Internal migration in Brazil: Exploring migration of high-skilled workers towards economic complex locations

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Abstract. This paper researches the determinants for internal migration in Brazil towards economic complex cities using logit estimates on data of the Brazilian Census in 2010. It contributes to existing literature in the way that it is part of the first academic works combining internal migration patterns with economic complexity, a measure of economic growth. The most important findings of this paper are twofold. Firstly, people who already lived in an economic complex city in 2005 had a higher probability of migrating to another economic complex city in 2010 than people who did not live in an economic complex city in 2005. Secondly, low-skilled workers (at most completed high school) have a lower probability of migrating to an economic complex city than high-skilled (at least graduated) workers, which is in line with the expectations. Studying internal migration patterns is of importance as national and regional policymakers could get more understanding of the internal migration patterns towards economic complex locations and use the findings of this paper to steer internal migration in Brazil.

JEL-classification: C25, J61, R23

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1. Introduction

Brazil has a large history of internal migration patterns. Ever since the first settlers set foot in Brazil in the 16th century, most internal migration flows were caused by economic reasons. A study by Focus Migration (2008) shows that in the 16th and 17th century many people were active in the sugar cane production in the northeastern parts of Brazil, especially in Pernambuco, where, during the boom period, this crop and gold had almost the same value. In the later part of the 17th century however, according to Naritomi et al. (2012), the sugarcane production began to subside due to competition of other Latin American countries and inefficient presence of the Portuguese state. As the sugarcane sector was less flourishing than

before, people started to migrate towards gold and diamond mines in the South, especially in the state of Minas Gerais. Filho and Martins (1983) state that Minas Gerais became the economic center of the country, attracting also people from other areas in Brazil.

The next large internal migration flows of Brazil occurred in the 19th century, when coffee trade was in its heyday. In the southeastern parts of Brazil the coffee plantations flourished and thousands of job seekers migrated towards this area. Also external (foreign) workers, especially Italians, but also the Portuguese and Spaniards, were demanded as the coffee plantations could not only be managed by Brazilians (Focus Migration, 2008). In Minas Gerais, the fastest growing coffee region of Brazil at the end of the 19th century, exports raised significantly, leading to increased economic growth rates in the region. According to Filho and Martins (1983) other areas with a dominant coffee industry, like Paulista West and the Paraiba Valley in Rio de Janeiro and Sao Paulo, showed an expansion of exports as well, leading to increasing export and growth rates for the whole country of Brazil.

More recently, in the past century, industrialization determined the migration destination of people in Brazil: the population movements were caused due to the trajectories that were imposed by the transformations taking place in Brazil's economy (Sessao, 2001). According to Vainer and Brito (2001), industrialization created new jobs in the country and led to huge urbanization processes. People from the countryside migrated to the big cities as there would be more job opportunities and higher income possibilities, increasing Brazil's urban population rapidly in only a few decades. Before the 1950's, the Brazilian urban network was only starting and at the roots of its expansion. The most populated urban areas at the time were in the states of São Paulo and Rio de Janeiro, where infrastructure was adapted to the size and growth of the urban population. Lima et al. (2016) state that there was a strong turning point at the 1950's, during which the expansion started to emerge. Migration trajectories from here on have been fundamental for Brazilian market development as Vainer and Brito pointed out (2001), because between 1950 and 1960 urban growth rates throughout the whole country increased rapidly with approximately 5.3% a year.

Following Martine and McGranahan (2010), this led to the fact that in 1950 only 36% of Brazil's population lived in cities, whereas in 1960 that was 45%. From the 1960's onwards, industrialization played a huge role in Brazil's migration patterns in a way that it brought along a variety of new jobs which were mainly located in the cities and not in the countryside (Focus Migration, 2008). The main pull-factor for Brazilian people was formed by the job opportunities, coming along with a push-factor, as the peasant population was suffering from increasing poverty rates. Amaral (2013) states that job opportunities for the peasant population decreased because of strong population growth and the industrialization of agriculture.

For two decades this rural-urban migration increased more and more and in the 1980's the country faced the consequences of these huge migration flows. The infrastructure in and outside the major cities became incapable of facilitating the flows of migration. As the phenomenon of industrialization reached its limits at the end of the previous century, all major cities were overloaded with job seekers. This led to high levels of unemployment and eventually the building of slums at the borders of cities. According to Martine and McGranahan (2010), the urbanization rates were still high at the beginning of the 21st century and in 2006, 84% of the inhabitants of Brazil lived in cities. From the beginning of the 21st century however, as stated by Rigotti (2006), one can observe new migration flows from the major cities of for instance São Paulo and Rio de Janeiro towards medium-sized cities in the inlands. Lima et al. (2016) state furthermore that emerging pull-factors as increasing job opportunities, higher safety standards and better provision of public services in these areas are the main causes.

Various scholars (Borjas, 2016; Morten and Oliveira, 2014; Sahota, 1968) agree on the fact that migration will lead to an increase in income in the destination region. Migrants tend to be positive selected groups: they are more open to risk and innovation. This probability is more expressive nowadays because the main migration flows in Brazil are urban-urban. Still, income can be distributed differently among individuals in a society. According to Freire (2011) and Borjas (2016), an increase in the skill wage gap in urban areas might happen when the amount of urban migrants increases, once migrants have lower levels of education and thus skills compared to urban workers.[1] Possible consequential income inequality is, apart from the ideological aspect of fairness, not preferred because of inequality of opportunities that can entail large social costs (Dabla-Norris et al., 2015), which makes it important to analyze where high- as well as low-skilled workers migrate to. Studies of the impact of rural-urban migration on urban wages contribute to the evaluation of both national and regional policy decisions. Freire (2011) and Hagen-Zanker (2008) state that regional policies have the power to steer the magnitude of rural-urban migration either upwards or downwards and high migration flows to a destination region might make labor scarce in the origin community, improving the job prospects of people left behind. Although, as migration explains 3% of the decrease in the wage gap between high- and low-skilled workers in Brazil between 1991 and 2000, migration flows show to be of importance for economic developments in destination regions (Freire, 2011).

Apart from internal migration theories, Hidalgo and Hausman (2009) introduced the concept of economic complexity, stating that the wealth of a nation is connected to its production structure: the set of products and services that a nation can deliver. In practice this

[1] This is mostly the case with rural migrants, as migrants tend to be a positive selected group: they are more risk-lovers and innovative

means that the products that a country is able to produce are more important than the extracted value of these products, as products have different levels of sophistication. These sophistication levels define the income of a country or a city, along with the variety of products that a country or city makes, decreasing the importance of the traded value of its exports. The production framework of countries or cities exists of local input availability that can be used for production, which Hidalgo and Hausman (2009) name 'capabilities': specific building blocks of production. Both tangible (airports, harbors) as intangible (skill, networks) inputs form capabilities and in order to produce certain products, a country or city needs the capabilities that are locally available. The more capabilities are needed to produce a certain product, the higher the sophistication level and economic complexity is derived from the available capabilities a country or city has. As this research elaborates on internal migration within the country of Brazil, the focus will be upon economic complexity in cities.

