Volume 21 Issue 21
Originally issued as E3



Global Journal of HUMAN-SOCIAL SCIENCE: E
Economics
Volume 21 Issue 3 Version 1.0 Year 2021
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-460x & Print ISSN: 0975-587X

Migration Flows in Brazil: A Spatial Analysis using Tobler´S Approach

By João Francisco de Abreu, Dr. Leônidas Conceição Barroso
& Christiano Ottoni Carvalho

Introduction- Brazil finds itself in an advanced phase of the process of demographic transition. The shrinking of the base of the aging pyramid and the growth of its vertex are already noticeable. This essay intends to compare the migration flow figures of two distinct periods: 1995/200 and 2005/2010, in order to ascertain what kind of migration flows is occurring in this period, that could eventually explain some of its migration behavior.(Figures 1-7)

A new phenomena that concern these migratory fluctuations has been taken to note and has been the studies of various research projects in the academic environment: a decline in net migration rate from traditionally underdeveloped regions (mainly the northeast) to more industrialized regions (primarily the southeast).

This decline in the net migration rate can be partly explained by return migration. Considering that fact, it is of fundamental importance to know migratory patterns of the population so as to foresee the spatial redistribution of the population in general that will eventually result in the reformulation of social policy to better regionally allocate national resources.

GJHSS-E Classification: *FOR Code: 349999*



Strictly as per the compliance and regulations of:



© 2021. João Francisco de Abreu, Dr. Leônidas Conceição Barroso & Christiano Ottoni Carvalho. This is a research/review paper, distributed under the terms of the Creative Commons Attribution-Noncommercial 3.0 Unported License http://creativecommons.org/licenses/by-nc/3.0/), permitting all non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Migration Flows in Brazil: A Spatial Analysis using Tobler´S Approach

João Francisco de Abreu [α], Dr. Leônidas Conceição Barroso [σ] & Christiano Ottoni Carvalho [ρ]

I. Introduction

Brazil finds itself in an advanced phase of the process of demographic transition. The shrinking of the base of the aging pyramid and the growth of its vertex are already noticeable. This essay intends to compare the migration flow figures of two distinct periods: 1995/200 and 2005/2010, in order to ascertain what kind of migration flows is occurring in this period, that could eventually explain some of its migration behavior.(Figures 1-7)

A new phenomena that concern these migratory fluctuations has been taken to note and has been the studies of various research projects in the academic environment: a decline in net migration rate from traditionally underdeveloped regions (mainly the northeast) to more industrialized regions (primarily the southeast).

This decline in the net migration rate can be partly explained by return migration. Considering that fact, it is of fundamental importance to know migratory patterns of the population so as to foresee the spatial redistribution of the population in general that will eventually result in the reformulation of social policy to better regionally allocate national resources.

Spatial analysis and GIS are widely used in order to study such events (Bailey and Gatrell, 1996). Specifically in this case, Tobler's approach is used (Tobler, 1976) for mapping the flows and, for the identification of migration patterns.

II. Tobler's Approach

If a potential migrant is taken at random in a population sample and is "thrown in the air", there will be a general migration tendency that this person will follow. Tobler calls this tendency a "wind" (Tobler, 1976). He has focused on the difficulties associated with the symmetry of the gravity model and tried to remove this problem introducing the "wind" in order to account for interaction in particular directions. The approach facilitates the description of large flow matrices by analyzing the asymmetric part of the from-to-tables.

It is interesting to see that the antecedents of the approach were motivated by the calculation of geographical locations from data on separations or on interaction. The inversion of models was used: for example, the social gravity model can be written as:

$$M_{ij} = K.P_i.P_j\, f\left(D_{ij}\right)$$

And the inversion is

$$D_{ij} = f^{-1}\left(\frac{M_{ij}}{KP_iP_j}\right)$$

The problem was that the social gravity model is symmetric, i. e, $D_{ij} = D_{ji}$ and M_{ij} must be equal to M_{ij}. In practice the data are different ($M_{ij} \neq M_{ji}$). This would imply that if the model is inverted, $D_{ij} \neq D_{ji}$.

He stated that has "the consequence that the tri-lateration solution can result in more than one geometrical configuration or that the standard errors of the position determination are increased" (Tobler, 1976. p. 2).

