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LIST OF ABBREVIATIONS

ACP – Population Concentration Area

ANMR - Aggregate Net Migration Rate

ASR – Aggregated Spatial Regions

BSU – Basic Spatial Unit

CMI – Crude Migration Intensity

GPEM - School of Geography, Planning and Environmental Management

IBGE - Brazilian National Institute of Geography and Statistics

IC – Interaction Component

IMAGE – “Internal Migration Around the GlobE” Project

MAUP - Modifiable Areal Unit Problem

MEI - Migration Effectiveness Index

MR – Metropolitan Region

PR – Polarization Reversal

QCPR - Queensland Centre for Population Research

REGIC 2007 - Area of Influence of Cities 2007

SIDRA-IBGE - Automatic Data Recovery System of IBGE

SIM – Spatial Interaction Model

UQ - The University of Queensland

SUMMARY

LIST OF ILUSTRATIONS

ABSTRACT

Since the relative stabilization of mortality levels and the beginning of a widespread fertility decline in the 1970s, internal migrations became the main mechanism of population (re)distribution in Brazil. In this regard, by the 1980s, an inflexion of tendencies was observed, supposedly a delayed reflex of changes in the national space economy in the previous decade. The complexity and magnitude of the processes involved generated a plethora of different - and often conflicting - interpretations and concepts. This thesis aims to provide a theoretical and empirical basis for the discussion of the processes of population concentration and dispersion in the country, by analyzing multiple dimensions of migration (intensity, impact, distance and connectivity) over the last three decades at a variety of spatial scales. First, a conceptual framework is presented to contextualize the changing patterns of population (re)distribution in broader spatial cycles regarding economic and urban dynamics. Then, the general patterns and changes in key dimensions of migration over the last three decades at national level are described. A multiscale approach was adopted, in order to face the Modifiable Areal Unit Problem (MAUP) challenge regarding migration analysis in Brazil. After that, the changing patterns of migration between hierarchical levels of the Brazilian urban system are explored. Finally, Network Analysis methods are used to determine the changes in the topology of migration networks over the last three decades and unveil the spatial structure of migrations in Brazil since the 1980s.

Keywords: Spatial distribution of the population, population (de)concentration, internal migrations, Modifiable Areal Unit Problem (MAUP), Network Analysis.

RESUMO

Desde a década de 1970, com o início de um declínio generalizado da fecundidade e relativa estabilização dos níveis de mortalidade, as migrações internas se tornaram o principal mecanismo de (re)distribuição populacional no Brasil. Nesse sentido, uma inflexão de tendências foi observada na década de 1980, um reflexo tardio das mudanças ocorridas no espaço econômico nacional na década anterior. A complexidade e a magnitude dos processos envolvidos geraram uma infinidade de interpretações e conceitos, frequentemente conflitantes. Esta tese pretende fornecer uma base teórica e empírica para a discussão dos processos de concentração e dispersão populacional no país, analisando múltiplas dimensões da migração (intensidade, impacto, distância e conectividade) nas três últimas décadas, em várias escalas espaciais. Em primeiro lugar, apresenta-se um arcabouço teórico-conceitual para contextualizar as mudanças nos padrões da (re)distribuição da população em ciclos espaciais mais amplos, envolvendo dinâmicas econômicas e urbanas. Em seguida, os padrões e mudanças em dimensões-chave das migrações internas brasileiras ao longo das três últimas décadas são analisados e descritos. Uma abordagem multiescalar foi adotada, para enfrentar o desafio do "Problema da Unidade de Área Modificável" (MAUP) nas análises migratórias. Posteriormente, as mudanças nos padrões migratórios entre os níveis hierárquicos do sistema urbano brasileiro são exploradas. Por fim, métodos de Análise de Redes são utilizados para determinar as mudanças na topologia das redes migratórias e revelar a estrutura espacial das migrações no Brasil desde a década de 1980.

Palavras-chave: Distribuição espacial da população, (des)concentração populacional, migrações internas, Problema da Unidade de Área Modificável (MAUP), Análise de Redes.

1 – INTRODUCTION

With the relative stabilization of mortality levels and the start of a widespread fertility decline in the 1970s, internal migrations have become the key factor to understand processes of population (re)distribution in Brazil. In the last decades, these processes have been directly affected by dramatic changes in the composition, volumes and directions of migration flows, as pointed out by several studies (IPEA-IBGE-UNICAMP, 2002; Matos e Baeninger, 2004; Brito, 2006; Baeninger, 2011; Braga, 2011; Rigotti e Cunha, 2012). From the 1980s onwards, many authors pointed out a process of "population deconcentration" in Brazil, supposedly a delayed reflex of the productive restructuration and relative economic decentralization initiated in the 1970s, especially of industrial activities (Martine and Camargo, 1984; Diniz, 1993; Matos e Baeninger, 2004). Although exhaustively mentioned in the literature, there is a lack of a more rigorous definition of "population deconcentration" (related to the "counterurbanization" concept in the international literature) and significant theoretical and empirical gaps regarding the subject.

At first glance, "deconcentration" may seem a clear idea, but, when key issues such as scales emerge, things start to get blurrier. Disregarding this matter can lead to serious errors in the interpretation of spatial processes in the national level, because a process of population deconcentration can happen in one scale at the same time that a process of concentration occurs in another. The Modifiable Areal Unit Problem (MAUP), a well-known issue for geographers and researchers who work with spatial data in general, is virtually ignored in migration studies in Brazil. Since spatial statistical data is conditioned by the way and by the number of units that a given space is divided - respectively, the zonation and scale effects of MAUP (Openshaw, 1984) - it represents a real challenge for migration analysts and cannot be ignored.

Besides scales, there is a serious conceptualization problem – terms related to deconcentration as "counterurbanization", "concentrated deconcentration" (or "concentrated dispersion"), "productive restructuration", "decentralization" are poorly defined and frequently taken for granted, as well as the relation between *economic, urban* and *demographic* dynamics. Whenever processes of spatial concentration or deconcentration are mentioned in the literature of the fields of Demography, Urban and Regional Studies, Geography and

Economics, they refer to one or more of the three. The majority of studies simply implicitly assume the links between them without clarifying it. Thus, the lack of a theoretical framework that connects the changes in migration patterns with broader changes in the economy and in the urban system is another gap in the literature. More broadly, the lack of more substantial theoretical developments in Demography is a common criticism to the field (Burch, 2003).

Comprehending the population distribution and the spatial dynamics of population flows in an area with the size and complexity of the Brazilian territory is challenging and requires a great analytical effort. In this regard, migration studies in Brazil have tended to be descriptive and *ad hoc*, focusing in specific areas or regions, without a consistent methodological basis. The overarching framework of the four dimensions of migration proposed by Bell et al. (2002) can help fill this gap and deepen our understanding of the new Brazilian migration patterns and its impacts on the process of population (re)distribution, especially the typically overlooked connectivity dimension (with very few exceptions, like Tranos *et al.*, 2015, Maier and Vyborny, 2005 and, in Brazil, Braga, 2011; Fazito, 2005; Soares, 2002). That said, the overall aim of the thesis is to provide a theoretical and empirical basis for the discussion of the processes of population concentration and dispersion in Brazil, by analyzing different dimensions of migration over the last three decades at a variety of spatial scales. This goal can be divided in four objectives, each one corresponding to one chapter of the thesis:

1) Develop a conceptual framework to contextualize the changing patterns of population (re)distribution in broader spatial cycles regarding economic and urban dynamics

The conceptual framework consists in a descriptive model of national spatial development, in the form of cycles of concentration and dispersion. It makes explicit connections between different models and concepts already established in the literature, as the theories of Demographic Transition (Notestein, 1945; Caldwell, 1976), Mobility Transition (Zelinsky, 1971; Skeldon, 2012), Polarization Reversal (Richardson, 1980) and the discussion about the relation between zones and networks. By encompassing different spatiotemporal processes, the model links sequential changes in migration patterns with broader economic and urban dynamics, elucidating its impacts in the settlement system. It will serve as a guide for the interpretation of the empirical results and to contextualize the Brazilian case in a broader perspective.