In 2010 the most recent Brazilian census took place, of which the results are representative for the whole country of Brazil (IBGE, 2010). This paper aims to use this census to see whether migrants move to economic complex locations and what the main determinants are, where a comparison is made between high and low-skilled workers. As economic reasons seem to be the most explaining factors of migration throughout the history of Brazil, Lima et al. (2016), Borjas (2016), Malamud and Wozniak (2012) and Haug (2009) state that job availability and the wage premium between the destination region and the current region are the main pull-factors.

As income differences can be explained according to the concept of economic complexity, the aim of this research is to find which people could migrate to economic complex cities. In that sense, this research question is to what extent do low and high-skilled workers have the same probability of migrating to an economic complex location?

The research question is used to find what the probability is of migration of high-skilled workers in Brazil in 2005 to an economic complex location in Brazil in 2010, using logit estimations for the empirical analysis, according to a model with variables that are constructed from the IBGE Census 2010 and economic complexity indices from DataViva/FAPEMIG (2015). The specification between high and low-skilled workers is made, to explore which group of workers has the highest probability to migrate internally to complex cities in Brazil.

In order to answer the research question five hypotheses are tested. The first hypothesis tests whether people who are living in more complex cities in Brazil have a higher probability of migrating to another complex city in Brazil. It is expected that the probability of migration of people who live in a complex city to another complex city is higher than the probability of migration of people who do not live in a complex city already. The higher human capital stock

and knowledge spillovers in complex cities are forming the explanation of this expectation, as externalities can improve a country's technological progress and therefore stimulate economic growth (Lucas, 1988; Romer, 1990). Schumacher et al. (2011) agree, stating that positive externalities arise from human capital and knowledge spillovers among others. The second hypothesis tests if high-skilled workers have a higher probability of migrating to an economic complex city than low-skilled workers. This paper expects that there is a higher probability of migration to economic complex cities for high-skilled workers than for low-skilled workers, as more complex cities require more capabilities of workers, so for workers more human capital is needed specifically (Hidalgo and Hausman, 2009). To give a complete profile of the high-skilled workers, a specification of high-skilled workers is made: an analysis is constructed to test whether workers with graduation, a master's degree or a PhD have the highest probability of migrating to an economic complex location. Furthermore, this paper aims to show in which occupational field the high-skilled workers with the highest probability of migrating to an economic complex location is active. The third hypothesis tests whether high-skilled young workers have a higher probability of migration to an economic complex location than high-skilled older workers. The fourth hypothesis tests whether high-skilled females have a higher probability of migrating to an economic complex cities than high-skilled males. Finally, the fifth hypothesis tests whether white high-skilled workers have a higher probability of migrating to an economic complex location than high-skilled workers with another skin color.

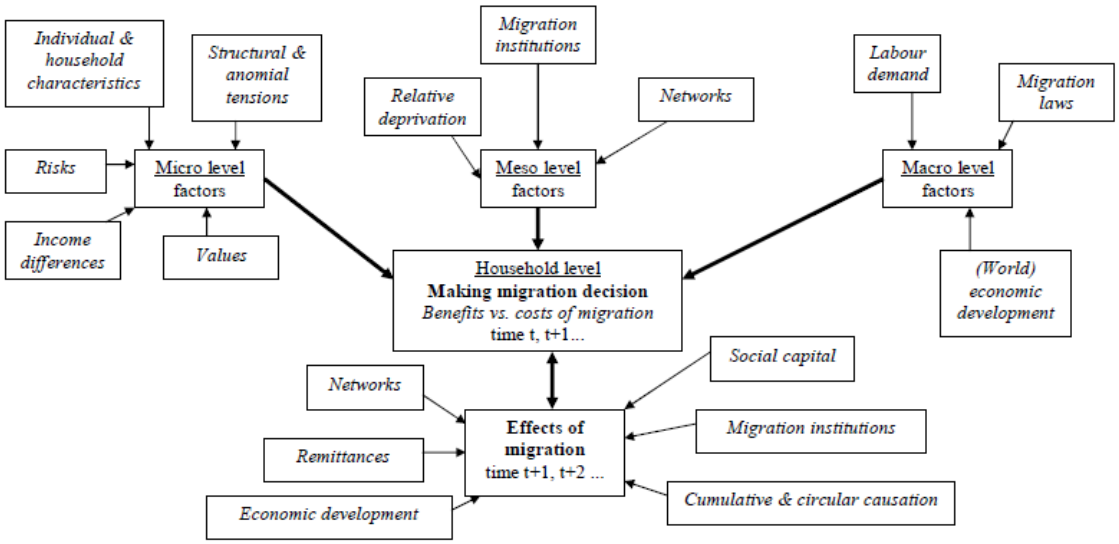
This paper is organized as follows. Section 2 gives an outline of the theoretical framework and overviews the main hypotheses. Section 3 gives the model and its variables as well as the data collection and a data description. Afterwards, in section 4 the results are presented. Section 5 outlines the conclusions of this research.

2. Theoretical Framework

2.1 Migration theories

As presented by Hagen-Zanker (2008), migration is defined as the temporary or permanent move of individuals or groups of people from one geographic location to another for distinct reasons, which can vary from employment possibilities to political reasons, with different levels from which the migration perspective can be viewed. The macro, meso and micro-levels are all contributing to whether people migrate on the individual (household) level (Figure 1).

Figure 1: Framework of migrants' decision-making



Source: Hagen-Zanker, 2008

One can see from Figure 1 that on the micro-level, values, income differences, risks, individual and household's characteristics, and structural tensions form the push- and pull-factors of migration. Micro-level economic migration theories as pointed out by Haug (2009) take wage rates and unemployment levels into account, but neglect non-economic migration motives, because the non-economic motives are suffering from empirical weaknesses and a large variety of different push- and pull-factors, of which no consensus exists in migration decision research (King et al., 2012). At the meso-level, Hagen-Zanker (2008) and Faist (1997) state that relative deprivation, migration institutions and networks play a role in migration decision-making.

Fawcett (1989) emphasizes the importance of networks in migration theories, stating that it enhances the interconnectedness of migration systems. At the macro-level labor demand, migration laws, and economic development are of importance. This importance however is doubted by Haug (2009) and Hammar and Kamas (1997), as it is incomplete in explaining migration motives and processes.

Hendrix (2005) combines the micro and the macro-level stating that on the micro-level, migration is a mix of rational concerns about work and reliance on family in finding information on working and living conditions. Small kinship based chain migration flows go to a variety of destinations, producing a macro-level pattern of migration that seems to be rational and meeting the migration requirements of most of the individuals. All three levels combined are taken into account on the household-level, as migrants do not take migration decisions on their own but with influence of the family (Hagen-Zanker, 2008; Fawcett, 1989; Haug, 2009; Boyd, 1989).

The above stated migrants' decision-making variables apply to both international as internal migration flows. On a quantitative level, King et al. (2012) pointed out that internal migration is more important than what most scholars are studying, which is international migration. Internal migration flows can be seen as a mechanism of demographic transfers from stagnant regions to dynamic regions. Lima et al. (2016) describe these dynamic regions as regions where the urban-industrial economy is more developed, or where an agricultural frontier has expanded. Migration flows appear with historical developments, taking economic, social, political, and demographic demands of a country into account.

According to Lima et al. (2016), these flows combined form a migration pattern, which can be dynamic: regional influences define such a pattern and on the other hand the migration pattern can alter regions in different ways.