To overcome this problem, a "wind" was introduced in order to facilitate interaction in some direction. This vector is estimated by the data. In its formal aspect, each location i, with coordinates (x, y), has associated with a vector with magnitude and direction:

$$vi = \frac{1}{n-1}\sum_{\substack{i=1\\ j=1}}^{n}\frac{m_{ij}-m_{ji}}{m_{ij}+m_{ji}}.\frac{1}{D_{ij}}\left[\left(x_j-x_i\right).\left(x_j-y_i\right)\right]$$

Where $D_{ij}^2 = \left(x_j-x_i\right)^2+\left(y_j-y_i\right)^2$. For the complete algebraic development, see Tobler (1979).

Author α: Ph.D, (PUCMINAS-BRAZIL). e-mail: jofabreu@hotmail.com
Author σ: (PUCMINAS-BRAZIL)
Author ρ: MSc. (Ph.D, Student)

© 2021 Global Journals

Sometimes we have an incomplete matrix for a set of data, so in order to overcome this situation a complete set of data is generated, using Baxter entropy program (Tobler, 1976). The program follows Wilson's derivations of the gravity model using entropy-maximizing techniques. It has three variations and one can use a complete matrix or only the marginals as input. The program permits two variations with the gravity model or with the entropy model.

In the research described here we have used a table with the results of migration for two distinct periods: 1995/2000 and 2005/2010, which corresponds to a state-to-state Brazilian migrations table. Looking to other examples, it is usually not necessary to draw more than 25% of the flow arrows. The Wind and Pot flow programs of Waldo Tobler are used to plot the basic flows and Transcad and Map viewer are used to construct the final maps. The micro data of 2000 and 2010 Brazilian Population Census were used for the migration table.

III. Results

In the comparison of the data migration between the periods of 1995/2000 and 2005/2010 for the Northern region, the States of Rondônia, Amazonas, Roraima, Amapá and Tocantins continued to receive immigrants, showing a positive balance for both periods, with the exception of the States of Acre and Pará that continued to show a negative balance, but with a significant decrease in the number of emigrants in the comparison between the two periods considered.

In the Northeast region it was observed a quite expressive negative balance for almost all States, especially for the States of Bahia and Maranhão, who contributed with significant numbers of emigrants by repeating the tendency observed in the 1995/2000 period, without major modifications. The States of Piauí, Ceará and Alagoas kept negative figures, but decreased their numbers in absolute values for both periods, perhaps showing some modification in their migratory pattern, which should be better measured in the future. Only the States of Sergipe and Rio Grande do Norte presented a positive migratory balance, perhaps due to new investments in the tourism sector, typical of these States.

In the Southeast region the negative highlights went to the State of Minas Gerais, which was the only one to make a considerable change in its demographic profile presenting, in the 1995/2000 period, an expressive number of immigrants, but in the period 2005/2010 presented a negative number in its migratory balance. The State of Espírito Santo showed a significant increase of immigrants, nearly doubling its values of the previous decade, probably due to the new investments in oil extraction and in agribusiness. The States of Rio de Janeiro and São Paulo also presented a positive migratory balance, but with much smaller values than the previous decade, perhaps explained by the so called return migration, which has been shown to be significant in Brazil in the past two decades.

In the Southern region the Santa Catarina State occupies a prominent position showing an expressive positive migratory balance, almost tripling the number of immigrants in the last decade. The States of Paraná and Rio Grande do Sul have maintained the tendency of negative balances in the last two decades, but the State of Rio Grande do Sul, presented an even more expressive negative balance for the last evaluated period.

All States of the Midwest region showed a positive balance regarding migration, especially the State of Goiás which presented an expressive number of immigrants for both periods. The State of Mato Grosso do Sul showed a profound modification in its migratory pattern, showing a positive balance for the period 2005/2010 compared to a negative number for the period 1995/2000. The States of Mato Grosso and the Federal District (Distrito Federal) both showed positive balances but with much lower immigration values for the period between 2005/2010.

The number of Brazilians who have changed their State of residence is decreasing for the past 15 years, according to data from the Brazilian Institute of Geography and Statistics (IBGE). The survey shows that, between 1995 and 2000, about 5.2 million people have changed the State of residence. Between 2000 and 2004, the number went down to 4.6 million. The latest data indicates that between 2004 and 2009, just over 3.2 million people moved from their State of residence - there is an important decrease of 37% in the comparison between 2000 and 2009 data.

This decrease is also well perceived in interregional migration. According to the 2000 Census, 3.3 million people had changed regions in the five previous years. The national survey samples (PNAD) of 2004 already shows a reduction to 2.8 million. Finally, the National Household Survey of 2009 shows that just over 2 million people had chosen another region to live.