2) Identify changes in key dimensions of migration over the last three decades using multiple spatial scales

The intensity, impact, distance and connectivity dimensions of migration (Bell et al., 2002) in Brazil since the 1980s will be systematically explored using several indicators of each one of these dimensions at multiple spatial scales. This global description can help understand in what extent migration flows in different scales contributed to the processes of population redistribution in Brazil. Besides official political-administrative boundaries (municipalities, microregions, mesoregions, states and macroregions), aggregation and spatial modelling functions of the IMAGE Studio software will be used in order to confront the MAUP challenge.

3) Investigate the impact of the changing patterns of migration in the structure of the Brazilian urban system over the last three decades

Besides considering different scales of analysis, to fully comprehend the processes of population concentration and dispersion in Brazil, it is necessary to take into account that regions play different roles in the national economy and that cities occupy different positions in the urban hierarchy. If a process of economic and population deconcentration is occurring, we should expect an increase of population flows from the urban centres positioned in the higher hierarchical levels towards the lower levels. By investigating the overall structure and changes in migrations patterns between different "functional spaces" (regarding the relative positions of cities in the urban hierarchy), it is possible to elucidate the relation of the alleged processes of population deconcentration with changes in the Brazilian urban network. The functional spaces will be established in the basis of the hierarchical classification of the research "Areas of Influence of Cities 2007" (IBGE, 2008) of the Brazilian National Institute of Geography and Statistics.

4) Determine the changes in the topology of migration networks over the last three decades and unveil the spatial structure of migration using Network Analysis methods

Beyond the more obvious matter of scales, is important to highlight another potential source of misunderstandings in the discussions about population (de)concentration in Brazil: the structural changes occurred over the last decades in the way territories are controlled and organized. Due to the "space-time compression", an effect of the development and diffusion of transport and communication technologies, the growing importance of networks as a "mode" of spatial-territorial organization is a global phenomenon (Castells, 1996; Raffestin, 1993; Haesbaert, 2004; Santos, 2002; Corrêa, 2000). From the middle of the last century, urbanization and the multiplication of new agglomeration economies throughout the Brazilian

territory have been making the spatial distribution of the population more “discrete” or less “continuous”. Since the 1970s, the majority of the population was already living in cities and internal migrations had become predominantly of the urban-urban type (Matos e Baeninger, 2004; Braga e Fazito, 2010). That said, urban and migration networks are crucial to deepen the understanding of processes of population redistribution.

The theoretical and methodological framework of Network Analysis can be a powerful tool to investigate, identify and characterize the spatial structure of migration. It can help answer fundamental questions like “How dispersed or centralized are migration flows? Is migration activity clustered between specific spaces? How? And how this patterns change over time?” Considering the relational perspective of Network Analysis, if a process of population deconcentration is happening, we should expect an increase in the cohesion and density of migration networks and a decrease on its centrality and clusterization degrees. If migration flows are more “fragmented”, the result should be a *less* fragmented migration network. In order to neutralize the influence of population size, an “interaction component” was used to create origin-destination matrices that reflect more strongly the spatial structure of migrations (like in the works of Maier and Vyborny, 2005 and Raymer *et al.*, 2015). Besides traditional migration flows maps, the interaction component will be visually represented in a series of maps at different spatial scales, in order to reveal the main migration streams and migration sub-systems in Brazil.

In sum, from a theoretical point of view, the flagship of this thesis is the use of a conceptual framework to interpret the processes of population (re)distribution driven by migrations flows in Brazil. These will be described and analysed in depth, using multiple scales and the four dimensions of migration proposed by Bell and colleagues (2002). The empirical part was based on methodological strategies that aim to incorporate more explicitly the spatial dynamics of migrations and to unveil the main vectors of population redistribution in the country. The focus is on migration as a mechanism of population redistribution and it will not encompass migration decisions or motivations neither socioeconomic characteristics of migrants or of the places of origin and destination.

The thesis is divided in seven chapters, four of them dedicated to each of the abovementioned objectives. Chapter 2 consists in the theoretical foundations of the thesis and the presentation of the conceptual framework. Chapter 3 provides the data sources and some methodological guidelines used to generate the results of the empirical part. Chapter 4

provides a background on the process of population (re)distribution in Brazil, starting with a brief historic of the processes of spatial concentration and deconcentration in Brazil, in order to contextualize and shed light on the articulation between internal migrations, urbanization and the economy, especially after the 1970s, when processes of economic and demographic concentration reached a turning point. After the 1980s, a more formal approach is adopted and several migration metrics are provided in order to give a global overview of key dimensions of internal migration in Brazil at different spatial scales. In order to study the impacts of these process in the urban system, Chapter 5 explore the changing patterns of migration between urban hierarchical levels. Chapter 6 shows the evolution of migration networks in Brazil and the changes on its spatial structure, using standard Network Analysis metrics and maps representing migration flows and the abovementioned “interaction component”. In chapter 7, some final considerations and recommendations for future research are provided.

2 – LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

The goal of this chapter is to outline the research problem and present the conceptual framework, which will serve as a guide for the interpretation of the empirical results. It consists in a descriptive model of national spatial development in the form of cycles of concentration and dispersion, encompassing different spatiotemporal processes. The theoretical foundations of this model, as well as its potentialities and limitations, will be presented and discussed, starting with the most fundamental one: the relation between zones and networks, two distinct modes of spatial organization, influence and control that, explicitly or implicitly, will be subjacent to the analysis of the changing settlement and migration patterns in Brazil in the last decades.

2.1 Brief considerations about Zones and Spatial Networks

The growing importance of reticular structures as forms of organization, influence and control of territories have mislead some authors to the false conclusion that continuous-contiguous spaces[1] and spatial networks are mutually exclusive. However, this antagonism is not real. The organization of space in the form of networks denotes just another way of manifestation of power relations, but not the end of territories or the "end of Geography", as postulated by Richard O'Brien (1992). Zones and networks supports all spatial practice and, although apparently multiform, they are built from the same basic structure (it is no coincidence that the three basic cartographic elements of representation are *surfaces, dots* and *lines*). In the quote below, the Brazilian geographer Milton Santos elucidates this issue:

> *"The fact that networks are global and local, one and multiple, stable and dynamic, makes its reality, seen as a whole, reveal the overlap of multiple logical systems, the mixture of various rationalities, whose adjustment is led by the market and governments, but, above all, by the social-spatial structure"* (Santos, p.189, 2002. Own translation).

[1] From now on, "continuous and contiguous spaces" will be referred simply as "zones".

Historically, there is an increasing tendency of organization around networks, which "*modifies substantially the operation and the results of production processes and experience, power and culture*" (Castells, 1996 p.565). We live a new informational and technological paradigm, where network morphologies leads to a drastic reorganization of power relations (Castells, p.500, 1996). However, one should not confuse the new experiences of space and time - the mark of postmodernity - with the new "power geometries", because the weakening of spatial mediation in social relations does not mean the end of territories (Haesbaert, 2004).

In the 90s, the idea that globalization would reduce the role of States and national borders as political structures was popular in the academic community. Many believed that the affective dimension of national identities would weaken and people would move more freely (Wilson and Donnan, p.4-5, 2012). Despite the strength of this view in some circles, National States continue to play its role as the most prominent form of political and social organization. These ideas represent what Rogério Haesbaert (2004) calls the "Myth of Deterritorialization". According to these theories[2], the "space-time compression" resulting from globalization and technological advances in communication and transportation systems (as well as its diffusion) would have abolished the importance of geographical distances, condemning the world of territorial divisions of National States in favour of a world organized in the form of networks. The author deconstructs these arguments in three ways.