2.2 Internal migration patterns in Brazil

Scholars have different approaches of describing the history of internal migration patterns in Brazil. Matos and Baeninger (2001), Vainer and Brito (2001) as well as Lima et al. (2016) show that a new transition in migration patterns awaits at the end of the 20th century and the beginning of the 21st century. As pointed out by Lima et al. (2016), this new transition has its origins in the first half of the 1990s; a period that is characterized by several economic instabilities, such as low national income growth, high inflation rates, and external constraints. Financial liberalization, trade liberalization and economic deregulation processes were needed to reorganize the country. This reorientation of economic policies was essential to the implementation of a plan of monetary stabilization, the so-called Real Plan, which had positive results. From 1995 the monetary stabilization policies were flourishing at the cost of regional development policies, employment and growth.

Regional income inequality and differences in job opportunities were severe, causing migration flows to adapt, because the competition for investments among neighboring regions or comparable areas increased in this period. Data from the demographic census of the IBGE in 2000 showed that the dominant migration pattern between 1991 and 2000 had the same characteristics as before: the most significant displacements occurred from areas that are located in the Northeast and Minas Gerais to areas located in the Southeast (São Paulo).

At the beginning of this century, the inter-urban migration patterns form the most evident migration pattern of Brazil. According to Amaral (2013) and Rigotti (2006), the rise in attraction of medium-sized cities and suburbs along with migration within (mega-) cities are the main causes for this trend. The main characteristics of the Brazilian economy were high

unemployment rates, low GDP growth rates, macroeconomic stability, and the absence of regional policies (IPEA, 2010). From 2005 and onwards there was monetary stability, reduction of public debt, generalization of social policies to reduce inequality and poverty, and an increase of public investments in infrastructure. It is important to point out that less developed regions have grown at more expressive rates than the national average rate, stimulated by public investments. However, these regions still have their socioeconomic indicators lower than the national level, which clarifies the stability of Brazilian regional dynamics.

The economic movements in Brazil in the first decade of the 21st century have caused multiple impacts to migration flows (Amaral 2013 and Lima et al. 2016). Firstly, the high growth rates of the less developed regions in Brazil, for instance the North-Eastern part, could act as a pull-factor of the current population, but also for future immigrants. Also, the economic recovery in the most developed regions of the country, especially in the south-central part, could stimulate the already dominant migration pattern towards this region. These changes in Brazilian migration flows are part of the transition period of migration, of which the magnitude is not as big as previous migration patterns and the transition is relatively slow. As the concept of regional differences and income inequality amplifies the dominant migration patterns, changes in secondary flows that are part of the transition of migration in Brazil are weakened (Lima et al.).

Secondary migration flows, having a more regional character, are according to Freire (2011) and Lima et al. (2016) still the main drivers of the transition in migration flows. Data from the Brazilian census in 2010 showed that changes in secondary migration flows occur mainly between states with less regional disparities. Migration patterns towards new economic areas benefits the most dynamic regions that have medium sized cities. Migrants tend to be concentrated in specific areas of origin and destinations such as productive activities and as stated by Freire (2011), dominant and secondary migration patterns are defined by these specific flows. It is important to highlight that return migration, the voluntary or involuntary return of migrants to their place of origin, is also part of the transition in Brazilian migration flows of the 21st century

Concluding, since the 1970s, Amaral et al. (2015) point out that urban-urban migration flows have become more prominent. In the whole country of Brazil, Da Cunha (2002) shows that 61% of all the inter-municipal movements between 1981 and 1991 were between cities.

The new migration pattern of internal migration in Brazil between 1980 and 2010 shows that regional disparities of income and employment opportunities are evident and the main causes for new migration flows. These new migration patterns are mainly directed towards different locations as suburbs or large and medium-sized cities (Amaral, 2013; Rigotti, 2006).

According to Amaral (2013) and Amaral et al. (2015), they go hand in hand with old flows, which are the flows from the northeast to the southeast, partly because of stable and sustainable social networks of migrants.

Possible explanations for internal migrations flows can thus be on the micro, meso and macro-levels. People for instance migrate to where job opportunities are better and/or income is higher, with economic growth as the underlying reason for migration. Migrants could indirectly choose to migrate to places where economic growth is higher, as job opportunities and income might be higher as well. Economic complexity is a measure of economic growth (Hidalgo and Hausman, 2009) and therefore this paper suggests that people could also migrate to where economic complexity is high.

2.3 Economic complexity

Economic complexity is a measure for the knowledge in a society (Hidalgo and Hausman, 2009; Atlas of Economic Complexity, 2016). Economic growth can be measured in various ways, for instance according to the quality of institutions, human capital levels, measures of competitiveness, technological progress, culture or geography (Helpman, 2004). Krugman (2014) shows another way of measuring economic growth although, of which the fundaments are that wealth is related to the division of labor: specialization of workers (and firms) increases economic efficiency. Hidalgo and Hausman (2009) offer us a way of looking at economic growth and development giving economic complexity a central role. They look at trade data as a bipartite network: cities have a certain ubiquity and diversity in producing certain goods and the level of economic complexity shows in which development stage a country or region is. Hidalgo and Hausman (2009) enable a quantification of economic complexity of cities and regions, and these quantifications are correlated with income, leading to the fact that future growth patterns can be derived according to the economic complexity-index.

Diversity and ubiquity are the two core concepts of economic complexity: diversity is the measure for how many different products a country or region is able to produce and the number of links a city or region has in its network can be viewed as the measure of diversity. Ubiquity is the measure for the number of cities or regions that are able to make a certain product, and this number is equal to the amount of links that a certain product has in its network.

Diversity and ubiquity can be determined following matrices in which the rows represent countries and the columns stand for different products. One value of the matrix is equal to one if a country *C* produces a product *P*, a value of the matrix is equal to zero if it does not. When summing over either the rows or the column of such a matrix, one can measure

diversity and ubiquity. The equations for diversity and ubiquity are defined as below, where M_{cp} is the matrix.

$$Diversity = \ k_{c,0} = \sum_c M_{cp} \quad (1)$$

$$Ubiquity = \ k_{p,0} = \sum_c M_{cp} \quad (2)$$

The knowledge in a society can be divided into 'explicit' knowledge, the knowledge one acquires through reading books, articles, and newspapers for instance and 'tacit' knowledge: knowledge that can be acquired via networks. Differences between a country's ubiquity and diversity exist because of non-tradable 'capabilities': many specifications that can arise through the division of labor, cannot be imported, making tacit knowledge a more valuable capability than explicit knowledge. Differences in income between cities and countries can therefore be explained by economic complexity and a complex product is a product that requires many or exclusive capabilities.

The more capabilities a city or country has, the more diverse its export in products will be because of their broad availability of capabilities, which will increase the possibility of exporting relatively rare and complex products compared to other cities, and decrease the ubiquity level. Complex products have lower ubiquity levels and are therefore only produced and exported by cities with multiple and diversified capabilities. According to Poncet and De Waldemar (2013), cities that are able to produce these complex products have a higher revealed comparative advantage (RCA) than other cities. Economic complex cities are also seen as more developed cities because of higher diversity levels, which can be translated into capabilities as technology, human capital, institutions, inputs, culture, and geography, required to produce different products (Helpman, 2004).

