

# Internal migration flows in Brazil using circular visualization

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## Abstract

We adapted the chord diagram plot to visualize Brazil's interstate migration during 1991–2010. The arrowheads were added to present the direction of the flows. This method allows us to show the complete migration flows between 26 states and the Federal District in Brazil, including the direction and volume of the flows. The spatial component was also clearly depicted in the plot using four color palates representing five regions in Brazil (i.e. North, Northeast, Southeast, South and Midwest) and arranging the 27 states in approximate geographical order. Besides that, we will extend the chord diagram plot to describe the stocks of interstate migration in Brazil in 2010 in comparison to the bilateral flows presented.

Keywords: Internal migration. Migration flows. Brazil. Circular visualization. Chord diagram.

## Introduction

Migration contributes to shaping populations in the most varied aspects (age structure, reproductive behavior, labor market, social segregation, etc.), either at the place of origin or destination. This makes migration a key component when trying to understand the characteristics and profile of a society.

In Brazil – a developing country and one that in its last three Censuses, 1991, 2000 and 2010, presented a number of 5-year interstate migration of approximately 5 million, 5.2 million, and 4.6 million, respectively – internal migration is an integral part of the structural reform that makes up the country's development and cannot be understood unless all social, economic and historical aspects are taken into account. In short, migration and population distribution are not random and isolated phenomena. In Brazil, migratory movements generally occur as a consequence of strong regional and social imbalances that stimulate the transfer of surplus population not absorbed by the economy and society from places of origin to places of destination in which there is an opportunity for ascension (BRITO, 2002; BAPTISTA, 2017). Thus, to study internal migration in Brazil is a complex exercise given the size and diversity of the country. As highlighted by Baeninger (2012), the last 60 years of internal migration in Brazil "are strongly related to urbanization processes and spatial redistribution of the population, marked by intense population mobility, and inserted in the different economic stages, social and political, experienced by the country over this period".

The goals of this paper are to identify and analyze 1) the bilateral interstate migration flows in Brazil over 5-year periods of 1986/1991, 1995/2000 and 2005/2010, and 2) the stocks of interstate migration in Brazil in 2010. These migration patterns, the first portraying recent migration and the last representative of cumulative flows over a long period, can be very different from one another due to, for example, changes in economic conditions, new centers emerging, etc. We use the chord diagram plot, through the *circlize* package in R, to visualize the results and achieve our goals.

The incorporation of new methods and techniques of analysis are fundamental in the attempt to understand the migration that occurs in Brazil, since it brings challenges (social, economic, environmental, etc.) both to the places of origin and destination.

## **Contextualization of migratory movements in Brazil**

The way in which economic activities are organized in a society determines the location of employment opportunities and income, which, in turn, influence the level of quality of life of the population, making migration an alternative in the search for better survival conditions (MARTINE, 1989).

The occupation of the Brazilian territory until the beginning of the nineteenth century was made on time, following the geographic locus of the various cycles of primary-export exploration that emerged at each time of the country's economic trajectory - sugar, minerals, rubber, leather, coffee, etc. Until the 1930s, Brazil was characterized as a rural / primary society, with few urban areas. During this period, there was a dispersion of large populations, especially formed by Northeastern Brazil and those from the state of Minas Gerais, who left the 'paulista' coffee complex when it was hit by the crisis of the USA Stock Exchange in 1929 (MARTINE, 1989).

Between 1930 and 1950, the population expelled from the countryside moved further inland, to areas that were previously uninhabited, such as the west of São Paulo and the north and west of Paraná and Santa Catarina. Migration towards cities has gained momentum, motivated by the employment opportunities created as a result of the incipient urban industrial sector. In this context, the intensification of industrial activity that occurred due to the Second World War, coupled with the limited capacity of the industry, generated the need for production in two shifts in the country, increasing the demand for workers and, consequently, the wages offered to them, which increased the attraction of labor "expelled" from the field by the breakdown of the coffee economy. The cities, which up to that moment had negative vegetative growth, grew at an accelerated rate due to the impacts of demographic transition, which started in this period, and migration (MARTINE, 1989).

In the 1940s, emigrants from Northeastern Brazil and Minas Gerais accounted for 27.0% and 37.9% of the total emigration within the country, respectively, making up the majority of immigrants residing in São Paulo, Rio de Janeiro and the Center-West region. Immigration to these areas, together with Paraná, accounted for more than 91% of immigration within Brazil at the time. The state of São Paulo, despite being the largest migrant recipient (24.6% of the national total), was also highlighted as the region of origin of a large number of emigrants (20.0%), who mainly relocated to

Paraná. This flow formed one of the secondary trajectories of the Brazilian migratory pattern at the time, along with other flows from Espírito Santo to Rio de Janeiro, from Far South to Paraná, from São Paulo to the Center-West and from the South Northeast to Minas Gerais (BRITO, 2002).

