

Migrant networks, regional development and internal migration flows in Brazil

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Abstract

Purpose – This study analyzes the role of migrant networks in the migration flows in relation to the educational level of the migrants and economic growth of the states of origin and destination in Brazil.

Design/methodology/approach – Fixed effects estimator applied to microdata.

Findings – The results show migrant networks have a significant and positive impact on migration flows of the different educational levels. The economic growth in the destination state accentuates this effect, while the economic growth in the origin state has distinct impacts according to the educational level of the new migrant.

Originality/value – The authors investigate the importance of migrant networks in the internal immigration within a developing country with large internal movement of people. In Brazil, the socio-economic condition of the population varies considerably in relation to its geography, which explains the country's large internal migration flows.

Keywords Economic growth, Brazil, Education level, Migrant flows, Migrant networks

Paper type Research paper

The Brazilian economy, in this respect, provides an interesting example of a country that offers the best of both worlds for a study of migration. Thus, on the one hand, there are no visa problems or racial barriers among the states. On the other hand, the country is so vast and the economic disparities are so wide that, compared with the internal migration in this subcontinent, the international migration among, for example, the countries of Europe might look like a local phenomenon (Sahota, 1968, p. 219).

1. Introduction

Externalities originating from migrant networks may be associated with patterns of later migration flows, because they are a form of social capital that individuals can make use of even before migration. Massey *et al.* (1993) shows that migrant networks can reduce migration costs and facilitate access to jobs and information at the place of reception for new waves of newcomers. This subject has been intensely studied in the international literature on migration (Munshi, 2003; Beine *et al.*, 2011, 2015; Beine & Salomone, 2013; Comola & Mendola, 2015; Beine, 2016; Goel & Lang, 2019; Galbis, Wolff, & Herault, 2020; Dagnelie, Mayda, & Maystadt, 2019), establishing a relationship between the existing network of migrants and migratory flows.

This article proposes an extension of this analysis to investigate the importance of the socioeconomic context in which this relationship takes place. Given the established literature in which many authors use existing migratory networks to predict migratory flows, this article



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proposes as a contribution to investigate more about how the effectiveness of this predictor can vary depending on the context. Heterogeneous aspects of this relationship may arise from factors such as the migrant's educational level, the economic growth in their place of origin, and the economic growth in their destination. To the best of our knowledge, the two latter heterogeneous relationships have not previously been empirically studied in the literature.

Three examples can illustrate the importance of these factors and show how the relationship between existing migrant networks and migratory flows can change according to the socioeconomic context. Firstly, unskilled migrants have fewer resources to migrate and may be more penalized, for instance, by poor transport structure, linked to less dynamic economies. In this case, these unskilled migrants may find transport solutions from the existing migrant network to overcome transport difficulties. Secondly, more skilled migrants may be financially better able to seek levels of well-being that are not necessarily related to higher incomes found in more dynamic economies. These skilled migrants can benefit from comparative information from the migrant network when arbitrating between economic dynamism and amenities associated with the places of origin and destination of migration. Thirdly, the migrant network can provide information and help with the search for work and job placement of new migrants (whether they are unskilled or skilled), especially in more economically dynamic locations where these relationships may be more complex.

This paper empirically verifies the correlation of the interstate migrant network with the interstate migrant flows in Brazil between 2000 and 2010, according to the migrant's educational level and the economic growth of the places of origin and destination. We investigate the importance of migrant networks in the internal immigration within a developing country with large internal movement of people. In Brazil, the socio-economic condition of the population varies considerably in relation to its geography, which explains the country's large internal migration flows [1]. Some states in the Northeast Region, such as Maranhão and Piauí have *per capita* GDPs comparable to that of India, while Brasília has a *per capita* GDP comparable to developed countries such as Germany. Indeed, there is a historical and intense immigration from the northeast to the southeast region and to Brasília (Aguayo-Tellez, Muendler, & Poole, 2010, p. 840). Another advantage of studying internal migration in a single country is the possibility of eliminating some theoretical mechanisms specific to international immigration, such as those regarding migration policies and visa requirements, remaining only the mechanisms related to migration and installation costs.

We find significant and positive association between the migrant network and the flow of migrants. More importantly, we analyze the heterogeneous association of migrant networks with migration flows according to the educational level of the new migrant and the economic growth of the states of origin and destination. On the one hand, the association of the existing migrant network and migration flows is significantly (from a statistical point of view) higher in destination places with higher growth, regardless of the level of education of immigrants. On the other hand, this association is ambiguous in the places of origin with the highest growth, it decreases for the entire sample and for low-skilled immigrants and it increases for highly-skilled immigrants.

The paper is organized into five sections. [Section 2](#) reviews the related literature, [Section 3](#) presents the theoretical model that supports this study. [Section 4](#) describes the empirical analysis for the estimation. [Section 5](#) shows the results of the empirical estimates, and finally [Section 6](#) includes the study conclusions.

2. Literature review

The size of the migration flow between two locations may be less strongly correlated with wage differences or employment rates, as the effects of these variables on promoting or inhibiting migration may be progressively overshadowed by the reduced costs and risks resulting from the expansion of migrant networks.

Moser (1998) shows social capital can be considered an asset that diminishes individual vulnerability, making it particularly relevant for the poorest individuals. Indeed, the literature shows the benefits networks of compatriots provide, especially the financial benefits, may be more important to less privileged individuals. For such individuals, migration costs represent a higher proportion of their income (Chiquiar & Hanson, 2005; Tai & Ribeiro, 2016). This fact is particularly relevant in developing countries, such as Brazil, in which large proportions of the population have low-incomes, with difficulties related to the poverty of their place of origin. Some individuals while unable to pursue a better life abroad, are able to migrate to the relatively rich centers within the country, such as Brasília, São Paulo and Rio de Janeiro. From a conceptual point of view, migrant networks are thought to have a key role in determining domestic immigration in developing countries, primarily in the immigration of the poorest.