Revealed comparative advantage (RCA) is an index according to which one can calculate the relative advantage that a country has in exporting a certain good, compared to other cities (Atlas of Economic Complexity, 2016). When a country has a share that is equal to or greater than the share of total world trade that the product stands for, it is considered as having a RCA. In equation 3, X_{cp} stands for the exports of product P by country C. When a RCA is negative, it represents a relative comparative disadvantage in a certain good. This definition of RCA allows us to set a hard threshold for a cities export. When RCA_{cp} is greater or equal to 1, country c exports product p, and when RCA_{cp}< 1 that particular country is not an effective exporter of that certain product.

$$RCA_{cp} = \frac{X_{cp}/\sum_c X_{cp}}{\sum_p X_{cp}/\sum_c \sum_p X_{cp}} \quad (3)$$

Hausman and Hidalgo (2009) qualify goods as sophisticated when products need higher development levels before export than other goods. The sophistication level of a good *k* is called

'productivity' (Poncet and de Waldemar, 2013). In their research, Hausman and Hidalgo (2009) rank products by the amount of capabilities which are necessary to manufacture these products. X-ray machines and medicines are highly complex for example, because they require a sophisticated level of productive knowledge, but they also origin from large companies where multiple high-skilled workers produce. Less sophisticated products like fish and cheese for instance, only require a basic level of capabilities and can be produced by an individual or a small family-business (Atlas of Economic Complexity, 2016).

To measure this Product Complexity, Hausmann and Hidalgo (2009) put the indicator *PRODYk* forward: the weighted average of the income levels of good *k*'s exporters, where the weights are related to the RCA of each country *j* in a good.

$$PRODY_k = \sum_j [\frac{x_{jk}/X_j}{\sum_j x_{jk}/X_j}] \quad (4)$$

In equation 4, X_{jk} is the value of exports of good *k* by country *j*, X_j the total value of country *j*'s exports, and Y_j the per capita income of country *j*, measured as the real GDP per capita in PPP. As the weight of good *K* related to the exports of prosperous cities increases, *PRODY* also increases, and sophistication levels accordingly. Critics state however, that this indicator suggests that rich cities export rich-country products (Poncet and De Waldemar, 2013), which is why the city complexity function is preferred during the research of Hausman and Hidalgo (2009).

A location's complexity can also be measured, as a weighted average of the complexity of the products it exports. This weighing process corresponds with the relative importance of each product in a local export field. When looking at a local place and its capabilities of producing and exporting many different complex products, this is seen as proof of the existence of local capabilities. Hausman and Hidalgo (2009) set up the following equations to give a mathematical overview of what economic complexity exists of.

$$K_c = \frac{1}{K_{c,0}} \sum_k M_{c,k} K_{k,15} \quad (5)$$

In equation 5, $M_{c,k}$ is a dummy variable with a value of 1 if a city has a comparative advantage in a certain good *k*. $K_{c,0}$ is the number of products for which a city *c* has a comparative advantage and $K_{k,15}$ is the product-level complexity. Using this equation, equation 6 was formed, representing the average complexity of the goods a city exports with RCA (the share of product *p* in the export basket of country *c* to the share of product *p* in world trade) (Hidalgo and Hausman, 2009).

$$Complexity_c^t = \frac{K_c^t \sum_c K_c^t / n}{\sigma K_c^t} \quad (6)$$

Economic complexity as a measure of economic growth could also work the other way around: there might be reverse causality in this matter. Therefore, those indicators that prosper economic growth are also expected to increase economic complexity. This will be taken into account in setting up the hypotheses, as the concept of economic growth and development has been more widely researched than the concept of economic complexity.

As economic complex cities produce sophisticated and various products, the requirements for human capital in these cities is higher than in non-complex cities. People who already live in complex cities are surrounded by capabilities and positive externalities. Externalities can improve a country's technological progress and therefore stimulate economic growth. Positive externalities arise from human capital and knowledge spillovers among others (Lucas, 1988; Romer, 1990; Schumacher et al., 2011). Whereas Lucas (1988) states that an average stock of human capital has a positive effect on individual productivity, one might state that positive externalities occur more in complex cities than in non-complex cities. Romer (1990) found empirical evidence that knowledge that is acquired in the research center spills over the economy because it is non-rival and only partially excludable. These knowledge spillovers lead to productivity gains in all market sectors (Romer, 1990). It is expected therefore, that the probability of migration of people who live in a complex city to another complex city is higher than the probability of migration of people who do not live in a complex city.

2.4 Migration of high and low-skilled workers

The main causes of migration are differences in net economic advantages, especially differences in wages (Borjas, 2016; Hossain, 2001). Borjas (2016) states that most existing economic migration analyses use this hypothesis as their base point. Migration of workers, both low- and high-skilled, can be seen as human capital investments in a certain region. According to Hossain (2001), decisions are mostly made on possible labor opportunities and the costs of moving, after which workers decide whether it is economically efficient to move or not. Borjas (2016) names three propositions in the process of internal migration decision making: an increase in economic opportunities at the destination increases net gains to migration (1); an increase in economic opportunities at the current position decreases net gains to migration (2), and an increase in migration costs lowers the net gains to migration (3). The first two propositions can be related to increasing access to foreign markets according to Hering and Paillacar (2015): a higher foreign market access means a higher local labor demand and this attracts workers via the two pull-factors of higher wages and new job opportunities.

Another mechanism that is apparent when it comes to migration decision-making is the distance factor: when the distance of possible migration increases, the probability of migration decreases. Schwarz (1973) and Marques and Golgher (2009) state that distance can therefore be seen as a cost of migration. Freire (2011) found empirical evidence in his country-analysis that migrants are more likely to move to cities which are closer, using data of 123 cities and 3214 rural areas. A city that is 10% closer receives 0.2 percentage points more migrants. He also found that distance matters more for high-skilled workers than for low-skilled workers, although a 10% decrease in transportation costs, increases the number of high-skilled migrants with 3%.

In line with Freire (2011), Malamud and Wozniak (2012) state that there is a positive correlation between a worker's education level and the probability of migration. A possible explanation for this is that highly educated workers acquire the knowledge of different employment opportunities and their markets faster. Therefore, they are able to reduce their migration costs, which increases the probability to migrate (Malamud and Wozniak, 2012; Borjas, 2016). According to Rigotti (2006) and Golgher and Marques (2009), migrants from 2000 to 2010 are therefore usually more educated than in previous decades. Also, the labor market in a particular geographical region could be larger for high-skilled workers than for low-skilled workers in comparison to the other geographical region. Furthermore, Loureiro et al. (2004) point out that the higher the number of years of education, the higher the probability of participation is in the labor market.

3. Methodology and data

In this paper, an analysis of the probability of being migrant and moving to a complex city will be done according to a binary outcome model, in which there are two possible outcomes, as presented in the equation 7.

$$y = \begin{cases} 1 & with\ probability\ p \\ 0 & with\ probability\ 1-p \end{cases} \quad (7)$$

Once regressing a binary outcome model, the probability p varies across individual values as a function of regressors. The model needs to be parameterized with a conditional probability:

$$p_i \equiv \Pr[y_i = 1[x] = F(x'_i\beta) \quad (8)$$

In equation 8, F is a specified cumulative distribution function. There are two binary outcome models: a logit and a probit model. A logit model arises once F is the cumulative distribution function of the logistic distribution. The probit model on the other hand arises once F is the standard normal cumulative distribution function. Apart from these models, there is

also the linear probability model, which does not use a cumulative distribution function, but $p_i = x'_i\beta$. A linear probability model is relatively easy to estimate and to use, but it comes with a few disadvantages as well. Firstly, fitted probabilities could be less than zero or greater than one. Also, the partial effect of any explanatory variable, which is appearing in level form, is constant. The limitations of limited dependent variable estimations can be countered by using binary response models, at which most importance can be appointed to the response probability (Wooldridge, 2014).