First, Haesbaert criticizes the lack of a clear definition of “territory”, often confused with the concept of space or simply the material dimension of reality. So, for every concept of "territory" would be a correspondent definition of "deterritorialization”. The author points out that, even when a simple function of spatial or material mediation of social relations is projected into the territory, the idea of deterritorialization does not hold because of the several processes that re-emphasize the importance of a “geographical” basis: ecological issues (e.g., deforestation, erosion and pollution); access to new natural resources; epidemics diffusion; border issues and accessibility control (e.g., the current Syrian Refugee Crisis, the “Brexit”, the popularity of Donald Trump’s hard-line speech about immigration policies in the last USA presidential campaign) and new national-regionalist fights with strong territorial basis (e.g., the current tensions between Russia and Ukraine about Crimea).

[2] Defended by Badie, 1995; Virilio, 1982; Gilles Deleuze, Félix Guattari, 1986 and, in Brazil, for Ianni, 1992 and Ortiz, 1994 (*apud* Haesbaert, 2004).

It is noteworthy that, by having a material foundation, even networks are not fully "deterritorialized" (except in a metaphorical level). This misconception would be a result of the contraposition of networks to territories considering only its temporal dimension and ignoring the spatial dimension (Haesbaert, 2004, p.293). Manuel Castells (1996) deepens this topic, describing the three layers of material support of what he calls "space of flows": An electronic pulse circuit (information technology equipment), nodes (centres of important strategic and communication functions) and the spatial organization of the dominant managerial elites (not classes) that exercise the directional functions around which this space is articulated.

The second way Haesbaert criticizes the "Myth of Deterritorialization" is pointing out that it only reflects the partial view of hegemonic countries and groups, effectively "globalized", disregarding the multiplicity of experiences in the least developed countries, within metropolises and of those excluded from the globalization process (Haesbaert, 2004). For the author, the neoliberal ideology, that preaches the "end of borders" for the free deployment of market forces often underlies the discourse of deterritorialization (2004, p.367).

The third and last argument states that deterritorialization processes would often be addressed as generic and uniform, disconnected of its temporal and historical dimensions, within a dichotomous logic that does not correspond to reality. The criticism of the dissociation between time and space, stability and mobility, space and society, material and symbolic, territory and networks is shared by several authors. The concepts of "space of places" and "space of flows" of Castells (1996), "zone-territory" and "network-territory" of Haesbaert (2004), "fixed and flows", "object systems" and "actions systems" of Santos (2002) and "meshes", nodes and networks of Raffestin[3] (1993) make it clear that there are, in fact, different modes of organization and control of space. Furthermore, what these referential authors managed to demonstrate is that, despite its internal differences and conceptualizations*, there is an overlap and an interaction of zonal and reticular rationales in space and time*. As stated by Matos and Braga (2005, p.111),

[3] In a reinterpretation of Raffestin (1993), Haesbaert (2004) states that the territories are composed of two "invariants": zones or surfaces - corresponding to what Raffestin call “meshes” - and networks - the combination of nodes and flows, in the terms of Raffestin.

> *"The instability of borders and the inclusion of places previously isolated in global dynamics has been shaking significantly the rigidity of well-established spatial boundaries. However, the mobility of goods, people, information, values and limits does not disqualify the existence of "places", "regions" or even "territories", but inserts them in novel ways in the flexible world of reticular organizations"* (own translation).

The dualistic view of the socio-spatial dynamics (zones vs. networks) is based, according to Haesbaert, in an outdated conception of territory as a zone or surface relatively homogeneous and virtually devoid of movement (2004, p.286). For him, "*precisely because it is relational, the territory is also movement, fluidity, interconnection - in synthesis and in a broader sense, temporality*" (Haesbaert, 2004, p.82). This view of territories formed on and by movement is shared by other authors. For Raffestin (1993), "*circulation and communication networks contribute to model the spatial-temporal framework that is the whole territory*" (p.204, 1993). For Milton Santos (p.181, 2002), circulation defines geographical patterns and holds the command of value changes in space. Finally, the concept of "space of flows" of Manuel Castells (1996) is based on the idea of spatial organization through movement.

The coexistence of zonal and a reticular logic in the organization of space is not a novelty of postmodern times. Material and immaterial flows connecting spaces always existed. The novelty is that these became broader, faster and more diverse, allowing instant communication and influence and control over territories in the distance. Thus, networks have become the "instrument" *par excellence* of power (Castells, p.204, 1993) and have assumed an unprecedented role in history in relation to continuous-contiguous spaces, in what regards control of territories.

The concepts of "zone-territory" and "network-territory" created by Haesbaert (2004) help clarify this matter. The former are related to spatial controlling of continuous surfaces using well delimited borders and the latter refers to control of flows or connections. These "ideal types" of spatial-territorial organization are interconnected in an increasingly complex manner and do not manifest in a dual or dichotomous way in relation to each other. It reflect the multiplicity of territories and/or multiterritoriality in which we live and are not antagonistic conceptions - in the zone-territory networks are subordinate to zones, the opposite being true for the network-territories. The network concept emphasizes the dynamism of space and its connections prospects, relativizing the static condition normally assigned to territories as

zone-territories (Haesbaert, 2004, p.287). As stated by Raffestin (1993, p.204), "*the network do and undo the prison of space, made territory: both liberates and imprisons*".

The proponents of the deterritorialization idea argue that the "territorial-state classical modernity", marked by the zone-territory conception and for an exclusivist notion of power have been overcome in postmodernity by a discrete logic of multiple territorial overlays (and thus multiple relations of power) characteristic of zone-networks (Haesbaert, 2004). Nevertheless, multiple "temporalities" and "territorialities" currently coexist, and would be a serious mistake to assign homogeneity to the forms of domination and control of space. As will be seen in Chapter 6, the use of formal methods of Network Analysis shows that the study of spatial processes through a reticular perspective does not exclude the traditional geographical (zonal) approach, but reveals different aspects of these phenomena due to the "emergent properties" of relations (Soares, 2002). Network Analysis methods can be used to formalize the aspects of this discussion related to the frequently neglected connectivity dimension of migrations.

2.2 Theoretical foundations and overview of the model

In this section, we outline an integrated framework of spatial development, in order to link sequential changes in patterns of population (re)distribution in Brazil with broader spatial cycles of urban and economic concentration and dispersion. The model starts in a stage of relative dispersion, where the zonal mode of spatial-territorial organization prevails over the network mode. In the subsequent phases, as the patterns of population (re)distribution change, the network mode progressively grows in importance, leading to a new stage of “deconcentration” (but, this time, with the network mode prevailing over the zonal mode).

The proposed conceptual framework set forth in this research is original only to the degree that it makes explicit connections between different models and concepts already established in the literature. By encompassing the theories of Demographic Transition (Notestein, 1945; Caldwell, 1976), Mobility Transition (Zelinsky, 1971; Skeldon, 2012), Polarization Reversal (Richardson, 1980), the discussion about zones and networks and other concepts, it is possible to shed some light in the mechanisms and patterns of population (re)distribution. A

conceptual model can be a very useful tool for communication across disciplines[4], helping to improve the framing and formulation of research questions, find gaps in the literature and clarify system boundaries by representing the relevant processes contained in the researched phenomenon (Heemskerk et al., 2003). The conceptual model created for this research will serve as a guide to interpret the empirical results. In the following, its theoretical foundations will be discussed.

Skeldon (2012) defends the explanatory power of transitional approaches for the study of migration, especially when linked with other economic, social and political processes that are also diffusing in space and time. The most common criticisms to this approaches - such as the "modernization theory of development" - is that they have universalistic pretensions, deterministic character (as if a single neoliberal political-economic system was the only possibility of development) and that they are macro-level descriptions based on the experience of Western Europe and North America. Nevertheless, "*such reasoning need not necessarily lead us to adopt a position of absolute relativism and a retreat into the kinds of atheoretical interpretations that have been common in migration studies over the last decade or so"* (Skeldon, 2012). Although a transitional approach cannot provide an all-encompassing explanation for migration, it can offer a useful framework for the study of specific areas and create a "*fertile environment in which to generate future theories of migration*" (Skeldon, 2012).