A study by Beine *et al.* (2011) looked at the effects of diasporas [2] and found that they increase international migration flows and decrease the educational level of these flows. The effect of migrant networks seems to be more relevant for the less skilled, because as the networks expand, the costs and risks of migration decrease. Beine and Salomone (2013) analyzed the effects of networks on international migration in relation to education and gender. The results show the impacts vary due to differences in education, that is, such networks have heterogeneous effects regarding high-skilled and low-skilled migrants, as the literature suggests, networks were found to favor the migration of the less qualified. However, regarding gender the impact of networks was statistically identical between men and women of the same level of qualification.

Thus, the role of migrant networks would seem to differ according to the qualification level and income of the migrant. This paper extends the analysis and studies the role of the level economic growth of the places of origin and destination of immigration in this relationship. Some conceptual arguments support the existence of heterogeneous effects.

Firstly, underdeveloped places may have poor transportation infrastructure with no direct access to formal train, bus or air transport services. The World Health Organization (WHO, 2018) shows that Brazil reported 19 road traffic deaths per 100,000 inhabitants in 2016, making it the 14th worst result on a list of 175 countries. The history of the President Luiz Inácio Lula da Silva's migration from Pernambuco to São Paulo on an open-back truck [3] for lack of any other economically accessible means of transport illustrates this situation. Rioja (2003) shows the effectiveness of public infrastructure in Latin America corresponds to 74% of that of public infrastructure in industrialized countries. As in the case of the president Lula, this precariousness particularly affects the least skilled individuals who cannot afford to surmount the inadequate transport infrastructure. In this case, the experience accumulated by the migrant network can provide information and help regarding alternative forms of transport. By contrast, better qualified individuals, although also penalized, are better able to overcome the problem by using their own resources for transportation, such as their own car. According to this argument, the association of the existent migrant network with migratory flows of unskilled individuals would be expected to diminish with the economic dynamism, particularly of the place of origin. This is because migrants in general may avoid destinations that lack a minimally adequate transport infrastructure, and network performance is not observed in these cases.

Secondly, the most qualified individuals can derive specific benefits from the migrant network when departing from more developed locations. The literature shows that young skilled individuals seek employment opportunities in places with a business environment, while retired qualified individuals are attracted by quality of life rather than business environment (Gabriel & Rosenthal, 2004; Chen & Rosenthal, 2008). While the quality of the business environment may be indicated by the economic dynamism of the destination, the quality of life afforded by the amenities available in smaller or coastal cities lacks any such objective indicators. Comparative information on the quality of life in the destination, which may compensate for a better economic condition in the origin may be provided by the tacit

knowledge held by the migrant network. A fellow countryman that is aware of the amenities available in the destination can provide a comparative assessment that supports the decision to migrate. According to this argument, the association of the migrant network with migratory flows of skilled individuals would be expected to increase with the economic dynamism of the places of origin.

Thirdly, more economically dynamic target destinations may also have higher installation and adaptation costs. These may be incurred in a passive manner, for example due to formal landlord and tenant relationships that require the existence of a guarantor as a prerequisite for renting accommodation. In this case, a network of fellow countrymen may provide information about the real estate market and/or a guarantor. Such destinations may also have more complex, formal working relationships involving larger companies, which also provides scope for installed migrant networks to provide help. Barriers to migration in more developed locations may be more proactive in nature. [Feler and Henderson \(2011\)](#) show that “Localities in developed countries often enact regulations to deter low-income households from moving in”, the authors study how the Brazilian dictatorship prevented the internal migration of unskilled individuals by withholding water supplies to small houses where low-income migrants are likely to live. According to these arguments, the association of the network with the migrant flow generally increases with the economic condition of the place of destination and is accentuated for new, less qualified migrants.

3. Theoretical foundation

The main theoretical models regarding the migration decision were developed by [Borjas \(1987\)](#) and [Chiquiar and Hanson \(2005\)](#). The work of [Beine et al. \(2011\)](#) added to earlier migration decision models by including the effects of networks on the likelihood of migrating. [Beine and Salomone \(2013\)](#) added the gender dimension to the model. As the aim of this paper is to analyze the role of networks on the size and composition of migration flows in Brazil between 2001 and 2010, the theoretical model of this study is based on the model proposed by [Beine et al. \(2011\)](#).

A worker with units of human capital h , receives a wage $w_i h$ at his place of origin i , while w_i is the price of skills at that place i . To facilitate the description of the model, the time index t has been omitted from the equations. Individual utility is linear in income, but also depends on the characteristics of the place of origin, such as public expenditure, climate, and amenities, which are denoted by A_i .