To avoid the limitations of a linear probability model, a binary response model of the following form can be used:

$$P(y = 1|x) = F(\beta_1 x_1 + \ldots + \beta_k x_k) = F\ (\beta_0 + x\beta) \quad (9)$$

The estimated response probabilities therefore, are also strictly between zero and one. When the two alternatives of a linear probability model are applied to this function, a logit model or logistic regression model would have F as a logistic function:

$$F(z) = \frac{\exp(z)}{[1+\exp(z)]} = \ \Lambda(z) \quad (10)$$

F here is strictly between zero and one for all the numbers of z, being the cumulative distribution function for a standard logistic variable.

Using a logit model has several advantages: The logit model has a relatively simple form for the first-order conditions. Along with it comes the interpretation of coefficients in terms of the log-odds ratio. Another advantage of using the logit model is discriminant analysis: in this analysis *y* and *x* are random variables; *x* is observed but *y* is not observed. As *x* is given, it is up to the researcher to determine whether *y* equals zero or one.

When obtaining a maximum likelihood estimator that is conditional on explanatory variables, the density of *y* on *x* needs to be taken into account:

$$f(y|x_i: \beta) = [F(x_i\beta)]^{1-y}, y = 0, 1 \quad (11)$$

This function makes clear that when *y* = 1, the outcome depends on $F(x_i\beta)$ and when *y* = 0, it depends on 1- $F(x_i\beta)$. When taking the log of equation 11, the log-likelihood estimation can be determined for the observation i being a function of the parameters and the data of *x* and *y* (equation 12).

$$\ell_i(\beta) = \ y_i \log[G(x_i\beta)] + (1 - y_i)\log[1 - F(x_i\beta)] \quad (12)$$

F here is, again, strictly between zero and one for both probit and logit. When summing equation 12 for all observations, the log-likelihood can be obtained for all observations of *i*.

$$\ell(\beta) = \sum_{i-1}^{n} \ell(\beta) \quad (13)$$

The maximum likelihood estimation of β is defined by $\hat{\beta}$. Once *F* is the standard logit cumulative distribution function, $\hat{\beta}$ is the logit estimator. Based on previous literature as

described in section 1 and the econometric specifications of this section, this paper uses the following basic model (equation 14):

$$P(Y_i = 1) = \beta_0 + \beta_1 X_1 + \cdots + \beta_i X_i \quad (14)$$

Where $P(Y_i = 1)$ is the probability of an individual migrating to an economic complex city in Brazil and the variables X_i are described in Table 1. The control variables are constructed according to existing literature to explain migration, as described in the theoretical framework. Also, extra variables are constructed to test this research's hypotheses.

Table 1: Variables, specifications and sources

Variable name	Meaning	Variable type	Specification	Source
Complex-2010	Economic complexity index 2010	Dummy variable	When this variable has a value of one, a person moved to a complex city in 2010. When this variable has a value of zero, the individual did not migrate	Calculations by the authors using economic complexity indices from DataViva
ECI_2005	Economic complexity index in 2005	Continuous variable of values between -1 and 1	ECI is a scale that uses the theory of economic complexity to rank countries following Hidalgo	DataViva, FAPEMIG
High_skilled	High-skilled workers	Dummy variable	High-skilled = 1, Low-skilled = 0	Census 2010, IBGE
Loweduc	Low-skilled workers	Dummy variable	Low-skilled = 1, High-skilled = 0	Census 2010, IBGE
Age	Age of individual	Numbers of years of age	Whole numbers	Census 2010, IBGE
Sex	Gender	Dummy variable	1 = male 0 = female	Census 2010, IBGE
White	Skin color of individual	Dummy variable	1=white 0= others: which are brown, black, yellow, and indigenous	Census 2010, IBGE
Ln_Income	Individual income	Log variable	Individual income in Reais	Census 2010, IBGE

Graduation	Individuals with a bachelor's degree as the highest completed education	Dummy variable	1= graduated, 0= other	Census 2010, IBGE
Master	Individuals with a master's degree as the highest completed education	Dummy variable	1= master's degree, 0= other	Census 2010, IBGE
PhD	Individuals with a PhD as the highest fulfilled education	Dummy variable	1= PhD, 0= other	Census 2010, IBGE
Educ	Individuals who are active in the education occupational field	Dummy variable	1= education industry, 0= other	Census 2010, IBGE
Arts	Individuals who are active in the humanities and arts occupational field	Dummy variable	1= arts industry, 0= other	Census 2010, IBGE
Social	Individuals who are active in the social sciences, business, and law school occupational field	Dummy variable	1= social, 0= other	Census 2010, IBGE
Science	Individuals who are active in the science, mathematics, and computing college occupational field	Dummy variable	1= science, 0= other	Census 2010, IBGE
Eng	Individuals who are active in the engineering, construction, and production occupational field	Dummy variable	1= engineering, 0= other	Census 2010, IBGE
Agric	Individuals who are active in the agriculture and veterinary occupational field	Dummy variable	1= agriculture, 0= other	Census 2010, IBGE

Health	Individuals who are active in the health and social welfare occupational field	Dummy variable	1= health, 0= other	Census 2010, IBGE
Services	Individuals who are active in the services occupational field	Dummy variable	1= services, 0= other	Census 2010, IBGE

Source: Author's compilation from Brazilian Demographic Census 2010.

$P(Y_i = 1)$ here is the dependent variable and contains the probability of a worker migrating to an economic complex municipality in 2010. This is a dummy variable: people migrate to a complex city (1) or not (0). The complexity index is constructed through converting any complexity index value that is above 0 to a 1 (complex) and any complexity index value that is equal or below 0 to 0. The probability of migration to a complex city is dependent on the economic complexity of 2005, high-skilled workers, low-skilled workers, age, sex, color, and income.

The economic complexity index of 2005 is, contrary to our variable of complexity in 2010, containing the original values as constructed through DataViva data. Therefore it can be checked how complex the city of origin was in 2005 when people migrated to another complex city, measured in 2010. The dummy variable *High_skilled* contains workers that are at least graduated (1). This means that low-skilled workers have maximally completed their high school (0). On the other hand, the dummy variable *Loweduc* has values of 1 (maximally completed their high school) and 0 (at least graduated). The age variable comes directly from the Census (IBGE, 2010), and has values of whole years. The sex variable is a dummy variable where people are male (1) or female (0). The survey gave five options for people to fill in the skin color: white, black, brown, yellow and indigenous. This research chose to construct a dummy for white people (1=white, 0=others). Also, a logarithmic function of income has been constructed, controlling for the income of inhabitants of Brazil.

As a second step, this paper looks at workers with graduation, master's and//or PhD degree, to see which workers have the highest probability to move to complex cities according to their degree level. A dummy was created for graduation, master and doctor. After this, dummy variables of study areas are constructed in order to test in which occupational field the workers have the highest probability to migrate. Therefore, results will not only show whether high-skilled workers have a higher probability of migrating to complex cities, but also which degree has the highest probability, and in which occupational field the worker is active.