In this research, we assume a more "liberal" view of scientific theory, as defended by Burch (2003), which contests the traditional epistemological view of "logical empiricism". For the latter, theory is based on empirical laws, judged by true or false by its agreement with data. On his reflections about the nature and development of demographic theory, Burch (2003) supports a "model-based" or "semantic" view of science, where *models*, not empirical laws, are the central element of scientific knowledge. A model is any abstract representation of some portion of the real world which contains basic principles, generally regarded as laws. However, in the "model-based" epistemological view, these laws do not refer to the real world - they function as true statements about the model itself. "*A model contains generalisations, but they are formal generalisations, not empirical ones"* (Burch, 2003). Thus, the idea is not judge the validity of the theoretical model by its agreement (or disagreement) with empirical data, but by considering "*how well the resulting model fits the intended aspects of the real*

[4] In this case, Demography, Geography, Economics and Urban and Regional Science.

world" (Giere, 1999 *apud* Burch, 2003). *"The model-based view is equally concerned with empirical data, but these are used to judge whether a model fits some portion of the world closely enough for a given purpose, not whether the model is true or false in any absolute sense"* (Burch, 2003).

At the present moment, it is well established that there is no single pathway through any migration or developmental transition, but a retreat to total relativism would be counterproductive (Skeldon, 2012). It is not sensible to complete discard useful theories due to empirical exceptions. All models are inherently incomplete and oversimplifying, but is exactly this features that make them so useful to make sense of an otherwise inapprehensible reality. The point of constructing a model of spatial cycles is not create a rigid scheme with universal validity, but create a framework which can help us to understand complex patterns of population redistribution in the real world, even if it is not necessarily empirically true in all respects.

The *Demographic Transition model* (Notestein, 1945; Caldwell, 1976), for example, describes the transition from a regime of high to low mortality and fertility, accordingly to the stage of socioeconomic development of countries or regions. Like any model, it may not accurately describe all individual cases, but it is widely accepted in the Social Sciences as a universal phenomenon or, at least, an ideal but valid generalization. The stages of the Demographic Transition were defined by an induction process based on empirical regularities, that is, by common observed trends in developed countries. The extrapolation of these trends to developing countries was certainly useful to researchers and public policy makers, despite the different starting levels and rates of fertility and mortality decline (as well as the reasons for the decline)[5]. The model definitely applies to Brazil, regardless of the much faster pace in which it occur (due to fast social and economic transformations), when compared to the US or European countries.

One common criticism of the Demographic Transition is the non-inclusion of mobility, one of the three main demographic components[6]. To fill this gap, Zelinsky (1971) formulated the

[5] Other frequently mentioned inconsistencies are the considerable fluctuations of fertility and mortality in pre-transitional societies and the tendency of pre-industrial towns and cities to present higher mortality rates than those observed in rural areas.

[6] At this sense, the Demographic Transition could actually be considered as a "vital transition", since it considers only the vital events of births and deaths (Zelinsky, 1971).

hypothesis of "*Mobility Transition*", where he tried to relate modifications in migration patterns with stages of the demographic transition and stages of socioeconomic development. By assuming the presence of patterned regularities through space-time during recent history, he created a model representing orderly changes in the *form* and *intensity* of spatial mobility. The model was intended to be a "*highly idealized, flexible scheme that affords a general overview of a variety of places and periods"* (Zelinsky, p.229, 1971). In addition, he argues that

> *"It is aloof from 'accidents' or exceptional circumstances; it is of little help in describing or predicting specific patterns of migration or circulation for a particular small area or set of areas over a brief period; it is deliberately vague in indicated distances, elapsed time, and rates. But if geography and history are viewed in extremely soft focus through the lens of the hypothesis, it may have value in whatever broader insights are forthcoming" (Zelinsky, p.229, 1971).*

For this reason, the "Mobility Transition" model will also be incorporated in the conceptual framework, but relativised in the manner proposed by Skeldon (2012) and considering internal migrations only[7]. On Skeldon's interpretation, a "*Migration Transition*" refers to changes in migration patterns within certain contexts and the diffusion of such processes through space and time, which do not manifest themselves in a unique way and do not follow a linear and universal trend. It postulates that, as countries and regions develop, patterns of mobility evolve accordingly, reshaping settlement patterns and economic activities. Such transitions can occur over extended or short timeframes, depending on the triggering factors and transformations in the national context, but the importance of spatial mobility as an integral component of national development is widely recognised (Rowe, 2013). That said, transitional models applied to specific contexts, incorporating migrations and other dimensions, can provide the means for a better understanding of the complex relations between migration and development and provide an indication of future trends. According to Skeldon (2012),

> *"By overlaying evolving spatial patterns of migration onto changing agricultural and industrial transitions within the context of development policy at both national and local*

[7] For this reason, from now on, we will adopt the term "Migration Transition", as proposed by Skeldon. Although important, international migrations, commuting and other forms of circulation are beyond the scope of this work.

> *levels, a much more nuanced method of approaching the migration–development nexus will result. The objective is to link sequences of change in migration with the other selected variables across space and through time in an integrated system of migration and development (…) the idea of transition has been central to thinking and theorising about development, and the growing interest in the topic of migration and development once again should place transitions at the centre of concern."* (Skeldon, p.163, 2012).

Zelinsky (p.222, 1971) argues that "*the mobility transition closely parallels that of the demographic and that of other transitional sequences not yet adequately described*". Thus, to help make sense of the changing spatial patterns of population (re)distribution within the Brazilian settlement system, another transitional approach will be incorporated into the model. The term "*polarization reversal*" was coined by Harry Richardson (1980) to describe *"the turning point when spatial polarization trends in the national economy give way to a process of spatial dispersion out of the core region into other regions of the system".* It is one of the essential components of a general descriptive theory of national spatial development proposed by the author in order to describe this phenomenon, observed in several developed countries. In the original paper, Richardson already raises the question if the same path would be followed by developing countries. This issue will be discussed in the analysis of the Brazilian case, since several authors pointed out processes of demographic and economic deconcentration starting in the 1970s in Brazil, although limited to certain portions of the territory.

According to Richardson (1980), even when a clear process of polarization reversal is triggered, *"dispersion is a misleading term since the need to generate agglomeration economies as attractors for factors of production implies spatial concentration within these regions"* (Richardson, 1980). The expansion and densification of the urban system are directly related to the strengthening of the network mode of spatial-territorial organization. This means that the dispersion of populations and economic activities is not a homogeneous or continuous process in space – it happens in selected places. In other words, there is a coexistence of centripetal and centrifugal forces driving population and economic flows, which also depends on the observed *scales*. In what regards this matter, Richardson (1980) affirms:

> *"Most important of all, polarization reversal is associated with population deconcentration only in the core region itself or at the scale of the national space economy, at least initially. In other regions, polarization reversal almost always involves more spatial concentration with intraregional polarization toward regional cities continuing over a long period of time"* (Richardson, p.80-81, 1980).