In the South, the States of Paraná and Rio Grande do Sul perceived a considerable flow of return migration, while Santa Catarina is the southern State that attracts more new immigrants – its current migratory balance is 80 thousand immigrants. The same process can be observed in the Midwestern region, being the region that more retains its immigrants. According to the 2009 PNAD, in absolute terms, São Paulo remains as the State that receives more immigrants (535.000), followed by Minas Gerais (288.000), Goiás (264.000) Bahia and Paraná (both with 203.000 new immigrants). On the other hand, São Paulo is also the place that generates more emigrants (588.000), followed by Bahia (312.000), Minas Gerais (276.000), Paraná (171.000) and Rio de Janeiro (165.000). (Figures 1-3).

© 2021 Global Journals

Tables and Maps

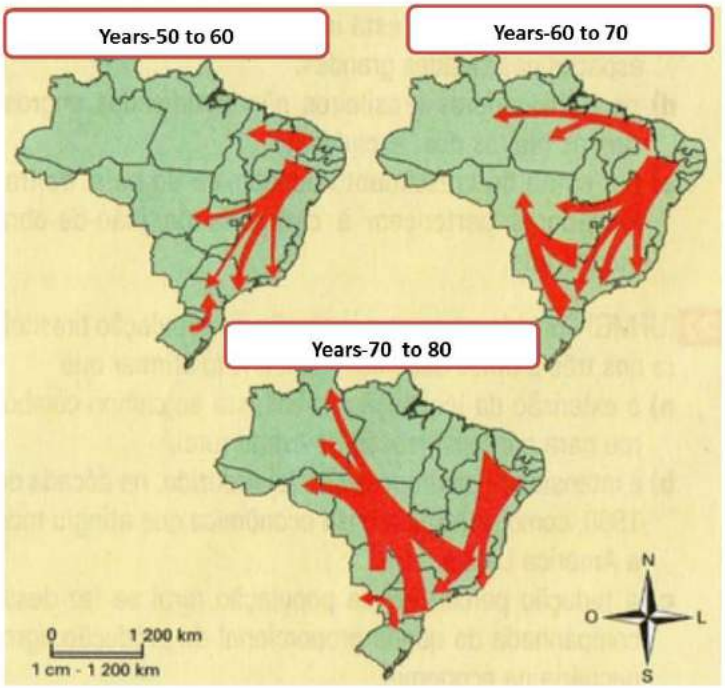
Table 1

Federation Units	1995/2000			2005/2010		
	Immigrants	Emigrants	Net Migration	Immigrants	Emigrants	Net Migration
BRASIL	5 196 093	5 196 093	0	4 643 754	‘4 643 754	0
Rondônia	83 325	72 735	10 590	65 864	53 643	12 221
Acre	13 634	16 070	- 2 436	13 882	14 746	-865
Amazonas	89 627	58 657	30 970	71 451	51 301	20 150
Roraima	47 752	14 379	33 373	25 556	11 204	14 352
Pará	182 043	234 239	- 52 195	162 004	201 834	- 39 830
Amapá	44 582	15 113	29 469	37 028	15 228	21 800
Tocantins	95 430	82 515	12 915	85 706	77 052	8 654
Maranhão	100 816	274 469	- 173 653	105 684	270 664	- 164 980
Piauí	88 740	140 815	- 52 075	73 614	144 037	- 70 423
Ceará	162 925	186 710	- 23 785	112 373	181 221	- 68 849
Rio G. do Norte	77 916	71 287	6 630	67 728	54 017	13 711
Paraíba	102 005	163 485	- 61 480	96 028	125 521	- 29 493
Pernambuco	164 871	280 290	- 115 419	148 498	223 584	- 75 086
Alagoas	55 966	127 948	- 71 982	53 589	130 306	- 76 717
Sergipe	52 111	56 928	- 4 817	53 039	45 144	7 895
Bahia	250 571	518 036	- 267 465	229 224	466 360	- 237 136
Minas Gerais	447 782	408 658	39 124	376 520	390 625	- 14 105
Espírito Santo	129 169	95 168	34 001	130 820	70 120	60 700
Rio de Janeiro	319 749	274 213	45 536	270 413	247 309	23 104
São Paulo	1 223 811	883 885	339 926	991 314	735 519	255 796
Paraná	297 311	336 998	- 39 687	272 184	293 693	- 21 509
Santa Catarina	199 653	139 667	59 986	301 341	128 888	172 453
Rio G. do Sul	113 395	152 890	- 39 495	102 613	177 263	- 74 650
Mato G. do Sul	97 709	108 738	- 11 029	98 973	80 908	18 065
Mato Grosso	166 299	123 724	42 575	143 954	121 589	22 365
Goiás	372 702	169 900	202 802	363 934	156 107	207 827
Distrito Federal	216 200	188 577	27 623	190 422	175 870	14 552

Source: IBGE, Micro Data of 2000 and 2010 Brazilian Population Census.