3.1 Descriptive statistics

Data on education in Table 2 shows that the group with an incomplete elementary education represents more than half of the total sample population (54.2%). The second largest group, people who completed high school but did not study further or did not complete their higher education, represents 21.6 percent of the sample. Therefore the percentage of individuals who did not finish high school related to the total researched population is 70.1%. The education group that is determined to be high-skilled in this research is the higher education group and is formed by people who are at least graduated. It forms the smallest group of this sample (7.7%). Looking at this high-skilled group, most people that are graduated are highly represented in the sample (Figure 2).

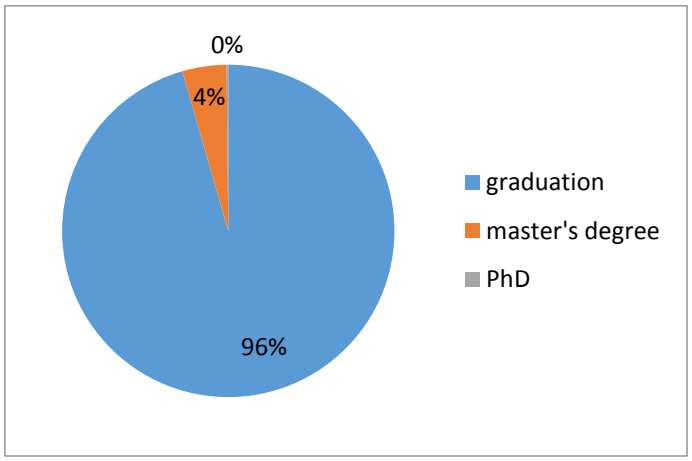
Table 2: Educational groups of people in Brazil in 2010

Education groups	Frequency	Percentage
1: no instruction and incomplete elementary school	90,702,678	54.17
2: complete elementary school and incomplete high school	26,728,554	15.96
3: complete high school and incomplete higher education	36,184,928	21.61
4: higher education	12,901,792	7.71
5: undetermined	926,043	0.55
Total	167,443,995	100.00

Source: Author's compilation from Brazilian Demographic Census 2010.

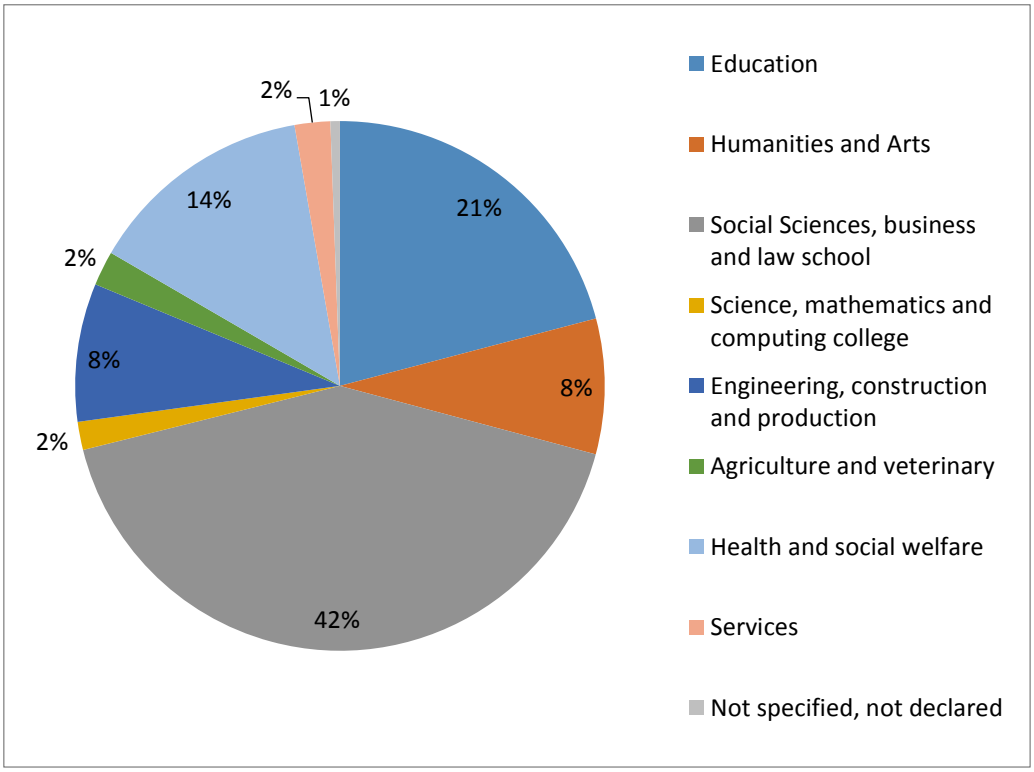
Of this sample, we can also see in which occupational field the high-skilled people are active (Figure 3). The largest group is formed by the Social Sciences, Business and Law School (41%), whereas the smallest groups are active in Services, Agriculture and Veterinary, Science, Mathematics and Computing college study areas. The male/female ratio is almost equal to one: 51.2 percent of the sample is male and 48.8 percent is female.

Figure 2: Spread of high-skilled educational groups in Brazil in 2010



Source: Author's compilation from Brazilian Demographic Census 2010.

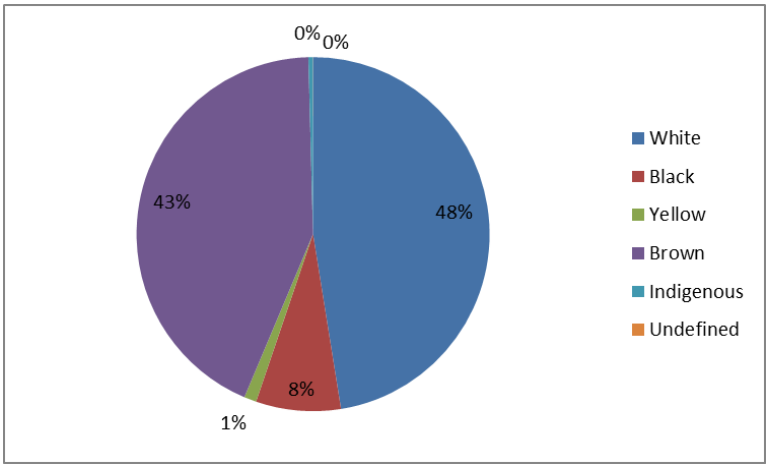
Figure 3: Spread of industries of high-skilled workers in Brazil in 2010



Source: Author's compilation from Brazilian Demographic Census 2010.

When it comes to color, white people form the largest group in the sample (47.5%), followed by the brown people (43.2%) (Figure 4). Indigenous people are the smallest group in the sample (0.4%).

Figure 4: Spread of skin color of people in Brazil in 2010



Source: Author's compilation from Brazilian Demographic Census 2010.

The constructed variables as outlined in this section as well as the build-up of the empirical model are used to test the hypotheses as stated in sect. The following section describes the empirical results of the testing of hypotheses, according to logit estimates.