In the 1950s, the expansion of the Paraná border attracted migrants from various regions of the country; however, once Paraná had exceeded its capacity to absorb this population, migrants began looking for opportunities in Brazil's central regions, including Mato Grosso, Mato Grosso do Sul, Goiás and Maranhão (MARTINE, 1989). Emigration from Northeastern Brazil was intensified (representing 47.8% of the national total) due to the great drought that affected the region, which ran parallel to the growth of job opportunities in large urban centers (in a period of intense urbanization), while emigration from Minas Gerais fell to represent only 22% of the national total, despite the increase observed in the number of emigrants over this period (BRITO, 2002).

Between 1950 and 1965, there were fundamental changes in the political and economic fields of the country, which had an impact on internal migration. The State began to intervene in the economy and in the occupation of Brazilian territory directly, through measures such as industrialization, particularly with association to the substitution of imports and policies to encourage interiorization (MARTINE, 2002). The total number of internal migrants in Brazil in the 1960s was almost 9.340 thousand people, mostly from the Northeast (35.6%) and Minas Gerais (21.9%). The main destinations remained the same: São Paulo (24.5%), Paraná (17.8%), Rio de Janeiro (15%) and Center-West (13.3%). The expansion of the Brazilian economy since the second half of the 1960s, the high growth of the industrial and civil construction sectors in the 1960s and 1970s (around 10% on average) and the participation of the tertiary sector were collectively responsible for the great generation of jobs in urban areas between 1960 and 1980 (FARIA, 1984). Such "pull factors" within large cities, combined with the high population growth in the countryside, the stagnation of agriculture in part of Minas Gerais and the Northeast, and the public policies of transportation and telecommunications, provided an incentive for the intensification of internal migration within the country in the decades 1960 and 1970 (BRITO, 2002). Pacheco and Patarra (1997) summarize by stating that, in the 1960s, the reorganization of the population in territory took place through two complementary

dimensions, interregional and rural-urban: centrifugal forces, in the direction of population expansion towards agricultural frontier areas, and centripetal forces, towards large urban agglomerations.

In the 1970s, São Paulo increased its role in national immigration, which was a consequence of the generation of jobs in the industrial and tertiary sectors of São Paulo, corresponding to more than 37% of the total jobs generated by these sectors in the country. This resulted in a large number of emigrants from the state (950,000 people), but its number of immigrants was about 3 times higher. The Northeast remained home to the largest number of Brazilian internal migrants, but the role of Minas Gerais in national emigration decreased because of industrialization and agricultural modernization policies adopted in the state throughout this period. The Center-West region suffered from a reduction in its population absorption and retention capacity, thus presenting a considerable increase in the number of emigrants (BRITO, 2002). On the structure of the urban network in the 1970s, Côrrea (2001) emphasizes the small functional complexity of its centers, the small degree of articulation and the existence of simple spatial patterns in relation to the urban network. However, the growing occupation of urban spaces (as a result of the intense rural / urban migration) resulted in the growth of the housing deficit, the emergence of agglomeration diseconomies and the beginning of the industrial decentralization process.

The economic crisis, which came about in the 1980s, was marked by a profound process of productive restructuring, called by Egler (2001) the "Financial Internationalization Phase", which resulted in the reduction of economic activities, with a strong impact on the generation of jobs and a considerable increase in informality rates, in parallel with the deepening of the periphery of the metropolitan population. During this period, there was a greater polarization of the urban network and of migration, a phenomenon that intensified in the 1990s in the context of globalization. The country has experienced great economic transformations, such as trade liberalization, production integration (due to economic policies and state infrastructure) and the dispersion of industry towards smaller cities, elements that were decisive in the reformulation of the country's migratory pattern.

At the same time there was an observed integration of the industrial economy, expanded geographic networks of various types, such as increasing the weight of so-called medium-sized cities and the emergence of a set of small towns, associated with

the expansion of the "new rural", thus offering spatial alternatives to the process of demographic deconcentration and economic activities observed in the last decades (MATOS, 2005).

In spite of, for example, the reduction in the last decades of the immigration of São Paulo in the volume of the interstate migrations – 27.8%, 23.6% e 21.3%, respectively for the five-year period 1986-1991, 1995-2000 and 2005-2010 – there are no polarization alternatives external to São Paulo, as stated by Pacheco (1998). São Paulo should remain so, as the productive center, in order to articulate more intensely with the peripheral regions, within a framework of greater interregional heterogeneity, although regional inequality remains a core dynamic of the Brazilian economy.

In this context, this work contributes to a new methodology for representing Brazilian migratory flows, with the aim of helping to understand and analyze the changes and trends of migration observed in the country in recent decades.

## **Data and methods**

### *Data and level of analysis*

The data used in this study come from the 1991, 2000 and 2010 Censuses of the Brazilian Institute of Geography and Statistics (IBGE)<sup>1</sup>. In the case of 5-year migration flows information, those persons five years of age or older on the date of reference of the Census are inquired about their place of residence exactly five years ago. If the place of residence is different on both dates, that individual is considered a migrant. Otherwise, that is, if the current place of residence is the same as five years ago, the person is considered non-migrant, even though within the interval some migratory movement may have occurred.