By referring to the seminal work of Berry (1976) about *"counterurbanization"* - another important concept to be discussed - Richardson (1980) points out that, despite apparent similarities with the polarization reversal idea, there are significant differences between them. While the former emphasizes the slowing down in population and economic growth in metropolises and the opposite trend outside them, polarization reversal is a *symptom of the economic growth of metropolises*. Since the original formulation of Berry (1976), the counterurbanization concept assumed a wide variety of meanings[8] and turned into one of the most popular terms used to describe population redistribution within national settlement systems. However, the massive bibliographical revisions conducted by Mitchell (2004) and Sexto (2009) show that its use is far from consistent. This term has been used to refer to heterogeneous processes of urban, economic and population deconcentration, driven by different factors and in different scales. In a general sense, Sexto (2009) concludes that counterurbanization relates to

> *"(…) a new explanatory paradigm of the urbanisation process; that is to say, the concentration of economic activities and population of the industrial society is followed by the deconcentration of the same in post-industrial society, in relation to a structural and technological change in the developed economies and negative cultural predispositions of the urban population towards large agglomerations. The true dimension of the change phenomenon is currently a question of debate and investigation" (Sexto, p.61, 2009).*

The same author also supports that *"the diversity of theories and interpretations doubtlessly presently serves to show the existence of a wide process of change in the migratory and economic flows that was generalised bit by bit in developed countries"* (Sexto, p.59, 2009). He calls attention for the fact that this processes of deconcentration are not exclusive of the

[8] The prosaic definition of Berry (1976) certainly did not help clarify the processes to which this term normally refers: "a process of population deconcentration; it implies a movement from a state of more concentration to a state of less concentration".

more developed regions of the world, providing examples of studies showing similar trends in Latin America. Although this concept is virtually inexistent in the Brazilian literature, a vast amount of research was made regarding the plethora of phenomena to which it corresponds. By approaching the subject of counterurbanization, it is possible to include the Brazilian case in a broader context and generate useful insights for the interpretation of the changing patterns of population (re)distribution in the country.

Mitchell (2004) describes three ways on which scholars approach the definitional issue of counterurbanization. The first refers to works that use the term arbitrarily, that is, without defining its meaning; the second refers to those who review existing definitions, but either do not explicitly indicates which one they will use or simply abandon it altogether; the third and last refers to those who provide explicit definitions and equate counterurbanization with *migration* or as a *process of settlement system change.* The former view considers migrations the key component of counterurbanization, more precisely defining it as the relocation of urban residents from large (often metropolitan) to small (often non-metropolitan) spaces; in the latter, the focus shifts to a process of settlement system change, that is, a transition of a settlement system from a state of concentration to one of deconcentration (Mitchell, 2004).

The theory of “differential urbanization”, proposed by Geyer and Kontuly (1993) and refined in Geyer (1996) fits into this last category. The authors propose a graphical and transitional model to describe sequential changes in mainstream migration flows according to *settlement sizes*, including three urban development cycles: *urbanization*, where migrations from small towards big or “primate” cities would prevail; *polarization reversal*, where migrations towards cities of intermediate size would be predominant; *counterurbanization*, where the opposite movements of the urbanization phase would take place. To each phase, a different type of mainstream migration flow would predominate. Despite the rigidity and deterministic character of the “differential urbanization” model, it can lead to important insights, helping the interpretation of changes in the *impact* of migrations during the process of development. In a critical revision of its postulates, Rees et al. (2016) proposed the use of *population density* instead of city sizes or the simplistic rural-urban dichotomy in order to compare the spatial impacts of internal migration in different countries. These authors suggest that the relationship between migration impact and development is an inverted U-shaped curve, with “polarization reversal” being the point of inflection in this relation. They also present a theoretical framework linking development to population redistribution, suggesting how

internal migration redistributes population across settlement systems during five stylised phases of development[9]:

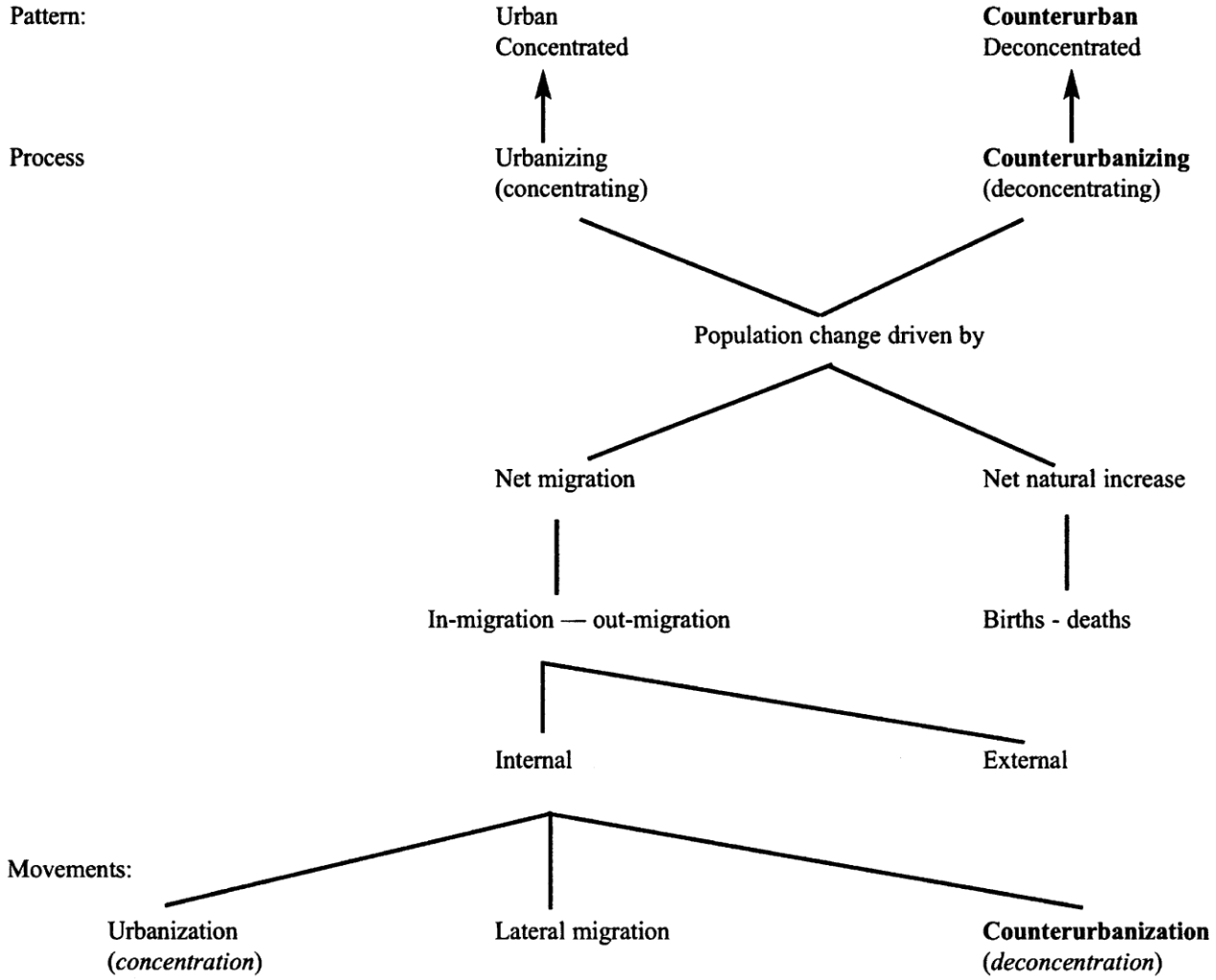
> "*Underpinning these shifts in spatial patterns, the overall impact of internal migration in terms of system-wide distribution first rises and then falls as the settlement system shifts from predominantly rural to urban, finally settling into dynamic equilibrium. Migration effectiveness declines as most migration flows are balanced by counter-flows. The evidence suggests that migration intensities, too, tend to fall after peaking at high levels of development (Bell et al., 2012). Thus, countries may experience migration flows between urban areas that involve high mobility but low effectiveness, leading to minimal population redistribution"* (Rees et al., 2016).