4. Empirical Results

4.1 The probability of migration towards economic complex locations

To estimate the probability of migration towards economic complex cities in 2010 three models are formed, as presented in the table 3. The first model has a dependent variable of the economic complexity dummy of 2010 *complexity_2010* and independent variables *ECI_2005*, *Loweduc*, *Ln_Income*, *Sexskilled*, *Ageskilled* and *Whiteskilled.* The second model includes the specification of high-skilled people, whereas the third model includes the different study fields.

For the first model a Wald test and a Likelihood-ratio test were performed in order to determine how likely model 1 and its (interaction) variables are fitting the data compared to an alternative model (without interaction terms). Both tests gave results in favor of model 1. After these two tests, a Goodness-of-fit test followed, of which the results show that in general the logistic model can classify properly for 75.45% of the analyzed observations in model 1. The observations for migration to economic complex cities (y=1) are correctly specified for a sensitivity measure percentage of 60.89% and the observations for no migration (y=0) are correctly specified for 80.66% of all observations (specificity measure). Finally empirical results all models are estimated via odds ratio (Table 3).

Table 3: Odds ratio estimations for three logit models

Model	(1)	(2)	(3)
ECI_2005	1.600***	1.600***	1.542***
	(0.001081)	(0.0010816)	(0.0017127)
Ln_Income	1.731***	1.728***	--
	(0.0020147)	(0.0020125)	
Loweduc	0.965***	--	--
	(0.0082209)		
Sexskilled	0.956***	0.965***	--
	(0.0049369)	(0.0050054)	
Ageskilled	0.991***	0.994***	--
	(0.0002018)	(0.0002076)	
Whiteskilled	1.515***	1.585***	--
	(0.00873)	(0.0092906)	
Highskilled	--	--	1.410***
			(0.0057679)
Graduation	--	0.849***	--
		(0.0076899)	
Master	--	1.127***	--
		(0.0178447)	
Education	--	--	0.568***
			(.0060708)
Arts	--	--	0.792***
			(.0106307)
Social	--	--	1.078***
			(.0107664)
Science	--	--	0.923***
			(.0119873)
Engineering	--	--	1.376***
			(0.0197181)
Agriculture	--	--	0.492***
			(0.011138)
Health	--	--	0.863***
			(0.0097988)
Observations	8,297,825	8,297,825	2,071,096
R-squared	0.1899	0.1900	0.2060

Source: Own calculations from Stata 12.0. The standard errors are reported in parentheses. ***, **, * means significant at 1, 5, 10% acceptance level respectively.

Hypothesis 1: People living in more complex cities in Brazil have a higher probability of migrating to another complex city in Brazil.

From the results of the first model, one can see that people who already lived in an economic complex city in 2005 had a probability of migrating to another economic complex city in 2010 that is 60% higher than the probability of migrating to an economic complex city of people who did not live in an economic complex city in 2005. This is in line with the expectation, as this research assumed that people who already live in an economic complex city

are surrounded by capabilities and positive externalities. As positive externalities can be formed by knowledge spillovers and more human capital, people living in economic complex cities could benefit from these knowledge spillovers (Lucas, 1988; Romer, 1990; Schumacher et al., 2011). Increases in human capital could therefore lead to more job opportunities, also outside the origin city. People living in economic complex cities could therefore migrate easier to another complex city than people that did not.

Hypothesis 2: High-skilled workers have a higher probability of migrating to an economic complex city than low-skilled workers.

The second hypothesis can be accepted as well. Low-skilled workers (at most completed high school) have a probability of migrating to economic complex cities that is 4,47% lower than the probability for high-skilled workers (at least graduated), according to the first model. This because economic complex cities require a certain amount of human capital in order to produce the sophisticated and complex products that are produced (Hidalgo and Hausman, 2009). The main research question is partly answered now, further specifications have been made however to look at which high-skilled workers exactly have higher probabilities of migrating to economic complex cities, which is described in paragraph 4. This paper showed in the theoretical framework that income has a high correlation with education. The variable of ln_income shows a highly positive and significant coefficient, showing that the higher the income, the more likely a migrant will move to economic complex locations. This is in line with the hypothesis as well. As migration costs can be very high for migrants, extra income can cover for these costs. Therefore, people who get a higher income can migrate more easily to economic complex locations.

Hypothesis 3: High-skilled young people have a higher probability of migration to an economic complex location than high-skilled older people.

The third hypothesis tests whether high-skilled young people are more likely to migrate than old high-skilled people. The interaction variable 'ageskilled' shows that the high-skilled young people are more likely to migrate to an economic complex city than high-skilled old people (0.95% lower probability of migration to an economic complex city in 2010 for old people). This probability is quite small comparing to low-skilled people moving to a complex city in 2010. The result is in line with previous literature on internal migration in Brazil, as empirical results showed that young people migrate more than old people (Bernard and Charles-Edwards, 2014; Amaral, 2008). It is therefore likely that young people also migrate more to economic complex cities than old people. Another explanation could be, that older people are

more likely to be married or to have families, which makes migration of a individual more dependent of other persons. Migration to economic complex cities however, is likely to be less probable for high-skilled old people because people might already live in an economic complex city, or employers are more in favor of hiring talented young people.

Hypothesis 4: Female high-skilled workers have a higher probability of migrating to an economic complex location than male high-skilled workers.

The fourth hypothesis looks at whether high-skilled females migrate more than high-skilled males to economic complex cities. This is expected, because existing literature on internal migration in Brazil showed that females migrate relatively more to economically developed locations than males (Amaral, 2008). The interaction variable 'sexskilled' shows that high-skilled females are 4.44% more likely to migrate to economic complex cities than high-skilled males. Reasons why high-skilled females migrate more to economic complex cities could be that there are more opportunities for insertion in the labor market for male migrants. Also, according to Amaral et al. (2015), the consequences are that competitive workers in complex cities might see their wages decrease as more high-skilled males choose to migrate to complex cities.

Hypothesis 5: White high-skilled workers have a higher probability of migrating to an economic complex location than high-skilled workers with another skin color.

This hypothesis looks whether white high-skilled workers have a higher probability of migrating to an economic complex location than high-skilled workers with another skin color. This is in line with existing papers of Lam (1999) and Reis and Crespo (2005), who found empirical evidence that white workers earn significantly more than workers with another skin color. The coefficient of the interaction variable 'whiteskilled' shows that white high-skilled workers are 51.53% more likely to migrate to an economic complex city in 2010 than high-skilled workers with other skin colors. This result could show that discrimination could play a role in skin color in Brazil. This is in line with existing theories about high-skilled white workers migration, although in this case it shows economic complex cities are the migration destination instead of cities where GDP is higher or other welfare measures of cities.

4.2 A closer look at economic complexity and high-skilled migration

The aim of the second model is to look which type of high-skilled workers has the highest probability of migrating towards an economic complex city. Therefore, high-skilled workers are divided between those who are graduated, have a master's degree and those who have a PhD. Also for this model both a Wald test and a Likelihood-ratio test were performed in

order to determine how likely model 2 and its (interaction) variables are fitting the data compared to an alternative model (without interaction terms). Both tests gave results in favor of model 2. After these two tests, a Goodness-of-fit test followed, showing that in general the logistic model can classify properly for 74.25% of the analyzed observations in model 2. The observations for migration to economic complex cities (y=1) are correctly specified for a sensitivity measure percentage of 61.26% and the observations for no migration (y=0) are correctly specified for 78.91% of all observations (specificity measure). Finally empirical results for model 2 are estimated via odds ratio[2].