One of the main advantages of using 5-year migration flows information is the possibility of calculating all the traditional measures of migration, i.e., immigrants, emigrants and net migration. "In addition, places of origin and destination are known, the period within which migration occurs is well determined and the concept of migrant is easily defined" (RIGOTTI, 1999). On the other hand, a limitation of using 5-year migration flows information is the impossibility of correcting potential problems of sub-

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<sup>1</sup> IBGE. <http://www.ibge.gov.br>

enumeration, besides capturing migratory flows within the 5-year periods. Despite this, UN Handbook VI (1970) points out that if there is a need to choose only one item for the migration study, the 5-year migration flows is the most appropriate. Thus, 5-year migration flows *date* information is used to calculate both Bilateral migration flows and Bilateral net migration.

In stock migration flows, the place of birth (state) is the origin, and the current place of residence (state) is the destination. All surviving individuals who, at some point in their lives, made an interstate migration, and who, at the end of the period, reside in a state other than that of where they were born are considered stock migrants. Individuals who undertook an interstate migration and subsequently returned to the state of birth (i.e., interstate return migrants) were not considered, regardless of their time spent elsewhere. The objective is to analyze, therefore, the dynamics of spatial redistribution of the population in a historical perspective, through migratory flows of stock that represent great displacement realized over several decades.

Firstly, it should be emphasized that between birth and place of residence at the time of the census, interstate stock migrants may have eventually carried out other migratory steps, meaning that stock migrations do not necessarily represent the migratory flows directly. A second important point is that stock migrations do not have a "temporal precision," either because the year of birth varies according to the age of the population, or because individuals may have carried out, over a lifetime, more than one migratory step, or for those whose migration between the state of birth and the current state of residence has been carried out directly, the moment with which these flows occurred vary over time.

Regarding these limitations, unlike 5-year migration flows, which aims to analyze recent trends in migration dynamics, the purpose of stock migration is to analyze large displacements accumulated in a historical perspective (for several decades). This, in turn, represents large migratory movements, which are important in the dynamics of spatial redistribution of the population of the country.

The units of analysis adopted in this study were the 26 Brazilian states and the Federal District. This level of spatial analysis, although macro, enables the identification of states that contribute most to the spatial redistribution of the population.

### *Chord diagram plot*

To visualize and understand the complex and dynamic internal migration system in Brazil, where 26 states plus the Federal District contribute to 702 interstate flows in the bilateral origin-destination migration system, we use the chord diagram plot. Chord diagrams provide a way to visualize numeric tables, especially useful when the data generates information regarding directional relations. Such diagrams present the visualization of tables in a circular way. The plot is created in R software using the *circlize* package (GU et al., 2014) and presents information on origin, destination, volume of movement and direction of migratory flows between all states (QI et al., 2017).

In the plot diagram, states of a same geographic region have similar color palettes (the Northeast region states are represented by blue, for example), while they are positioned side by side in an approximate geographical order. In addition, each chord starts from one state (origin) and ends in another (destination). “The direction of the flows is illustrated using arrowheads on each chord... The width of the chord at the origin represents the number of migrants who moved over the five-year period... The length of the province axis refers to gross migration size (total immigration and total outmigration) in each province” (QI et al., 2017).

## **Results**

Migration can be measured in two ways: flows and stocks. Flows are human movements between places over time, which are dynamic and difficult to define. Stocks represent the number of migrants living in a place at a point in time, which are static and easy to define.

Below, we present the results and discuss both measures with the Brazilian migration data.

### *Bilateral flows*

The chord diagram plots observed in Figures 1, 2 and 3 present, respectively, a complete interstate migration system in Brazil in the periods 1986-1991, 1995-2000 and 2005-2010. Each chord, regardless of the size of the flow, starts from the state of



origin and ends at the state of destination. However, “larger flows are plotted last, on top of the smaller flows, to highlight the biggest bilateral migration corridors” (QI et al., 2017).

In all three periods, the plots show that the largest migration flows in Brazil are destined for the state of São Paulo, with greater relevance for immigrants from the states of Bahia, Minas Gerais, Paraná, Pernambuco and Ceará, although the number of immigrants to São Paulo decreased over the periods. At the same time, the flows from São Paulo to the states of Minas Gerais, Paraná and Bahia are also significant, which according to Baptista et al. (2017), may be the result of return migration.