© 2021 Global Journals

FIG 1– BRAZIL MIGRATION FLOWS –50\80



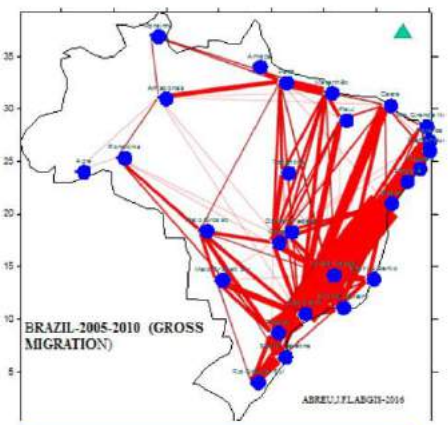


FIG 2-BRAZIL-2005-2010 (GROSS MIGRATION)

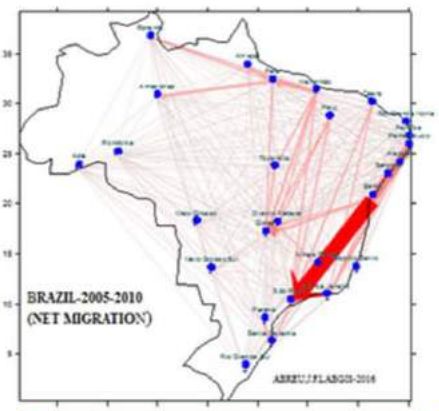


FIG 3-BRAZIL-2005-2010 (NET MIGRATION)

© 2021 Global Journals

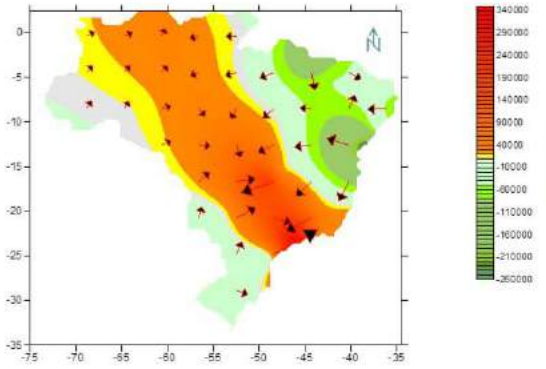
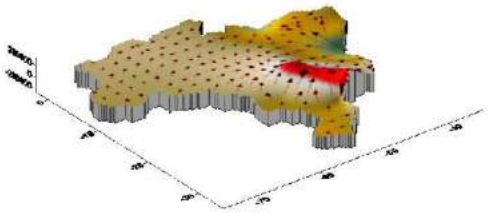


FIG 4 (BRAZIL-1995-2000)
WINDS-NETMIGRATION



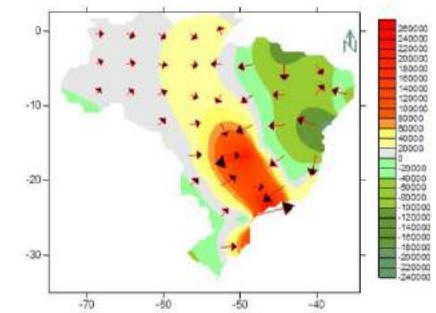
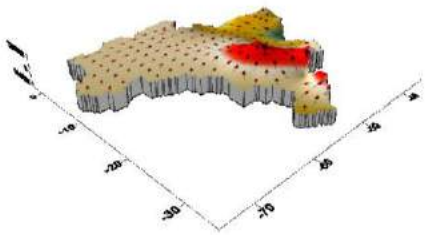


FIG 5 (BRAZIL-2000-2005)
WINDS-NETMIGRATION



© 2021 Global Journals

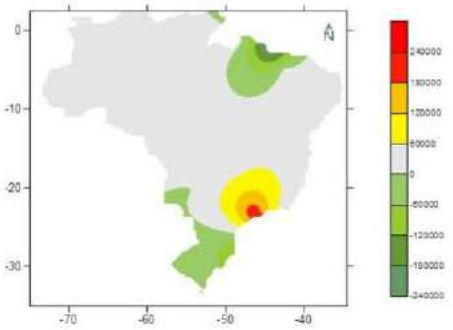
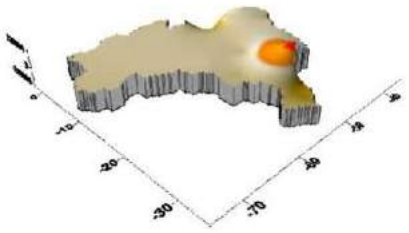