The utility of the type h individual, born at location i remaining at place i is given by (for the sake of clarity, we have omitted the index t for the time dimension):

$$u_{ii}(h) = w_i h + A_i + \varepsilon_i \quad (1)$$

The utility obtained when the same individual migrates to location j is given by:

$$u_{ij}(h) = w_j h + A_j - C_{ij} + \varepsilon_j \quad (2)$$

Where C_{ij} captures the migration costs to be absorbed by the individual migrant, these costs depend on factors such as the geographical distance between locations i (origin) and j (destination), denoted by d_{ij} , the social and cultural characteristics of the destination and origin locations (x_i, x_j) , as well as the level of human capital of the individual h and the network of migrants (stock) from the location i residing in j , denoted by M_{ij} , of the economic growth of the places of origin and destination (y_i, y_j) and the interaction between M_{ij} and these levels of development $(M_{ij} \times y_i, M_{ij} \times y_j)$. Thus migration costs can be described as:

$$C_{ij}(h) = c\left(d_{ij}, x_i, x_j, y_i, y_j, M_{ij}, M_{ij} \times y_i, M_{ij} \times y_j; h\right) \quad (3)$$

This paper analyzes the association of the migrant network (M_{ij}) with migration flows with different educational levels, as well as the association of migration flows with the interactions of the migrant network with the economic growth of places of origin ($M_{ij} \times y_i$) and destination ($M_{ij} \times y_j$). Networks are assumed to reduce transport, information and assimilation costs. Thus, we expect the migrant network has a positive association with migration flows.

The association of migration flows with the interaction of the migrant network with the economic growth of the place of origin ($M_{ij} \times y_i$) may vary according to the educational level of the migrants. On the one hand, a negative coefficient is expected for the interaction between migration network and economic growth in the place of origin for low-skilled migrants. Such migrants are the most penalized by the lack of transport infrastructure typical of poorly-developed regions and can thus gain greater benefits from the knowledge of transport alternatives accumulated by the migrant network. On the other hand, a positive coefficient is expected for the interaction between the migrant network and economic growth in the place of origin for highly-skilled migrants. Such migrants can use the comparative knowledge obtained from the migrant network to arbitrate a migration decision by comparing the economic condition in the place of origin and amenities at the proposed destination.

The coefficient of interaction of the migrant network with the economic growth of the destination ($M_{ij} \times y_j$) is expected to be positive for all educational levels in the migration flows. In this case, the network would be expected to provide assistance with job-related activities, which are more complex in more dynamic destinations.

The size of the native population of migration age in place i is denoted by N_{ii} . After analyzing the set of variables that influence migration flows, we can write [equation \(4\)](#):

$$\ln \left[\frac{N_{ij}(h)}{N_{ii}(h)} \right] = (w_j - w_i)h + (A_j - A_i) - c \left(d_{ij}, x_i, x_j, y_i, y_j, M_{ij}, M_{ij} \times y_i, M_{ij} \times y_j; h \right) \quad (4)$$

The model presented in [equation \(4\)](#) allows us to analyze the main features of migration flows, especially how migrant networks influence the size of such flows.

4. Materials and methods

This section describes the variables associated with the interstate migration flows in Brazil from 2001 to 2010, their size and their educational composition by educational levels in different Federal Units (FUs) of origin and destination. In line with the theoretical model, the impact of migrant networks among other factors associated with recent migration flows were evaluated.

4.1 Data

The estimates are based on microdata from the 2010 Census microdata, produced by the Brazilian Institute of Geography and Statistics (IBGE) that have been aggregated by federative unit of origin and destination. To calculate the migrant networks, we considered the stock of individuals born in FU i , residing in FU j , at time $t-1$. To calculate the migration flows, we considered the stock of individuals previously living in FU i and who migrated to FU j , in year t . The year of migration t was calculated considering the reported length of time in the FU of residence in 2010. The sample consists of 7020 observations, which describe flows and networks of 702 pairs ij from 2001 to 2010.

Four levels of education were considered: incomplete primary school, complete primary school, complete secondary school and tertiary education. Low-skilled individuals were defined as those who had completed primary school and high-skilled individuals those who had completed secondary school or tertiary education.

[Table 1](#) shows the stock of migrants from 2000 to 2009 by FU of birth.

Federal unit	Number of migrants	Stock/population
Paraíba	984,881	0.261
Piauí	733,833	0.236
Alagoas	588,959	0.189
Pernambuco	1,603,596	0.182
Paraná	1,841,041	0.176
Bahia	2,387,659	0.170
Maranhão	1,089,190	0.166
Minas Gerais	3,093,606	0.158
Ceará	1,234,696	0.146
Sergipe	294,005	0.142
Tocantins	163,556	0.118
Espírito Santo	413,669	0.118
Rio Grande do Norte	372,250	0.118
Mato Grosso do Sul	227,582	0.093
Goiás	526,410	0.088
Rio Grande do Sul	889,918	0.083
Santa Catarina	514,535	0.082
Acre	50,108	0.068
Distrito Federal	157,836	0.061
Pará	425,381	0.056
Mato Grosso	168,538	0.056
Rio de Janeiro	634,663	0.040
São Paulo	1,583,686	0.038
Amazonas	118,570	0.034
Rondônia	50,080	0.032
Amapá	18,655	0.028
Roraima	11,830	0.026

Table 1.
Stock of migrants by
FU of birth

Source(s): 2010 Census, table created by authors

Of the ten FUs with the highest stock/resident population ratio, eight are from the Northeast. The FU with the largest stock of emigrants in relation to its population is Paraíba, followed by Piauí and Alagoas.

Table 2 shows the ranking of the 15 largest paired *ij* flows. The cumulative flows from 2001 to 2010 are generally composed of low-skilled migrants. In addition, most of the *ij* pairs with the largest flows are, in general, also those with the largest migration networks. For example, Bahians living in São Paulo have the second largest network of individuals residing in a different state from where they were born, and the BA-SP pair has the largest flow of *ij* pairs from 2001 to 2010, moreover 73% of this volume is composed of low-skilled migrants.

The *ij* pair with the lowest ratio of flow of low-skilled is Acre-Rio Grande do Sul, followed by Roraima-Paraíba, with less than 2% of the flow being low-skilled. These pairs are also placed 640th and 575th, respectively, in the volume of migrant networks [4].