Graduated high-skilled workers have a probability of migrating towards an economic complex city that is 15.07% lower than the probability of migration of people holding a Master's or PhD degree. This could be because graduated people have less job opportunities in complex cities than PhD's or Master's, as complex cities require higher human capital capabilities. When comparing this with the probability of migration of a high-skilled worker with a Master's degree however, this is higher (12.7%) than the probability of migration of people who hold undergraduate and PhD degrees to economic complex cities. High-skilled workers with a Master's degree seem therefore to have sufficient knowledge to be integrated in an economic complex city's environment, which makes them more interesting for companies in economic complex cities, as they will ask lower wages than PhD's. Also, high-skilled people who hold a PhD degree have more capabilities to identify different opportunities of better income and jobs, even though those opportunities are not in complex cities.

To look at the hypothesis more closely, another distinction of high-skilled workers was made. We created eight study fields in which a person is active: 'Education', 'Humanities and Arts', 'Social Sciences, Business and Law School', 'Mathematics and Computer Science', 'Engineering, Construction and Production', 'Agriculture and veterinary', 'Health and Social Welfare' and 'Services'. A third model is constructed to analyze this aspect empirically.

Also for this model both a Wald test and a Likelihood-ratio test were performed in order to determine how likely model 3 and its (interaction) variables are fitting the data compared to an alternative model (without interaction terms). Both tests gave results in favor of model 3. After these two tests, a Goodness-of-fit test followed, showing that in general the logistic model can classify properly for 61.86% of the analyzed observations in model 3. The observations for migration to economic complex cities (y=1) are correctly specified for a sensitivity measure percentage of 79.22% and the observations for no migration (y=0) are correctly specified for

[2] All results are significant at a 1% acceptance level

52.97% of all observations (specificity measure). Finally empirical results for model 3 are estimated via odds ratio[3].

Only the coefficients of 'Social' and 'Engineering' are higher then 1, which indicates a higher probability of migration towards an economic complex city in 2010 compared to the other study fields. It shows that high-skilled workers in the fields of the Social Sciences, Business, and Law School, as well as high-skilled workers who are active the Engineering, Construction, and Production occupations are more likely to migrate to economic complex cities than the people in other fields, 7.8% and 37.6% respectively. One might have expected this outcome: the production of sophisticated and complex products must be led by adequate business models in order to maintain productivity and margins on these products. Also, patents of complex and sophisticated products must be protected for instance, which is the working field of law school graduates. Planning of housing, infrastructure and office spaces for instance are part of the social sciences fields that need to be taken into account to facilitate these workers among others. The fact that the probability of migration of the field of Social Sciences, Business, and Law School to complex cities is higher can be explained accordingly.

The reason behind this is straightforward: Engineering, Construction, and Production industries are all requiring high capabilities in the work fields of economic complex cities. Therefore, people in these fields are more likely to migrate to these complex cities than people in other industries. People in the 'Agriculture and Veterinary' and Education occupations have coefficients that are the lowest between the fields analyzed. That means people who did their undergraduate, Master's or PhD studies in this field have lower probability to move to economic complex locations comparing to other study areas. The explanation for this is straightforward as well: farmers and other agriculture and veterinary occupations are mostly more rurally located because they have a specific working location, which makes migration to economic complex cities complicated. Education

5. Conclusion

Migration is a subject that has been extensively researched throughout the years with push- and pull-factors as phenomena that come back in most of the papers on migration theories. Economic complexity could mainly be considered as one of the pull-factors. In order to gain further understanding of (internal) migration and its possible relation to economic complexity, first the existing internal migration patterns have been explained before migration has been linked with economic complexity. The main research question of this paper is to what extent do low and high-skilled workers have the same probability of migrating to an economic

[3] All results are significant at a 1% acceptance level

complex location? In order to address this question, this paper has first examined the determinants of the probability of internal migration towards economic complex locations, using a logit model for a broad selection of inhabitants in Brazil in 2010.

The first estimations that followed from the regressions showed that people who already lived in an economic complex city in 2005 had a higher probability of migrating to another economic complex city in 2010 than people who did not live in an economic complex city in 2005. Also, low-skilled workers (at most completed high school) have a lower probability of migrating to an economic complex city than high-skilled (at least graduated) workers. As economic complex cities require high capabilities to produce complex and sophisticated products, human capital requirements are high as well. High-skilled workers therefore are more wanted in these cities, making it more likely for high-skilled workers to migrate towards economic complex cities.

The control variables that were used for these first estimations were age, sex, skin color and income levels, in line with previous literature on internal migration in Brazil. Results showed that high-skilled young people are more likely to migrate to economic complex cities than high-skilled old people. Also, high-skilled males have a lower probability of migration towards economic complex cities than high-skilled females. The final control variable in the first estimations, which is skin color, showed that high-skilled white people are more likely to migrate to an economic complex city than other skin colors that are high-skilled (brown, black, yellow and indigenous).

After the first estimations, this research aimed to zoom in on the probability of migration of high-skilled workers towards economic complex cities. In the second model, high-skilled workers were divided between people who are graduated, have a Master's degree, or a PhD. Empirical results showed that graduated high-skilled workers have a lower probability of migrating towards an economic complex city than workers with a master and PhD studies. The probability of migration of a high-skilled worker with a Master's degree however, is slightly higher than the probability of migration of other university degrees. High-skilled workers with a Master's degree seem therefore to have sufficient knowledge to be integrated in an economic complex city's environment.

Finally, a third model was constructed to explain in which study field the probability of migration of high-skilled workers to economic complex cities was highest. Empirical results showed that high-skilled people with study fields of the 'Social Sciences, Business, and Law School', as well as high-skilled people in 'Engineering, Construction, and Production' study fields are more likely to migrate to economic complex cities than the people in other study fields. Especially the high-skilled workers in Engineering, Construction and Production show

a highly positive significant coefficient, which could be explained in the way that those industries are all requiring high capabilities in the work fields of economic complex cities.

The results from this research have both academic as well as societal relevance. The findings of this research provide an exploration of high-skilled workers migrating to economic complex locations. Migration of high-skilled workers for instance can bring human capital externalities to certain regions (Borjas, 2016). On the other hand, the regions of origin could suffer economically from outmigration of high-skilled workers (Docquier and Rapoport, 2012). Therefore, there is significant scope for further research to extend the findings of this research in several ways. Firstly, further research could include control variables that this research chose not to include due to data limitations. Including more control variables could extend the findings of this research. Secondly, the influence of the race discrimination on the results could be researched more extensively in future research. Thirdly, further empirical research could include probit estimations to verify the results of this research. Once probit estimators give relatively similar results, this could form as a robustness check for this research. Finally, the concept of return migration should be included in further research. The expectation is that different results will show, because of temporary migration flows.

From a societal perspective this research contributes to improving the understanding of the determinants of internal migration to economic complex cities in Brazil. This better understanding helps regional as well as national policy makers in their decision-making of migration policies, which could lead to more economic growth of the country. As internal migration in Brazil is responsive to earning differences, internal migration policies could contribute to economic growth. The research found that economic complex cities attract high-skilled workers more than low-skilled workers, which benefits the economic complexity indices of these cities. As economic complexity is a measure of economic growth, this phenomenon of high-skilled migration towards economic complex cities can be seen as growth-enhancing.

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