FIG 6

BRAZIL-DIF.(1995\2000 - 2005\2010)

INTERNAL IN MIGRATION



LABGIS-PUCMINAS (2015)
ABREU,JF/CARVALHO,CC

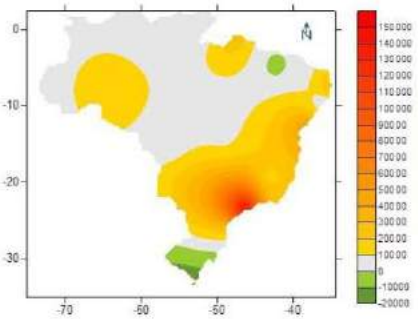
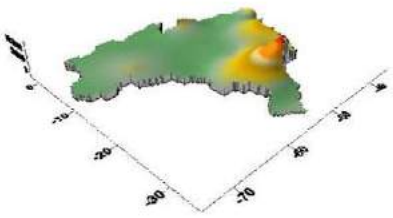


FIG 7

BRAZIL-DIF.(1995\2000 - 2005\2010)

INTERNAL OUT MIGRATION



LABGIS-PUCMINAS (2015)
ABREU,JF/CARVALHO,CC

© 2021 Global Journals

Bibliography

1. *Abreu, J. F; Barroso, L C. Geografia, Modelo de Análise Espacial e GIS.* Belo Horizonte: PUC Minas, 2003.
2. *Abreu, J. F.; Muzzarelli, A., Introduzione ai Sistemi Informativi Geografici.* Franco Angeli, Forum Católica de Minas Gerais, Milano, Italy, 2003.
3. *Abreu, J. F (82): "Migration and Money Flows in Brazil. A Spatial Analysis". U. of Mi. Press, Ann Arbor, Michigan.*
4. *Abreu J.F; Mingucci, R.; Muzzarelli, A.; Desigualdades Econômicas e Sociais: Aplicacões Computacionais.*Belo Horizonte, PUCMINAS, 2018
5. *Alvarez-Plata P, Brucker H, Siliverstovs B. (2003): Potential migration from Central and Eastern Europe into the EU-15—an update. Report for the European Commission, DG Employment and Social Affairs.*
6. *Anderson JE, van Wincoop E. (2003): Gravity with gravitas: a solution to the border puzzle. Am Econ - Rev 93(1):170–192.*
7. *Bailey, T. C and Gatrell, A. C (96): "Interactive Spatial Data Analysis" W. S. Press, N. Y.*
8. *Beijer, G. 1970: ''International and National Migratory Movements.'' International Migration VIII (3):93–109.*
9. *Carvalho, J. A. M. (88): "O tamanho da população brasileira e sua distribuição etária: uma visão prospectiva. "In VI Encontro Nacional de Estudos Populacionais. v. 1, p. 37 – 66. Recife.*
10. *Castles, S. and M. J. Miller 2009: The Age of Migration. Houndmills, Basingstoke, Hampshire and London: MacMillan Press Ltd.*
11. *Chan, Kam Wing and Li Zhang (1999): The Hukou system and rural-urban migration: processes and changes. The China Quarterly, No. 160, pp. 818-855.*
12. *Chan, Kam Wing and Man Wang (2008): Remapping China's regional disparities, 19902006: A New Assessment of de facto and de jure Population Data. Eurasian Geography and Economics, Vol. 49, No. 1, pp. 21-56.*
13. *Machado, C.C. and Abreu, J. F. (91): "The Elderly Mobility Transition in Brazil, An Exploratory Analysis". Paper presented at Elderly Mobility Transition Seminar – Aspen Colorado.*
14. *Sahota, Gian S. (1968): An Economic Analysis of Internal Migration in Brazil - Journal of Political Economy, Vol. 76, No. 2 (Mar. - Apr., 1968), pp. 218-245.*
15. *Tobler, W. (76): "Spatial Interaction Patterns" Journal of Environment Systems 6; 264-299.*
16. *Tobler, W. (79): "Estimation of Attractivities from Interactions" Environment and Planning A, 11, 121 – 127.*

© 2021 Global Journals