4.2 Variables associated with migration flows

In the theoretical model described in equation (4), the main variables associated with migration flows are the wage differential (specific to each skill level), the features of the places of origin and destination or amenities, and the migration costs.

In the empirical analysis, the specific factors of the *ij* pairs that influence migration costs are captured by the geodetic distance between the FUs of origin and destination. The lagged [5] *per capita* GDPs of the origin and destination FUs were used to capture the economic growth (as origin and destination fixed effects are applied, the coefficients of the *per capita*

Table 2.
Ranking of the 15
largest accumulated
migration flows and
networks

<i>ij</i> pair	Accumulated flow	Low-skilled flow	Low-skilled %	Migrant network	Network ranking
<i>BA-SP</i>	238,867	174,411	0.73	1,365,687	2
<i>MG-SP</i>	202,070	115,773	0.57	1,407,474	1
<i>SP-MG</i>	170,921	98,430	0.58	263,560	14
<i>PE-SP</i>	113,573	86,393	0.76	831,640	4
<i>SP-BA</i>	108,442	72,939	0.67	97,255	50
<i>SP-PR</i>	129,059	69,342	0.54	424,331	6
<i>PR-SC</i>	116,894	69,080	0.59	270,218	12
<i>PR-SP</i>	115,993	65,425	0.56	879,776	3
<i>MA-PA</i>	78,679	62,087	0.79	339,027	8
<i>CE-SP</i>	69,450	50,091	0.72	401,854	7
<i>DF-GO</i>	84,490	49,613	0.59	71,771	66
<i>RS-SC</i>	100,971	47,080	0.47	331,613	9
<i>PI-SP</i>	54,212	42,088	0.78	206,565	20
<i>AL-SP</i>	50,682	40,784	0.80	294,823	10
<i>SP-PE</i>	52,886	36,530	0.69	43,018	99

Source(s): 2010 Census, table created by authors

GDPs capture only their within variation, i.e. economic growth) of the federative units, which may also reflect the effect of the wage differential on migration [6].

The fixed effects of the origin FU that capture the combined effect of all unobserved time-constant features of the origin FU i were included. The same fixed effects also capture all the migration-related impediments or facilitations specific to the origin FU (x_i) in equation (1).

Similarly, the fixed effects of the destination FU that capture the combined effect of unobserved time-constant features of the destination FU, as well as the migration-related impediments or facilitations to the destination FU were also included.

The inclusion of these fixed effects for origin and destination also captures the effects of the amenities (A_i and A_j). Time fixed effects from 2001 to 2010 were also included, as were cluster effects in the FU ij pairs due to the possibility that the random errors of the ij pairs could be correlated.

Finally, the migrant network (i.e. the stock of individuals born in FU i residing in FU j at time $t-1$) are denoted by the variable (M_{ij}).

The introduction of these variables provides a specification for the migration flow, now explaining the t index of the time dimension:

$$\ln[N_{ijt}(h)] = \alpha_0 + \alpha_1 \ln(M_{ij(t-1)}) + \alpha_2 \ln(d_{ij}) + \alpha_3 \ln(\text{PIBpc}_{i(t-1)}) + \alpha_4 \ln(\text{PIBpc}_{j(t-1)}) + \gamma_i + \gamma_j + \gamma_t + \varepsilon_{ijt} \quad (5)$$

Where $N_{ijt}(h)$ is the flow of migrants observed in year t born in FU i residing in FU j , with the educational level h , $M_{ij(t-1)}$ is the size of the migrant network in the ij pair in $t-1$. Fixed effects for FU i , FU j and t are captured by γ_i , γ_j and γ_t , respectively.

The main estimable equation including interactions of the existent migrant network with lagged *per capita* GDP is shown in equation (6):

$$\ln[N_{ijt}(h)] = \beta_0 + \beta_1 \ln(M_{ij(t-1)}) + \beta_2 \ln(M_{ij(t-1)}) \times y_i + \beta_3 \ln(M_{ij(t-1)}) \times y_j + \beta_4 \ln(d_{ij}) + \beta_5 \ln(\text{PIBpc}_{i(t-1)}) + \beta_6 \ln(\text{PIBpc}_{j(t-1)}) + \gamma_i + \gamma_j + \gamma_t + \varepsilon_{ijt} \quad (6)$$

4.3 Econometric issues

The estimation of migration flows, eq. (5) involves econometric issues that may cause inconsistency if estimated using ordinary least squares (OLS) alone.

The first problem is related to the occurrence of zero values for the dependent variable, “migration flow”. The second problem is the potential correlation between migrant networks, denoted by $\ln M_{ijt}$ with the random error, denoted by ε_{ijt} . The presence of unobservable components that affect both the size of the migrant network and the characteristics of new migrants can lead to endogeneity problems in the estimations. For example, in Santa Catarina discrimination against individuals born in the neighboring state of Rio Grande do Sul might inhibit them from emigrating there.

4.3.1 Zero value for the dependent variable. Among the migration flows analyzed, the flow of individuals with complete primary schooling constitutes the largest number of nonexistent observations (equal to zero), representing 30% of the sample in this group, followed by the migration flows of individuals with tertiary education, for which there are 1,929 flow observations equal to zero, representing 27% of the sample in this group. In the other flows, 17% of the observations are equal to zero. There are no observations whose migrant network is zero.

These occurrences of zero values in the estimation of equation (5) using OLS could lead to inconsistent estimates. Using the natural logarithm specification reduces the zero observations in the sample, which would likely result in biased estimates of the association of networks and other variables on migration flows.

Excluding these observations could underestimate the impact of variables that affect migration costs, such as distance or the migrant network.