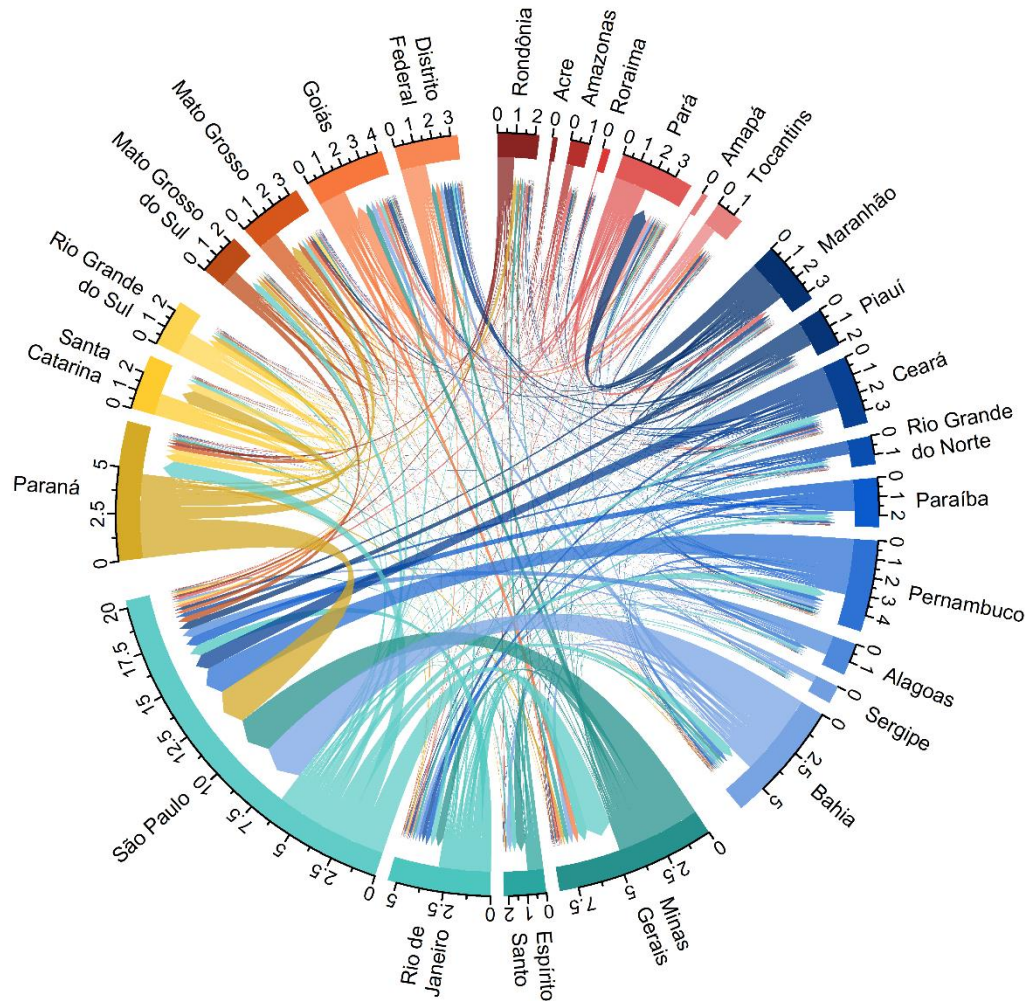
Specifically on the period covered by Figure 1 (1986-1991), the fundamentals of the articulation between the historical context and the migratory trajectories in Brazil began to change in the 1980s, as the large interregional rural-urban migratory flows became less significant. In the 1980s, traditional areas of emigration, such as the Northeast and the state of Minas Gerais, lost around 2.9 million and 770 thousand people respectively, and regarding the latter, there was a drastic reduction compared to the previous period. The state of São Paulo showed signs that the height of its power of attraction had passed. The Metropolitan Region of São Paulo (RMSP) was the main region responsible for the reconfiguration of Brazilian migratory flows in the period 1986-1991, according to data from the 1991 Demographic Census (RIGOTTI, 2008). The main migratory routes of the country continued in the Northeast (beyond Minas Gerais) towards São Paulo (in spite of the reduction in the volume of these flows), due to the growth of other flows, such as the migrations from São Paulo to Paraná, Minas Gerais and the Northeast Region, largely due to return migration (BAPTISTA et al., 2017).

In short, in the period 1986-1991 (Figure 1), it is necessary to highlight the emigration from the state of Paraná, which, besides the aforementioned state of São Paulo, moved in a direction towards the states of Santa Catarina and Mato Grosso; the state of Goiás, with immigrants coming from the Federal District; Pará, with an important influx of immigrants from Maranhão; and the state of Rio de Janeiro, as a result of the increase in emigration to the states of São Paulo and Minas Gerais, among other flows.

The 1980s represented, to a certain extent, the continuity of a process of economic deconcentration in Brazil, characterized by the displacement of the agricultural and

mineral frontier, urban deconcentration, emergence of environmental pressures related to industry, governmental policies, economic crisis and other changes in the field of the economy (PACHECO, 1998).

Figure 1 – Bilateral migration flows during 1986-1991 in Brazilian States (unit: thousands)