To conclude the discussion about the controversial "counterurbanization" notion, in order to "make sense" of the term, Mitchell (2004) proposes three distinct concepts: The first, "counterurban", refers to a deconcentrated *pattern* of population distribution (that is, "small numbers of people distributed in many settlements"). The second, "counterurbanizing", refers to the *process* of change whereby a settlement system is transformed from a concentrated to deconcentrated state (either through natural increase or migrations). The third, "counterurbanization" is redefined in a narrower sense, referring to the downward *migratory movements* in the urban hierarchy. It is important to highlight that in Mitchells framework *deconcentration* is the critical element of all these definitions. Figure 1 visually shows this framework[10]. Although this exact terminology do not necessarily have to be adopted, the distinction between *patterns, processes* and *types of migratory movement* can be very helpful to elucidate the different meanings that the term "counterurbanization" assumes in the literature.

[9] "As the country urbanises, as both a cause and consequence of development, the first phase involves net internal migration from low density areas (rural settlements) to high density areas (urban settlements), and in the second phase, the process of urbanisation accelerates. In the third phase, it slows and may reverse into counter-urbanisation, with a negative slope in the net internal migration–density relationship in phase four. The final phase recognises three alternative outcomes: (a) re-urbanisation, (b) counter-urbanisation, or (c) dynamic equilibrium" (Rees et al., 2016).

[10] The framework proposed by Mitchell (2004) contains an adjacent piece regarding migrations motivations. Since it is beyond the scope of this work, it was not included.

Figure 1 - Mitchell (2004) conceptualization of the process of population redistribution



As already indicated, another potential source of misunderstandings regards the *scales* at which those concepts can be applied, a crucial question in any geographic approach. Mitchell (2004) suggests that, as long as the basic unit of measurement has an appropriate level of disaggregation, they are applicable at the local, regional or national level. However, some authors argue that, at the local level, the movement of residents from an urban core to an adjacent area "*represents nothing more than the continual expansion of the urban centre into areas yet designated 'metropolitan'"* (Mitchell, 2004, p. 25), that is, it could be considered more as the deepening of a process of *urbanization* than *counterurbanization.* Nevertheless, if the result is an outward spread and a population decrease in the urban core (or, at least, the slowing of its growth), a deconcentrating trend is present. Other scholars argue that the nation or aggregated statistical areas are not appropriate for approaching the topic. Mitchell (2004) supports that work with national trends can be useful, if comparisons of rates of changes in less aggregated areas across the nation are made to identify the presence of

counterurbanization tendencies (the approach adopted in this work). Distinguishing scales to understand processes of deconcentration is a matter of central importance to this thesis, since *"how the transitions vary over time will depend upon the scale of the unit being used to analyse the transition and its place in the global spatial system*" (Skeldon, p.163, 2012).

2.3 Cycles of Spatial Development

The conceptual framework consists in a descriptive model of national spatial development in the form of cycles of concentration and dispersion, subject to the qualifications mentioned in the previous section. Figure 2 shows a summarized schematic representation of the model in a single panel, presenting the same structure of five sequential stages used in the Demographic and Mobility transitions, but also incorporating urban and economic spatial dynamics[11]. Due to feedback effects, a high degree of interaction among these processes is expected. Like in Zelinsky's (1971) proposal, the phases of different transitions are placed in parallel position to suggest contemporaneity and, probably, interdependence. However, no indication of duration or specific periods are set forth (this will be made only in the application of the model to the concrete Brazilian case). The segmentation in discrete steps is for intelligibility purposes only, since these processes manifest themselves in a continuous manner across time. It must be emphasized that different trends can be identified depending on the scale of analysis and different portions of the national territory can be delayed in relation to others, regarding certain aspects of the framework, as suggested by Geyer (p. 54-55, 1996), for his model of "differential urbanization":

> *"The fact that an urban system enters an advanced phase of development at the national level does not mean that individual regions within the national system could not still be in one or more of the earlier phases of development (…) Although a country may be in an advanced phase of development overall, prominent differences in mainstream and sub-stream migration could still be visible at the sub-national level because certain regional systems of cities could still be in an earlier phase of development than others"*

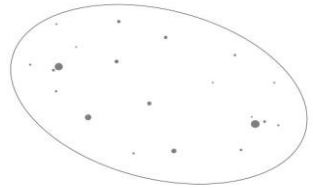
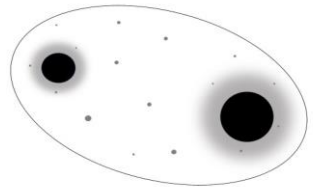
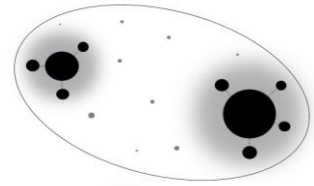
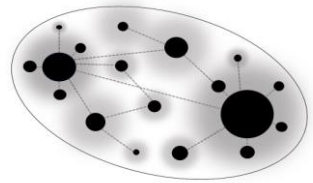
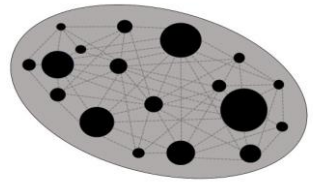
[11] Hein De Haas (2010) also proposes a five stage conceptual framework exploring "*the conceptual links between temporal and spatial migration models*". Although the focus of this author is on the developmental drivers of *international* migration processes, it can be easily related to the framework presented on this thesis, including the relation between the demographic and mobility transitions and spatial patterns of "centralization" and "decentralization" within countries.

In what regards the visual representation, it should be clear that it must not be interpreted factually – it is just a reference for a better comprehension of the model and an illustration of its key concepts. The challenge of this depiction is that it includes material and immaterial dimensions and the fact that, due to extension of the "urban-industrial fabric" beyond cities, through the countryside - as implied by the "extensive urbanization" [12] concept proposed by Monte-Mór (1994, 2006, 2007) - there is no obvious way to distinguish urban and rural areas in a visual representation, especially in later phases of development. As the urban logic of (re)production of space diffuses towards rural areas (through the dissemination of urban activities and ideas), the contrasts which traditionally separate them weaken and a "rural-urban continuum" is formed.

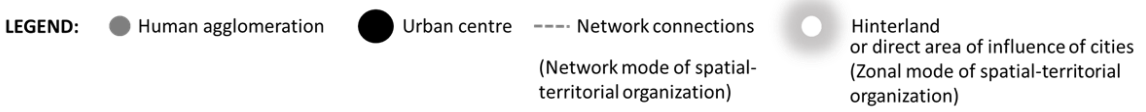
Likewise, reticular and zonal modes of spatial-territorial organization also overlap in space and time. While network connections can be interpreted as channels for the exercise of power (influence and control of territories) disregarding geographical proximity, hinterlands can be interpreted as a dense network of material and immaterial connections formed in the surroundings of an urban centre or metropolis (the hub of a "star topology" network). By addressing the multifaceted character of spatial processes, this model provides a basis for the interpretation of patterns of human settlements and migration in the real world. It will be used as a backdrop to guide the description and analysis of the data in the empirical part of this thesis and study the Brazilian case within a more general framework. In the following, each "spatial cycle" will be descripted in detail.

[12] There is a lot of terms and phrases in the literature referring to the increasing blurring of the rural-urban dualistic notion, the most common being "diffuse urbanization", "rural rebirth", "rural-urban continuum", "urban decline" and "urbanization of the countryside" (Pahl, 1966 and Clout, 1976 *apud* Sexto 2009).