Two techniques are available to address this problem. The first is to use the Poisson regression, which is based on pseudo-maximum likelihood estimates. This procedure is common in the trade literature [7], Poisson estimates are viable for analyzing the impact of the networks on the flows. The other way involves using techniques that take into account a potential selection bias via two-stage Heckman estimation. In general, when analyzing migration flows it is first necessary to estimate a selection equation - to estimate the probability that a given ij pair will have a positive migration flow. The usual procedure implies the use of an instrument in the probit equation, that is, a bilateral variable that influences the probability of observing a migrant flow between the two FUs, but does not influence the volume of the flow. Finding such an instrument is hard work. Wooldridge (2008) reports that an instrument for this procedure is not absolutely necessary. We chose to perform two-stage Heckman regressions without any instrument, similarly to Beine *et al.* (2011).

4.3.2 Unobservable variables correlated with networks. Another important econometric issue is the possibility that unobservable bilateral components may affect the size of the migrant networks (M_{ij}) and the dependent variables (migration flows by educational level). For example, socioeconomic and cultural patterns between an FU i and an FU j may simultaneously affect the migrant network (stock) and recent migration flows as well as the selection of these flows. These effects will be included in the error term, which in turn leads to some kind of omitted variable bias and some correlation between M_{ijt} and its interactions with the error term, ε_{ijt} .

To mitigate this problem, it is necessary to use an instrument, a variable correlated with the size of the migrant network, but uncorrelated with the migration flows from 2001 to 2010. For this purpose, the variable “migrant stock par ij from 1974 to 1980”, extracted from the 1980 census, was used. To construct the stock, individuals younger than 45 years old in 1980 were excluded from the sample, thus avoiding their inclusion in the migration flows from 2001 to 2010. As the state of Tocantins had not yet been created in the 1980s, the flows

containing Goiás and Tocantins as the state of birth were excluded from the estimates, as it is impossible to separate the natives from these states in data from the 1980 Census. The stocks of migrants prior to 1974 were also excluded, as information from the database does not provide length of residence in the federative unit when the respondent lived for more than six years in that FU. Thus, the flows prior to 2005 (for which inventory information for the previous 30 years was not observed) were also excluded from the sample.

The migrant network (stock) from 1974 to 1980 is expected to be associated with the migrant network from 2005 to 2010, but not the contemporary flows of migrants from the UF i . In other words, the low degree of serial correlation in the variable “migrant stock from 1974 to 1980” ensures that the instrumental variable (IV) is not correlated with the dependent variable (migrant flow). A number of studies use historical state migration rates as an instrument for migrant networks (McKenzie & Rapoport, 2010; Hildebrandt, McKenzie, Esquivel, & Schargrodsky, 2005).

5. Results and discussion

5.1 Simple association of existent migrant network and migratory flows

Table 3 presents the results of the estimations for the simple association of existent migrant network with migratory flows and, with no interactions with growth. This provides a starting point that allows estimating an average association, comparable with the literature. Columns (1) to (3) show the results for the total flows $Ln(flow)$, while columns (4) to (5) show the results for the flows of low-skilled migrants. $Ln(flow-prim)$ corresponds to the flow of individuals with incomplete primary school and $Ln(flow-prim)$ corresponds to the flow of individuals with primary school. The flows of highly-skilled migrants are presented in columns (6) and (7). $Ln(flow-sec)$ corresponds to the flow of individuals with secondary education and $Ln(flow-ter)$ corresponds to the flow of individuals with tertiary education.

The estimates obtained via OLS from equation (5) are presented in columns (1), where 454 observations with zero migration flows have been eliminated from the estimation and in column (2) where zero flow observations have been replaced by $\ln(flow + 1)$. Columns (3) to (7) report the results of the two-stage Heckman estimations where regressions without additional instruments are used as a reference. Estimates of the selection equation (1st stage) are presented in Table A1 in the Appendix.

Cameron and Trivedi (2005) show that not using an instrument in Heckman’s first stage can lead to regression multicollinearity problems, although the problem is less severe if there is large variation in the regressions across sample observations in first stage estimates. With this concern in mind, the Mills Inverse Variance Inflation Factor (VIF) was estimated in a Heckman two steps procedure, the results are presented in Table 3 and do not indicate an important multicollinearity.

The correlation of networks with migration flows was found to be statistically significant, with a positive coefficient for all educational levels. As expected, the OLS estimation, column (1), produces an underestimated coefficient due to the exclusion of zero observations and to the selection bias. In this estimation, a 10% increase in the network of immigrants is associated with a 7.40% increase in the flow of immigrants. Methods that account for these zero values lead to slightly higher estimates. Although the context of this study is different, the magnitude of the coefficients of the network variable is comparable to that found by Beine (2016).

The Poisson estimations (see the Appendix - Table A2), in general, present coefficients that are slightly higher although close to those found with two-stages Heckman estimates, emphasizing the robustness of the results.