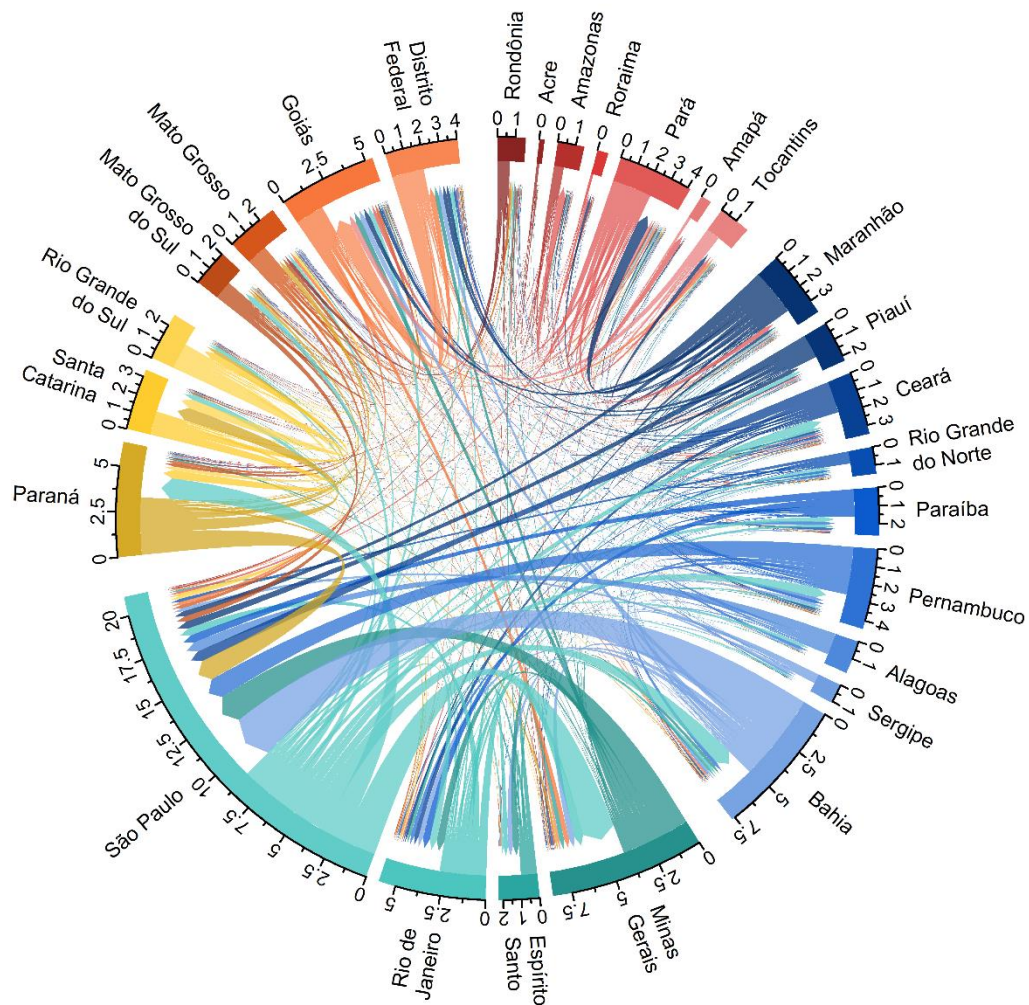


Compared to previous periods, new migratory flows became important in the Brazilian context from the 1990s. Although often origin states of migrants, the regions in which metropolitan areas or state capitals are located began to attract populations residing in their immediate surroundings. This fact indicates the existence of a regionalization of economic activities in the period, which tended to change the spatial pattern of migration until then, bringing about ever stronger intraregional movements and also the increasing importance of return migration (RIGOTTI & VASCONCELLOS, 2005; BAPTISTA et al., 2017).

In addition, the emergence of regional economic poles capable of absorbing their respective populations was observed, as was the case in Minas Gerais, Paraná, Goiás, and in the Northeast region as a whole. Minas Gerais, for example, observed the inversion of negative net migration that decade. However, one of the most important aspects revealed by Census 1991 and reinforced by Census 2000 was a tendency for the spatial redistribution of the population towards western Brazil, predominantly in the Cerrado areas. This is something more evident in Goiás and the Federal District, but certainly already affects other areas, such as western Bahia (a phenomenon largely related to agribusiness).

In short, in the period 1995-2000 (Figure 2), notable events include bilateral migration flows from the Federal District to Goiás; people arriving in Santa Catarina coming from the neighboring state of Paraná and immigrants leaving from Maranhão, destined to Pará. There was also an important flow from Alagoas to São Paulo – in addition to the large migratory flows already known in previous decades, such as the flows of immigrants from the Northeast region to São Paulo – and the intensification of return migration.

Figure 2 – Bilateral migration flows during 1995-2000 in Brazilian States (unit: thousands)



The most recent data from the 2010 Demographic Census allow for the monitoring of the spatial redistribution of population in the country. One of the most significant findings was that the absolute number of interstate migrants decreases between 2005 and 2010, which is not trivial if we take into account that the working age population has increased<sup>2</sup>. Therefore, at this level of disaggregation, it can be said that migration has declined. On the other hand, the number of intrastate migrants, which stood at 8.9 million people between 1986-1991, increased to 9.5 million in the five-year period 2005-2010. One of the consequences was that, in general, interstate migratory balances declined, both in federated units with net gains and in those with population losses - with the exception of the South region, which went from net losses to a substantial gain, due in large part to Santa Catarina. The only state that has maintained an increase in population gains was Goiás, who presented the second largest Brazilian

