	(0.0153)	(0.0145)
Time dummies	Yes	Yes	Yes	Yes	Yes
Number of observations	9610	237,780	25,810	14,6260	177,420
Number of individuals	961	23,778	2581	14,626	17,742

1. Heteroscedastic-robust standard deviations are in parentheses. 2. ***Statistically significant at 1%. **Statistically significant at 5%. *Statistically significant at 10%. 3. Estimated marginal effects (100×)

Appendix 2: Dynamic model

Based on a panel dataset, the temporal dynamics of the mobility can be explored. Thus, consider the following dynamic version of Eq. (1):

$$y_{it}^{*} = \gamma y_{i,t-1} + r'\beta + z_{i,t}'\mu + w_{i,t}'\theta + \nu_{i,t}, \quad i = 1, \ldots, N; t = 1, \ldots, T \tag{2}$$

$$\nu_{i,t} = \alpha_i + u_{i,t}$$

in which y_{it-1} is the inter-firm worker mobility in period $t-1$, γ is a parameter restricted to the interval $|\gamma| < 1$, α_i is a term that captures the individual characteristics that are invariant in time[8] (i.e., the individual heterogeneity omitted), and $u_{i,t} \sim N\left(0, \sigma_u^2\right)$.

The estimation of dynamic versions[9] of nonlinear panel data models was performed with an empirical formulation based on the studies of Heckman (1981)[10] and Stewart (2006a, b). The estimated results are presented in Table 12.

Furthermore, when considering the results from columns 1 and 2 of Table 12, some important evidence can be observed. First, the temporally lagged coefficient of inter-firm mobility is statistically significant, suggesting that the inter-firm mobility at time t potentially depends on the inter-firm mobility in period $t-1$. Second,

[8] According to Cameron and Trivedi (2005), the introduction of the variable y_{it-1} into the model makes it autoregressive, allowing the temporal dynamics of the inter-firm mobility to be captured under the absence of serial autocorrelation of the error term $\nu_{i,t}$.

[9] See Stewart (2006a, b) and Stewart (2007) for more details on the dynamic versions of nonlinear panel data models.

[10] If the error term is autocorrelated, the estimator of Heckman is inconsistent. In this context, Stewart (2006a) suggests an extension to the estimator of Heckman (1981) which involves the use of estimators of the simulated maximum likelihood (SML) developed by Geweke (1991), Hajivassiliou and Mcfadden (1998), and Keane (1994). In the literature, there are alternative methods to that of Heckman (1981) for estimating dynamic models for panel data with a binary-dependent variable, such as the methods suggested by Orme (1997, 2001) and Wooldridge (2005). However, studies such as those of Miranda (2007) and Arulampalam and Stewart (2009) have demonstrated the superiority of the estimator of Heckman (1981) in terms of the precision in estimation of coefficients, despite it being a computationally more intensive method.

Table 12 Brazil: Dynamic probit coefficients: effect of employment density on the likelihood of inter-firm mobility (2003–2013). *Source*: Own preparation based on RAIS data

	(1) Heckman (1981)	(2) Stewart (2006a, b)
Employment density	0.0290*** (0.0041)	0.0285*** (0.0038)
Mobility ($t-1$)	−0.2905*** (0.0112)	−0.0614*** (0.0201)
Characteristics of the individual		
Gender	0.1349*** (0.0078)	0.1260*** (0.0072)
Age	−0.0225*** (0.0004)	−0.0205*** (0.0004)
Elementary incomplete	−0.0782* (0.0450)	−0.0724* (0.0426)
Elementary completed	−0.0523 (0.0451)	−0.0477 (0.0427)
High school incomplete	−0.0607 (0.0455)	−0.0544 (0.0431)
High school completed	−0.1108** (0.0449)	−0.1009** (0.0425)
Higher education incomplete	−0.1380*** (0.0467)	−0.1251*** (0.0442)
Higher education completed	−0.1422*** (0.0456)	−0.1238*** (0.0432)
From 12.0 to 59.9 months	−0.3881*** (0.0105)	−0.3784*** (0.0103)
60.0 months or more	−0.6589*** (0.0115)	−0.6680*** (0.0112)
Characteristic of the company		
Industry	−0.2404*** (0.0233)	−0.2257*** (0.0220)
Construction	0.2724*** (0.0253)	0.2634*** (0.0239)
Commerce	−0.0967*** (0.0236)	−0.0910*** (0.0223)
Services	0.0373 (0.0234)	0.0378* (0.0221)
From 20 to 99 workers	−0.1358*** (0.0074)	−0.1199*** (0.0071)
From 100 to 499 workers	−0.1935*** (0.0082)	−0.1711*** (0.0078)
500 or more workers	−0.2774*** (0.0083)	−0.2523*** (0.0079)
Regional factors		
Northeast	−0.1275*** (0.0374)	−0.1207*** (0.0348)
Southeast	−0.0723** (0.0360)	−0.0680** (0.0335)
South	−0.0410 (0.0366)	−0.0387 (0.0340)
Center-west	0.0677* (0.0403)	0.0601 (0.0374)
Intercept	0.1383** (0.0676)	0.0300 (0.0639)
Number of observations	596,880	596,880
Number of individuals	59,688	59,688
λ	0.7622*** (0.0250)	0.1421*** (0.0032)
ρ	0.1823***(0.0032)	0.8173*** (0.0291)
AR (1)		−0.1064*** (0.0087)

Heteroscedastic-robust standard deviations are in parentheses. ***Statistically significant at 1%. **Statistically significant at 5%

The model of Stewart (2006a, b)—column 2—was estimated based on ten repetitions. The model of Heckman was estimated on the basis of 24 points of quadrature

The variables of the vector x used as instruments were age and length of employment

this relationship is negative, which indicates that the individuals who moved from one job to another in period $t-1$ are less likely to make another change in period t. An explanation would be the costs associated with geographical mobility, especially travel costs, which are directly affected by the distance between the places of origin and destination. Finally, the uncertainties regarding the economic conditions of the destination region may negatively affect the likelihood of a new change, as Borjas (2012) highlights. Moreover, most individuals tend to live and work in urban areas and one of the benefits of living in a dense area is that there exist more job opportunities and, thus, less likely that job switching.

However, one explanation for the negative coefficient of lagged job switching could simply be that the matching between the worker and the job has improved or that it takes some time on the new job to find out if the match is a good one. In addition, residents of dense regions have a larger choice set of potential employers within commuting time distance. This means that the potential to change job without change in residence is greater.

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