The correlation of networks with flows is greater for low-skilled migration flows, as predicted in the self-selection theoretical model. For low-skilled migration flows, a 10%

Method	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Ln(flow ijt)	Ln(flow ijt)	Ln(flow ijt)	Ln(flow- iprim ijt)	Ln(flow- prim ijt)	Ln(flow- sec ijt)	Ln(flow- ter ijt)
	OLS		Heckman	Low-skilled Heckman		High-skilled Heckman	
Ln migrant networks ij(t-1)	0.74*** (0.02)	0.76*** (0.02)	0.75*** (0.02)	0.94*** (0.02)	0.76*** (0.02)	0.66*** (0.02)	0.38*** (0.02)
Ln distance ij	-0.20*** (0.04)	-0.25*** (0.05)	-0.20*** (0.04)	0.04 (0.05)	-0.05 (0.04)	-0.23*** (0.03)	-0.51*** (0.04)
Ln <i>pc</i> GDP i(t-1)	-0.67*** (0.23)	-0.59** (0.30)	-0.63*** (0.23)	-0.09 (0.29)	-0.14 (0.32)	-1.46*** (0.28)	-0.40 (0.31)
Ln <i>pc</i> GDP j(t-1)	0.01 (0.22)	0.24 (0.29)	0.03 (0.22)	-0.08 (0.28)	0.33 (0.31)	0.34 (0.28)	-0.23 (0.32)
FE i			Yes	Yes	Yes	Yes	Yes
FE j			Yes	Yes	Yes	Yes	Yes
FE t			Yes	Yes	Yes	Yes	Yes
Cluster ij			Yes	Yes	Yes	Yes	Yes
Rho			0.20*** (0.03)	0.30*** (0.04)	0.40*** (0.04)	0.31 *** (0.03)	0.46*** (0.03)
Mills Inverse - VIF			2.07	3.17	4.44	3.64	4.12
R ²	0.87	0.84					
Uncensored Observations			6.566	5.759	4.942	5.794	5.091
Observations	6.566	7.020	7.020	7.020	7.020	7.020	7.020

Table 3. Determinants of migration flow by educational level: OLS and Heckman regressions

Note(s): Robust standard errors in parentheses
 ****p* < 0.01, ***p* < 0.05, **p* < 0.1
 Selection equation: $pbf_educ_tot = \text{Ln migrant networks } ij(t-1) \text{ Ln distance } ij \text{ Ln } pcGDP \text{ } i(t-1) \text{ Ln } pcGDP \text{ } j(t-1) \text{ } i, \text{year } i, j$
Source(s): Table created by authors

increase in the network of immigrants is associated with a 9.4% and 7.6% increase in the flow of immigrants in columns (4) and (5) of Table 3, respectively. This is because a large network of migrants diminishes the advantage that individuals with higher levels of human capital have in reducing migration costs.

These costs, which are captured by the bilateral distance between the FUs, present statistically significant coefficients on the estimation of total and the highly-skilled migration flows. The coefficient of distance is greater for tertiary migrants than for secondary school migrants. The coefficient of distance for the low skilled (migrants with complete or incomplete primary school) are not statistically significant. These results are in contrast to those found by Beine *et al.* (2011) for international migration flows, in which the effects of distance are greater for low-skilled workers.

The lack of statistical significance of distance for low-skilled migration flows may suggest that, for this group, the choice of destination is correlated with other variables, which somewhat weaken the linear relationship between migration choice and distance. It is important to note that the costs of a migration within a country with the same laws and language are much less expensive than a migration between countries. As pointed out by Beine and Salomone (2013), this does not mean that distance does not affect destination choice unconditionally, however in some cases distance (or cost of migrating) will not be the driving force of migration choice.

The *per capita* GDP lagged coefficient of destination is not significant for migration flows of highly-skilled individuals, suggesting that for this group the destination's economic

growth alone (with no interaction with migrant network) is not relevant in the decision-making process regarding migration.

Table 4 presents the estimates using the instrumental variable for the migrant networks in equation (5). Observations of flows prior to 2005 and all *ij* pairs containing the states of Goiás and Tocantins as their state of birth were excluded. In all, 4,550 observations remained.

The results from the IV estimation produce similar coefficients for the correlation of the existent network with migration flows to those found with the OLS and two-stage Heckman estimations. For example, if we compare the corresponding sample estimates, the coefficient of column (7) in Table 3 is 0.38, which is close to the coefficient of column (5) of Table 3, which is 0.38. This proximity of magnitude of coefficients of the network variable happens between all the corresponding estimations of Table 3 and Table 4. Statistical significance remains high, emphasizing the quantitative and statistical importance of networks on migration flows. Thus, it is concluded that the estimated correlation of existent networks with migratory flows is robust to several econometric specifications, including the treatment of selection bias and the correlation of migrant networks with unobserved factors of the flows.

5.2 Interactions of existent migrant network and economic growth

In this section we estimate the main equation of the article (6), which includes the interaction between the existent migrant network and the *per capita* GDP of origin and destinations place (remembering that origin and destination fixed effects are applied, thus the coefficients of the *per capita* GDPs capture the economic growth). The two-stage Heckman estimations are presented in Table 5.

The estimates of the selection equation (1st stage) are presented in Table A3 in the Appendix.

The interactions of migrant networks with *per capita* GDP lagged, whether in the origin state or the destination state, show the expected signs. The results show the association of existent networks with migration flows increases with the economic growth of the

Method	(1)	(2)	(3)	(4)	(5)
	Ln(flow ijt)	Ln(flow-iprim ijt)	Ln(flow-prim ijt)	Ln(flow-sec ijt)	Ln(flow-ter ijt)
	IV	IV	IV	IV	IV
Ln migrant networks ij(t-1)	0.68*** (0.03)	0.84*** (0.03)	0.64*** (0.03)	0.60*** (0.03)	0.38*** (0.03)
Ln distance ij	-0.28*** (0.05)	-0.10* (0.06)	-0.17*** (0.05)	-0.30*** (0.04)	-0.47*** (0.05)
Ln <i>pc</i> GDP i(t-1)	-0.82*** (0.30)	-0.41 (0.45)	-0.36 (0.43)	-1.35*** (0.41)	-0.86* (0.48)
Ln <i>pc</i> GDP j(t-1)	0.71** (0.33)	0.57 (0.40)	1.05** (0.44)	0.74* (0.43)	0.43 (0.52)
FE i	Yes	Yes	Yes	Yes	Yes
FE j	Yes	Yes	Yes	Yes	Yes
FE t	Yes	Yes	Yes	Yes	Yes
Cluster ij	Yes	Yes	Yes	Yes	Yes
F of the 1 st stage	177.20	164.90	177.75	173.87	171.08
R ²	0.88	0.83	0.78	0.81	0.75
Observations	4006	3623	3176	3644	3297