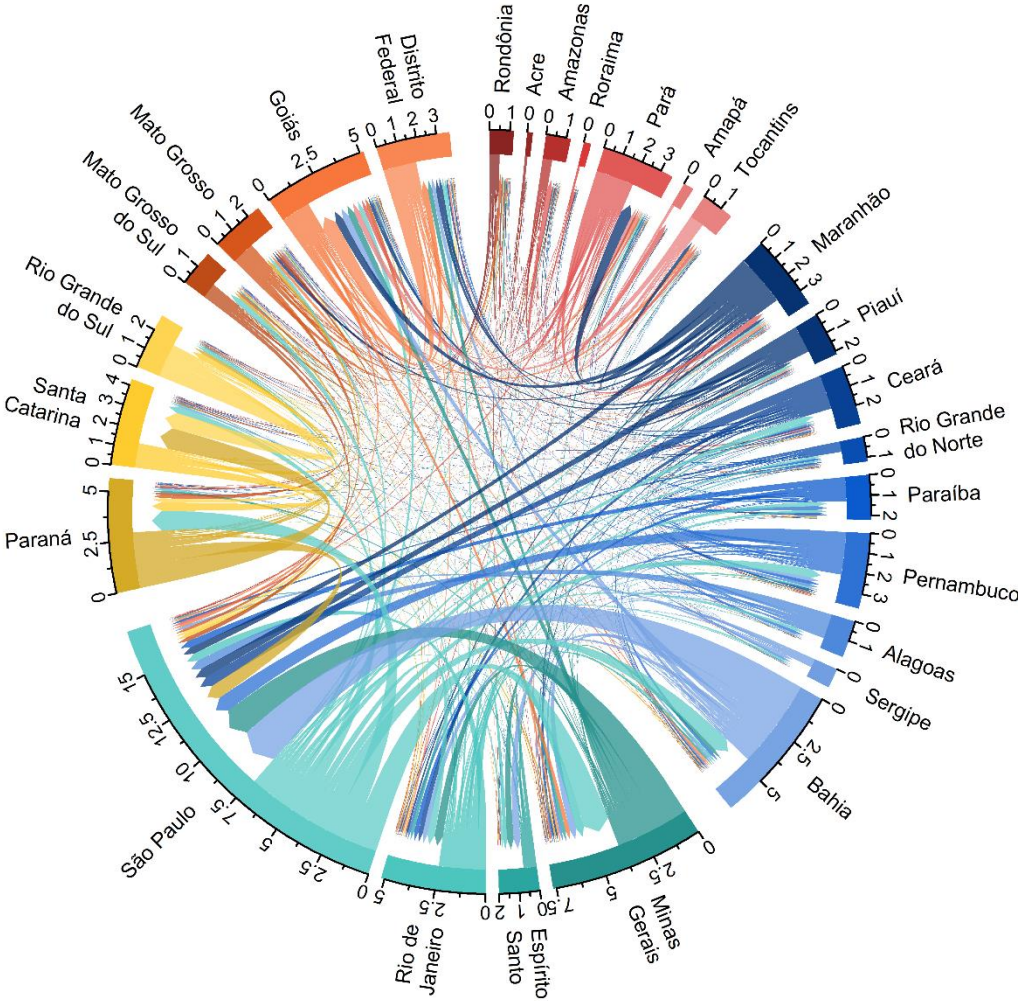
<sup>2</sup> On reducing the volume of migration and the probability of emigrating between the 1990s and 2000s, see Rigotti et al. (2017).



net migration between 2005 and 2010, at 208 thousand migrants. This corresponded to 3.5% of the registered population of Goiás in 2010 (RIGOTTI, 2012).

In summary, in the period of 2005-2010 (Figure 3), important bilateral migration flows were present for the state of Santa Catarina, as a destination, coming especially from its neighbors Paraná and Rio Grande do Sul. In addition, as in the two previous periods, bilateral flows of migration from the Federal District to Goiás and Maranhão to Pará are worth consideration. If, on the one hand, there has been a reduction in the volume of immigration towards São Paulo (although still extremely important in absolute and relative terms), the maintenance of important bilateral flows should be noted, especially from Pernambuco, Bahia, Minas Gerais and Paraná, to São Paulo, and from São Paulo to these states, due to return migration.

Figure 3 – Bilateral migration flows during 2005-2010 in Brazilian States (unit: thousands)