Figure 2 – Conceptual spatiotemporal model of population redistribution within the national settlement system (schematic summary table)

Spatial Cycles	Economic and Urban Spatial Dynamics (Patterns and Processes)		Demographic Transition	Migration Transition (Zelinsky, 1971; Skeldon, 2012)	Spatial Patterns (Visual representation)
	Traditional rural and agricultural society				
I **Spatial dispersion** (Zonal Mode)	*Agglomeration economies*	Fast urbanization	*High fertility* *High mortality* Stable population (or slow increase)	Low level of migrations	
II **Spatial concentration**	*Agglomeration diseconomies*	Metropolizaton	*High fertility* *Fast decline of mortality* Vary rapid increase of the population	Rural Exodus and movements to "colonization frontiers"	
III **Intraregional deconcentration**	*New agglomeration economies (within the core region)*	*"Concentrated deconcentration"*	*Fertility decline* *Decline of mortality* Increase of the population slows down	Reduction of rural-urban flows and migrations to colonization frontiers. Emergence of more complex patterns	
IV **Interregional deconcentration**	*New agglomeration economies (outside the core region)*	*Polarization Reversal* (Richardson, 1980)	*Low fertility* *Low mortality* Stable population (or slow increase)	Predominance of urban-urban migrations, with vigorous movements from city to city or within individual urban agglomerations. Stagnant or retreating settlement frontiers.	
V **Spatial dispersion** (Network Mode)		Expanding and denser urban network. Functionally and economically integrated spatial system	*Very low fertility* *Low mortality* Stable population (or slow decline)	Probable decline in levels of migration, which are, nearly all of the interurban or intraurban variety	
	Modern, urban and industrialized society				

Source: Prepared by the author.



1st Stage – Spatial dispersion

The model starts in a stage of relative spatial dispersion of the population. It refers to a traditional rural and agricultural society, characterized by high levels of fertility and mortality. The population is stable or presents a slow pace of growth. Zelinsky (1971) postulates that, in this initial phase, there would be "*little genuine residential migration and only such limited circulation* ". Although the zonal mode of spatial organization prevails at this point, it must be clear that networks are present even in the most rural nations. "*A major characteristic of human settlements is the presence of many separate nodes or centers of concentrated activity*" (Hansen, 1976).

2nd Stage – Spatial concentration

Because of the scarcity of investment resources, the onset of the urban-industrial process of national development begins in one or two regions only (Richardson, 1980). A cumulative causation process emerges due to the "*increasing returns to scale and consequent polarization of labour and any surplus capital from other regions*" (Richardson, 1980). The decline of mortality rates and maintenance of high levels of fertility result in a young age structure and a very fast increase of the population, creating a labour surplus to meet the demands of the fast growing urban areas. The rapid natural growth combined with a "rural exodus" - the "massive movement from countryside to cities" (Zelinsky, 1971) - induces a process of spatial concentration, by enabling the differential demographic growth of core regions.

Paradoxically, as land gradually becomes a more valuable and scarce resource, the pressure caused by the "demographic explosion" in rural areas also induces the expansion of the national settlement system in "colonization frontiers", although in a much lesser extent in comparison to the expansion of urban areas. At this stage, the *zonal mode* of spatial organization, influence and control still prevails in relation to the *network mode,* with the core region and its hinterland dominating the rest of the space economy, called the periphery. Though, considering a reticular perspective, a "star" network topology - that is, a highly centralized monocentric spatial structure - starts to emerge in the urban system, with the consolidation of metropolises ("metropolization" process).

3rd Stage – Intraregional deconcentration

This stage is characterized by a "*relative decentralization of economic activities to satellite centres within the core region*" (Richardson, 1980), a process triggered by the formation of *agglomeration diseconomies*. This phenomenon refers to problems caused by excessive economic and population concentration, with the rising prices of all inputs, particularly space, increasing transportation costs (in terms of money and time) and the impracticability of development of certain economic activities in highly saturated areas (Sposito, 2007). As a result, new agglomeration economies are generated in selected locations of the "periphery". Nevertheless, core regions continue to grow at a faster rate than the rest of the country - a process denominated by some authors as "*concentrated deconcentration*".

At this point, migrations starts to become the most important mechanism of population redistribution, as fertility declines and the levels of mortality begins to stabilize, resulting in a slower pace of natural increase. The rural-urban migration flows show a fast relative or even absolute reduction, being surpassed by urban-urban movements. More complex migratory and circulatory patterns emerge within the urban network, from city to city or within a single metropolitan region (Zelinsky, p.243-244, 1971). The flows towards colonization frontiers decrease as the demographic pressure in rural areas reduces and less labour demanding forms of agriculture and cattle raising starts to dominate in these areas. As the spatial restrictions to information, capital, goods and population flows weaken, the network mode of spatial-territorial organization starts to increase in importance. Despite the impression of a less hierarchical system, this is not necessarily true, since processes of territorialisation continue to exist, but in a form that defies the simple core-periphery spatial configuration.

4th Stage – Interregional deconcentration

This stage is marked by what Richardson (1980) calls "*polarization reversal",* when intraregional decentralization is accompanied by *inter*regional dispersion. This process is led by the escalation of agglomeration diseconomies in metropolitan areas, which induces an increasing number of migrants to choose urban destinations outside the core regions and the formation of new agglomeration economies. Thus, with the expansion and densification of the urban system, intermediate cities start to grow in importance (as poles of attraction of migrants and economic activities) and the metropolitan areas begin to show growth rates below its surroundings and the national average.

In what regards the Demographic Transition, fertility and mortality reach low levels, resulting in a slow increase (or even stabilization) of the population and, consequently, of potential

migrants. This factor hinders the massive volumes of population flows characteristic of the previous phases of the Migration Transition. Besides the lower volume of potential migrants, the expansion of agribusiness and more capital-intensive forms of production in rural areas (less labour demanding, especially of unskilled labour) can led to the stagnation or even retraction of previous settlement frontiers. Rural-urban movements continue, but they are further reduced in absolute and relative terms. Vigorous urban-urban migration is observed *"within a highly elaborated lattice of major and minor metropolises*" (Zelinsky, p.245, 1971). Migration flows become more dispersed, as well as the patterns of economic activities and human settlements, a result of the strengthening of previous tendencies. In Rees et al (2016) framework, this stage would correspond to the beginning of a negative slope in the net internal migration–density relationship.

These trends reflect the prominence of the network mode of spatial-territorial organization, which can elucidate the apparent paradox of dispersion tendencies occurring at the same time that the population becomes increasingly urban, that is, more *concentrated* in cities. At this point, it must be clear that polarization reversal relates to a process of *relative* deconcentration, as stated by Richardson (1980): *"Very unevenly spatial dispersion (relative dispersion): the national concentration within the core region is replicated by regional concentration in major regional centres".*

5th Stage – Spatial dispersion

The last stage of the model, which refers to a modern, urban and industrialized society, is, again, a stage of relative spatial deconcentration. Nevertheless, "deconcentration" here assumes a complete different meaning from the first stage, because of the strong predominance of networks over the zonal mode of spatial-territorial organization (which, however, do not cease to exist). The model proposed by Richardson (1980) suggests a path through a functionally and economically integrated spatial system of interdependent regions, with the breakdown of the core-periphery relation of dominance[13], but this is highly questionable, especially regarding developing countries. Through networks, the centrality levels of the original urban cores tend to be maintained and the spatial obstacles to the increase of their power of influence and control of territories can be overcome. Thus, the

[13] Geyer (1996) also affirms that the core-peripheral differences in a country tend to decrease at the national level as the urban systems develop over time.

relations of dominance and processes of territorialisation just assume another form, manifested spatially in the protagonism of metropolises over the command of the *urban network.* It consists in a system of cities arranged in a functional hierarchy, each one with its corresponding hinterlands or zones of influence, where the same area can be under the influence of a variety of cities of different sizes and positions in the urban hierarchy.

Given the stable or even slow decline of the population, characterized by very low levels of fertility and low levels of mortality, the role of migration as the main mechanism of population redistribution is consolidated, although with declining levels. In the correspondent stage of Zelinsky's (1971) Mobility Transition, nearly all migrations are of the interurban or intraurban variety. However, it must be emphasized that the dichotomy rural-urban becomes increasingly blurred, because of the *extensive urbanization* phenomenon. Since industry and service activities typically associated with the "urban" world are more and more present in rural areas and settlement frontiers, the definition of rural areas simply through agriculture and/or cattle raising is increasingly more problematic. *"Counterurbanization contributes to the diffusion of urbanisation in the territory and society, because it implies the diffusion of values, habits, culture, economic activities, etc. in said areas* (Sexto 2009).