Note(s): Robust standard errors in parentheses

****p* < 0.01, ***p* < 0.05, **p* < 0.1

Source(s): Table created by authors

Table 4.
Migration flow
determinants: IV
estimation

Method	(1)	(2)	(3)	(4)	(5)	(6)
	Ln(flow ijt)	Ln(flow ijt)	Ln(flow- iprim ijt)	Ln(flow- prim ijt)	Ln(flow- sec ijt)	Ln(flow- ter ijt)
	Low-skilled		High-skilled			
	OLS	Heckman	Heckman	Heckman	Heckman	Heckman
Ln migrant networks ij(t-1)	0.67*** (0.06)	0.69*** (0.06)	0.73*** (0.08)	0.46*** (0.08)	0.45*** (0.06)	-0.05 (0.07)
Ln distance ij	-0.24*** (0.04)	-0.24*** (0.04)	-0.01 (0.05)	-0.09** (0.04)	-0.25*** (0.03)	-0.48*** (0.04)
Ln <i>pc</i> GDP i(t-1)	-0.28 (0.26)	-0.22 (0.26)	0.32 (0.34)	0.20 (0.39)	-1.37*** (0.32)	-1.24*** (0.34)
Ln <i>pc</i> GDP j(t-1)	-0.58** (0.25)	-0.54** (0.25)	-1.16*** (0.33)	-0.95*** (0.36)	-0.41 (0.30)	-0.83** (0.34)
Ln of migrant networks ij(t-1) *Ln <i>pc</i> GDP i(t-1)	-0.06*** (0.02)	-0.06*** (0.02)	-0.05* (0.03)	-0.04 (0.03)	-0.01 (0.02)	0.10*** (0.02)
Ln of migrant networks ij(t-1) *Ln <i>pc</i> GDP j(t-1)	0.08*** (0.02)	0.07*** (0.02)	0.13*** (0.02)	0.15*** (0.02)	0.09*** (0.02)	0.07*** (0.02)
FE i	Yes	Yes	Yes	Yes	Yes	Yes
FE j	Yes	Yes	Yes	Yes	Yes	Yes
FE t	Yes	Yes	Yes	Yes	Yes	Yes
Cluster ij	Yes	Yes	Yes	Yes	Yes	Yes
Rho		0.18*** (0.03)	0.27*** (0.04)	0.35*** (0.04)	0.27*** (0.03)	0.37*** (0.03)
Mills Inverse - VIF		2.07	3.17	4.44	3.64	4.12
R ²	0.87					
Uncensored Observations		6.566	5.759	4.942	5.794	5.091
Observations	6.566	7.020	7.020	7.020	7.020	7.020

Table 5.
Determinants of
migration flows with
interactions of the
variables

Note(s): Robust standard errors in parentheses
****p* < 0.01, ***p* < 0.05, **p* < 0.1
Source(s): Table created by authors

destination state for all education levels. The increase is larger for new low-skilled migrants and smaller for new high-skilled migrants. This is indicated by the positive coefficient for the interaction between the network logarithm and the destination lagged *per capita* GDP logarithm, which is positive and significant in the six regressions in Table 5. The coefficient ranges from 0.07 for individuals with tertiary education in column (6) to 0.15 for individuals with primary education in column (4). Considering the 15 largest accumulated migration flows and networks (from Table 2), the first coefficient shows that a 10% growth in the *per capita* GDP lagged of the destination state is associated with a 9.06% [8] increase in the association of the migrant network with the migration flow of more skilled (with tertiary education levels). The second coefficient shows that a 10% growth in the *per capita* GDP lagged of the destination state is associated with a 19.4% [9] increase in the migration flow of low-skilled individuals. Economic development can mean more complex working relationships and difficulty finding housing, where the migrant network may be of greater importance in intermediating information and opportunities. The higher the qualification of the new migrant, the lower the margin for this possible benefit.

On the other hand, the economic growth of the state of origin distinctly determines the role of the network, according to the new migrant's educational level. If we consider only the terms that contain the network of migrants in column (3), concerning individuals with incomplete primary education, we have: $Ln(flow-iprim_{ijt}) = 0.73Ln(migrant\ networks_{ij(t-1)}) - 0.05Ln(migrant\ networks_{ij(t-1)})Ln(pc\ GDP_{i(t-1)}) + 0.13Ln(migrant\ networks_{ij(t-1)})Ln(pc\ GDP_{j(t-1)})$

The partial derivative of the logarithm of migration flows with respect to the migrant network on the is: $\frac{\partial \ln(\text{flow-}i\text{prim}_{ijt})}{\partial \ln(\text{migrant networks}_{ijt(t-1)})} = 0.73 - 0.05 \ln(\text{gdp}_{i(t-1)}) + 0.13 \ln(\text{gdp}_{j(t-1)})$

That is, the lower the lagged growth in the state of origin, the greater the correlation of the network with flows. In a state of origin with a declining economy, the lack of resources of the less educated individuals is penalized when the individual wishes to immigrate. The lack of local structure may inhibit access to adequate public transport. This may be more difficult to overcome for poorer individuals, who have few resources at their disposal. In this case, the network, which has accumulated experience in such transportation, can provide information to the new migrant, suggest alternative means of transportation and/or even pay for the costs. This effect is not statistically significant for individuals with complete primary education and complete secondary education (columns (4) and (5)), although the respective coefficient (of the interaction of the log of the state of origin *per capita* GDP lagged and of that of the migrant network) is also negative.