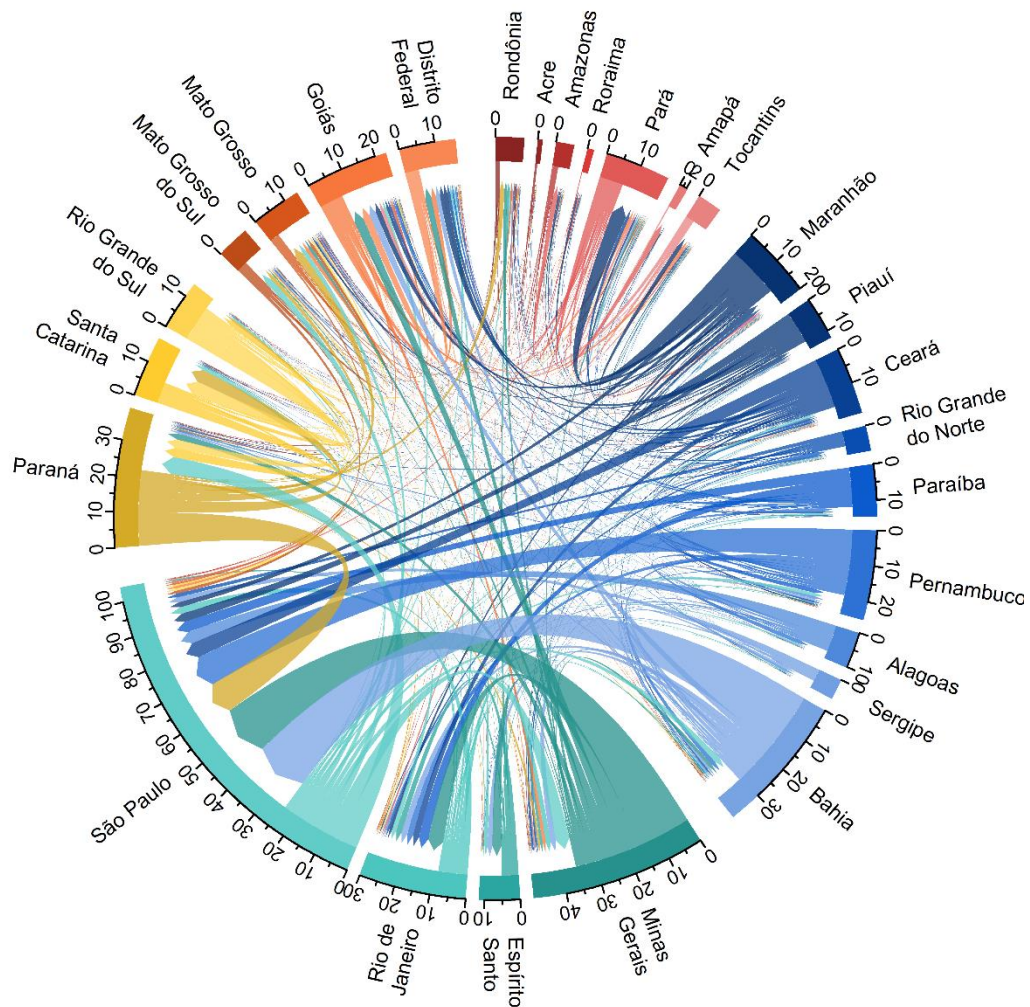


### *Stocks of migration*

The migration flows by stock make apparent the significance of São Paulo's influence on the fluctuation of spatial redistribution of the Brazilian population, over the decades. Considering inflows and outflows, São Paulo contributes to 39.6% of the interstate migrant stock, that is, more than one-third of surviving individuals residing outside their state of birth (i.e., born or resident at the time of the census) has some relation to the state of São Paulo. Of this group, 30.4% went to São Paulo, demonstrating the great power of attraction exercised by the state of São Paulo over the decades. The main origins of these flows are states that have historically served as reservoirs of labor for São Paulo, such as Minas Gerais, Bahia and Pernambuco, as well as other states in the Northeast region, as well as Paraná.

The Northeast states, such as Minas Gerais, portray the prevalence of population losses, even considering the recent reduction in population losses and an increase in return migration. Already the North and Center-West regions are notable, with respect to migration by stock, for the prevalence of immigration. This phenomenon is consistent with the historical process of occupation that these regions experienced, due to the expansion of the agricultural frontier, especially in the 1960s and 1970s. It should be noted that in Rio de Janeiro, in the accumulated period, immigration predominates, partly due to population gains up to the middle of the 20th century, in a period in which the State presented a strong power of population attraction. Finally, the South Region is marked by the population losses of Rio Grande do Sul and Paraná, in part related to the exhaustion of the agricultural frontier and strong immigration to the State of Santa Catarina, especially observed in the last decade.

Figure 4 – Stocks of migration in Brazilian States in 2010 (unit: thousands)



## Conclusion

The goals of this paper are to identify and analyze 1) the bilateral interstate migration flows in Brazil over 5-year periods of 1986/1991, 1995/2000 and 2005/2010, and 2) the stocks of interstate migration in Brazil in 2010, by means of a new form of representation of the migration, a chord diagram plot.

The stock migrations highlight some recent trends of interstate migration (observed in recent decades), in turn different from large migratory currents in the past. From a historical perspective, census information suggests that states that have exerted a large population attraction in the past will continue to lose representation in net migration of the total population in the coming decades. On the other hand, states that traditionally lose population should also continue to experience the relative reduction

of negative balances, either by the greater retention capacity of their population, or by the effects of return migration.

The analysis of internal migration in Brazil, between 1980 and 2010, shows that the representation of São Paulo in national immigration declined, although it remained the state that attracted the most immigrants from other regions of Brazil. The state of Rio de Janeiro also faced reduced immigration, despite having shown an increase in the absolute number of immigrants between the five-year periods 1986-1991 and 1995-2000.

The Center-West region, especially the state of Goiás, began to attract more immigrants, mainly in the period 1995-2000, reaching 16.03% of internal immigrants in Brazil between 2005 and 2010. The North region demonstrated stability in its relative participation (around 10%), while the Paraná, a former region of expansion of the agricultural frontier, faced a reduction in its ability to absorb interstate migration from the second half of the 1970s, representing 5.89% of internal immigrants in Brazil in 2005-2010, against 17.93% in the first five years of the 1970s.