For individuals with tertiary education, an increased state of lagged growth increases the positive correlation of the network with migration flows. This can be explained by the fact that such individuals have higher income, which provides more choice. Thus, these individuals can arbitrate between the high dynamism of the place of origin and the amenities of the state of destination. The most dynamic states in Brazil have the highest rates of violence and traffic accidents, with large cities often not located on the coast. The network, with knowledge of both contexts, can provide comparative information regarding the migration decision.

The variable logarithm of distance, which is a proxy for costs, has no statistical significance for the group of migrants with incomplete primary school, similar to the results shown in [Table 3](#). However, for the migration flow of individuals with primary education, the logarithm of distance gains statistical significance (in this case, a 10% variation in distance is associated with a reduction of migratory flows by 0.9%), suggesting that for this group, although the interaction of the economic growth of the place of origin with the network is not statistically significant, the costs alone may guide the migration decision.

The Poisson estimates ([Table A4](#) in the Appendix) generally have slightly higher coefficients when compared to the two-stage Heckman estimations presented in [Table 5](#). The association of the state of origin lagged growth with the network is not conclusive as it shows no statistical significance for any level of qualification.

The results of the IV estimation ([Table A5](#) in the Appendix) suggest that economic growth of the state of origin is positively associated the network, although regardless of the migrant's educational level, in contrast to those found with the Heckman estimation in that the development stage of the state of origin influenced the role of the network distinctly, according to the new migrant's educational level.

The destination state lagged growth also increases the positive correlation of the migrant network with migration flows in the Poisson and IV estimations. The increase is greater for new low-skilled migrants, corroborating the two-stage Heckman estimations, although for the migration flow of individuals with tertiary education, the Poisson and IV estimates have the opposite effect to that expected.

While there are divergences in the expected effect of interactions with the IV and Poisson estimations, the two-stage Heckman estimations are thought to simultaneously address the problems of selection bias and omitted variable bias, and is therefore considered the best estimator.

6. Conclusions

In conclusion, migrant networks have been found to have a statistically significant and positive correlation with migration flows, even when other variables that affect migration are

controlled. The results are robust for the several econometric techniques that adequately address the selection and endogeneity biases.

The contribution of this study lies in the analysis of the heterogeneous association of the migrant networks with migration flows according to the educational level of the new migrant and the economic growth of the states of origin and destination. The economic growth in the destination state increases the positive correlation of the migrant network with the migration flows of all individuals. Conversely, the economic growth of the origin state only increases this correlation for the new, more highly qualified migrants (only for those with tertiary education), while this correlation decreases for the new low-skilled migrants (only for individuals with incomplete primary education).

These correlations lead to some implications of the existent migrant networks for the economic development of Brazilian states. From the perspective of an immigration source state, the economic growth of that state is positively correlated with the emigration of high-skilled individuals and negatively correlated with the emigration of low-skilled individuals. In this case, there is a “net loss” of human capital caused not only by a brain drain, but also by the retention of low-skilled individuals. From the perspective of a state that is an immigration destination, the economic growth of that state is correlated with both the entry of low-skilled immigrants and the entry of high-skilled immigrants, with no clear effect on the “net loss or gain” of human capital.

The correlation of the migrant network with migrant flow, which is recognized in the empirical literature, may be modified by the economic growth of the places of origin and destination. The estimation conducted in a single developing country has permitted the reduction of the underlying theoretical mechanisms to those involving migration costs. This analysis can be extrapolated to international migration. Unskilled migrants from poor countries are expected to need help from migrant networks in order to obtain transportation from their countries of origin. Alternatively, skilled migrants from rich countries can be expected to obtain information that allows them to compare the economic conditions in the place of origin with any amenities at destination. Finally, for new migrants, regardless of their educational level, a network of compatriots can be expected to play a larger role when the destination is a developed country, where accessing the labor market and finding housing tend to be more complex.

Estimates made in this study are limited to a period of time (2001-2010), later migratory patterns may have changed and require further research. Moreover, in future studies the heterogeneous correlations of networks with flows on gender and age can be verified.

Notes

1. Data for the 2010 Brazilian Census show 26.3 million people (13% of the population) were living in Federal Units (states) other than those in which they were born.
2. A diaspora is the displacement of large populations originating from a given region to several distinct host regions, in general the name given to the dispersal of any people or ethnicity around the world.
3. See <http://www.institutolula.org/en/biography>, consulted on 6 May 2019.
4. The complete table with all 702 accumulated flows per pair can be requested from the authors.
5. Lagged *per capita* GDP are used to mitigate spurious correlation with migratory flows.
6. Estimates were also made using the GDP at constant prices in 2010 of the origin and destination FUs and the size of the origin and destination FU population. The results are similar to baseline estimates and may be requested from the authors.
7. For more details, see: [Silva and Tenreyro \(2006\)](#).

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8. This number is obtained by $0.0906 = 0.1 * 0.07 * \ln(416195)$ 416195 is the average for networks from [Table 2](#)
9. This number is obtained by $0.194 = 0.1 * 0.15 * \ln(416195)$ 416195 is the average for networks from [Table 2](#)

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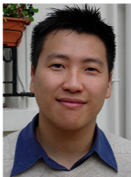
Appendix

The Appendix file for this article can be found online.

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