The South, in turn, increased its relative participation in immigration (from 5.58%, between 1986 and 1991, to 8.50% between 2005 and 2010), mainly due to the increase in the number of immigrants in Santa Catarina. The northeastern states, historically known to be population expelling regions, faced an increase in their relative representation in national immigration from the 1980s until 2010, during which they represented more than 20% of internal migrants (against 15.86% in the period 1975-1980). This result is related to return migration and also to migratory flows existing between northeastern states. Minas Gerais, which was also a historical supplier of labor in the country, began to attract more immigrants, who were often return migrants.

The twenty-first century was a mark of important changes in the economic, social and demographic frameworks of Brazil. In this new scenario, the process of spatial redistribution of the Brazilian population was also influenced by other forms of movement, at the level of interstate migration. Therefore, Brazilian internal migration in the new millennium seems to be marked by the inability of destination areas to absorb migrants over long periods, by the return migration to areas of origin, and by the emergence of new areas of retention of migrants.



## Reference

BAENINGER, R., 2012. Migratory turnover: a new look for internal migration in Brazil. *REMHU, Rev. Interdisciplinar da Mobilidade Humana*, pp.77-100.

BAPTISTA, E., 2017. Detection of clusters migratory in Brazil. *Revista da Associação Nacional de Pós-graduação e Pesquisa em Geografia (Anpege)*. p.40-56, V.13, n.22, set./dez. 2017.

BAPTISTA, E.A.; CAMPOS, J.; RIGOTTI, J.I.R., 2017. Return Migration in Brazil. **Mercator (Fortaleza)**, Fortaleza, v.16, e16010, 2017. <http://dx.doi.org/10.4215/rm2017.e16010>.

Brazilian Institute of Geography and Statistics. Censos Demográficos. 1991, 2000 e 2010.

BRITO, F., 2002. Brasil, final de século: a transição para um novo padrão migratório? In: CARLEIAL, A.,N. (org.) **Transições migratórias**. Fortaleza: Iplance, 2002. 44p.

\_\_\_\_\_, 2009. As migrações internas no Brasil: um ensaio sobre os desafios teóricos recentes. In: VI ENCONTRO NACIONAL SOBRE MIGRAÇÕES. Anais. Belo Horizonte, ABEP.

CÔRREA, R. L. A rede urbana brasileira e a sua dinâmica: algumas reflexões e questões. in: SPOSITO, M. E. B. (org.) *Urbanização e cidades: perspectivas geográficas*. Presidente Prudente: GAsPERR - FCT/UNESP, 2001, p.359-368. 643 p.

EGLER, C. A. G. Subsídios à caracterização e tendências da rede urbana do Brasil: configuração e dinâmica da rede urbana. Petrópolis, mar. 2001.

FARIA, Vilmar. **Desenvolvimento, urbanização e mudanças na estrutura do emprego**: A experiência dos últimos trinta anos; in *Sociedade e Política no Brasil pós-64*. Paz e Terra, 1984.

GU, Z.; GU, L.; EILS, R.; SCHLESNER, M.; BRORS, B., 2014. Circlize implements and enhances circular visualization in R. *Bioinformatics* 30(19): 2811–2812.

MARTINE, G. **Migrações internas no Brasil**: tendências e perspectivas. São Paulo: IPLAN, 1989 (Texto para Discussão,17).

MATOS, R. Das grandes divisões do Brasil à idéia do urbano em rede tripartite. In: MATOS, R. (Org.). **Espacialidades em rede: População, urbanização e migração na Brasil contemporâneo**. 1.ed. Belo Horizonte: C/ Arte, 2005, p. 17-56.

PACHECO, C. A. **Fragmentação da nação**. Campinas: Unicamp-IE, 1998.

PACHECO, C. A.; PATARRA, N. Movimentos migratórios anos 80: novos padrões?. 1º Encontro Nacional sobre Migração. Sessão Temática 4: Reflexões teóricas e metodológicas para os estudos de migração no Brasil. Curitiba, **Anais...**, 1997.

QI, W.; GUY, A.; MUTTARAK, R.; LIU, S., 2017. Circular visualization of China's internal migration flows 2010–2015. *Environment & Planning A*.

RIGOTTI, J.I.R., 1999. Técnicas de mensuração das migrações a partir de dados censitários: aplicação aos casos de Minas Gerais e São Paulo. 1999. 142f. Dissertação (Doutorado) - CEDEPLAR/FACE, Universidade Federal de Minas Gerais, Belo Horizonte.

RIGOTTI, J.I.R., CAMPOS, J., HADAD, R.M. Migrações internas no Brasil: (des)continuidades regionais à luz do Censo Demográfico 2010. **GEOgrafias**, v. il, p. 8-24, 2017.

United Nations Population Division, 1970. "Methods of Measuring Internal Migration." *Manuals on Methods of Estimating Population, Manual VI*, UN, New York.