In the next section, the Brazilian case will be studied in the light of the conceptual model, with special attention to the period after the 1980s, when the effects of the "productive reestructuration" initiated in the 1970s started to impact more clearly migrations and human settlement patterns in the country. By analysing the processes of concentration and dispersion in Brazil within a more general framework, it is possible to elucidate the linkages between demographic, urban and economic dynamics and shed some light in the mechanisms through which these patterns change over time. Once again, it is worth reminding that this is not a deterministic predictive model but a reference, based on observed empirical regularities in several countries, mostly developed. In 1980, Richardson had already called attention for the "(…) *danger of extrapolating from the experience of developed countries. (…) The pace and form of PR is likely to differ from country to country depending upon the existing settlement, geography, development "style" and culture*" (Richardson, p.82, 1980).

3 – METHODOLOGICAL GUIDELINES AND DATA SOURCES

The goal of this chapter is to outline the methodological strategies used to meet the research objectives and link the theoretical model presented in the previous chapter with the literature review and empirical analysis of the following ones. This approach was set forth to evaluate the fitness of the conceptual framework to different aspects of the Brazilian case - following the model-based epistemological view of Burch (2003) - with the purpose to make sense of the patterns of population redistribution within the national settlement system. In order to do so, this chapter was divided in three sections: Section 3.1 describes the internal migration data available in the Brazilian Censuses used in this thesis; Section 3.2 describes the spatial framework, that is, the spatial scales and boundaries considered in order to proceed with the multiscale analysis; Section 3.3 provides a general overview of the methods employed (technical details of the methods used will be provided in the respective chapters).

3.1 Brazilian Data on Internal Migration

The most important database related to migration in Brazil is the population census, which includes all questions related to internal migration recommended by United Nation's "Manual VI" (UN, 1970), a referential document in what regards internal migration estimation methods. In general, migration is understood as a "change of habitual residence between two distinct geographical units at a set time period". However, the representation of this concept varies according to research goals and the type of measurement. The two indicators most frequently used are the so-called "fixed interval" and "last move" data, each one containing different possibilities and limitations.

The "fixed interval" measure contains, by itself, a time and a spatial reference and is used for the calculation of net migration (which requires a determined time period). For this reason, it is the most common type of data in migration studies and was, by far, the most used in this thesis. According to this measure, migrant is every individual who resided in a different spatial unit of analysis (country, state, municipality or other) from that which he/she lived five years before the census reference date. By its very nature, only migrants with 5 or more years old, survivors and people who not remigrated are captured.

"Last move" data is a combination of questions related to "time of residence" and "place of last residence", thus integrating a temporal and spatial dimension. According to this measure, migrant is every individual who resided in a different spatial unit (country, state, municipality or other) in the 10 years preceding the census reference date, regardless of the place of residence at the previous census, which could even be the current place of residence (Carvalho and Rigotti, 1998).

The population flows captured by the abovementioned measures were organized in origin-destination matrices, with the former places of residence in the rows and destination locations (current places of residence) in the columns. Despite the Brazilian demographic censuses wealth of information, it is important to highlight that migration questions are present only at the “sample questionnaire”, that is, they were not applied to all households (with the exception of a question related to international out-migration, present in the “basic questionnaire”). In the last three censuses, this questionnaire was applied approximately to 10% of the population, with varying sample sizes, according to municipalities populations. The sample expansion to the total population is performed by applying weight factors to the microdata, procedure performed by the Brazilian Institute of Geography and Statistics itself (IBGE, 2013). This requires some caution in analysis, especially in very spatially disaggregated areas. For example, the out-migrants of municipalities with very low populations cannot be appropriately captured in the census sample and tends to be underestimated.

3.2 Spatial Framework

Migration analysis implies the use of spatial data and, as such, it is subject to the Modifiable Areal Unit Problem (MAUP), a well-known issue for geographers and researchers who work with spatial data in general. It represents a challenge for migration analysts, since spatial statistical data is conditioned by the way and by the number of units that a given space is divided - respectively, the zonation and scale effects of MAUP (Openshaw, 1984). This problem arises always that artificial limits are imposed and used to describe continuous geographic phenomena (like population movements in space), generating artificial spatial patterns that may raise doubts about the validity and reliability of the analysis (Heywood, 1998). The study of MAUP calls attention to the fundamental uncertainties intrinsic to any spatial analysis. It can raise awareness for the importance of choosing an adequate scale of

analysis and the limitations of this choice and of the data available – it is not always possible to disaggregate space in an ideal way.

Given the lack of practical solutions to deal with the random effects of MAUP, one straightforward strategy is to undertake analysis at multiple zones or scales (Oliver, 2001) – the approach adopted in this thesis. If a pattern of migration emerges at a certain scale of analysis, it is not correct to infer that the same will occur in others, since different scales may present distinct and sometimes contradictory trends. For example, the countermetropolisation[14] (Martine, 1994; Matos, 2000; Silva e Rodrigues, 2010, Ribeiro et al., 2009) refers to a process of population deconcentration *within* metropolitan areas, reflected on a general tendency of the core cities to lose population to its surrounding municipalities (faster population growth on the peripheries rather than in the core municipality of metropolitan areas). On the other hand, if microregions or mesoregions *containing* metropolises subject to this process show an above average demographic growth, how can we talk about deconcentration at national scale? In sum, the scale of analysis is one of the main potential sources of misunderstandings in what regards population (re)distribution - even within the same region, we can have opposite trends of concentration and deconcentration. For this reason, the Basic Spatial Unit (BSU) of analysis will be selected in accordance to its suitability to address processes of intraurban, interurban or macrospatial (de)concentrarion (Diniz, 1993).

In 2010, the Brazilian territory was divided in 5564 municipalities, 558 microregions, 137 mesoregions, 27 states (including the Federal District) and 5 macroregions. Although municipalities are the most disaggregated level of census migration data, besides the technical limitations mentioned in the previous section, there are empirical and theoretical reasons for using others BSUs instead. The growing interdependence between municipalities, reflected on the creation of several metropolitan regions and on the expansion and conurbation of urban zones in the past decades frequently makes the boundaries at this scale virtually meaningless beyond the political-administrative sphere. On the other hand, microregions and mesoregions boundaries are based on functional properties of spaces and were conceived in a way that assures some degree of internal coherence in socio-economic and geo-historical terms. In the hierarchy of territorial divisions defined by IBGE in 1990, they are located right above municipalities and right below mesoregions. The latter is defined as

[14] Called by “peripherisation” by Martine and McGranahan (2010)

> *"(…) sets of contiguous municipalities, belonging to the same Federation Unit [State], that have a regional identity originated from forms of organization of the geographical space defined by socioeconomic, natural and historical dimensions, and from the network of communication and places that configures a spatial articulation" (IBGE, p. 298, 2013).*

The microregions delimitation, besides taking into account the dimensions considered for the creation of the mesoregions, considers "(...) *relations at the local level, through the possibility of meeting the demands of its populations by the basic social sectors and the wholesale and retail trade markets*" (IBGE, p. 299, 2013). Because microregions are the most disaggregated level of analysis *which maintained the same boundaries since the 1991 Census*, it will be the most explored spatial unit in this thesis and will be used whenever more disaggregated levels of analysis are necessary. Besides official political-administrative boundaries, several scales of random aggregations of microregions (Aggregated Spatial Regions or ASRs) generated by the IMAGE Studio Software will be used to address the Modifiable Areal Unit Problem, as more fully described below.

3.3 Research strategies

In the following chapter, in order to contextualize and provide a background on the processes of population (re)distribution in Brazil until the 1980s, a brief historic will be presented, based on a literature review. From this decade onwards, besides the revision of referential studies, a more formal approach will be adopted. Following the work of Bell et al. (2002), shifts on migrations intensity, impact, distance and connectivity will be systematically explored in order to investigate how its changing patterns contributed to the processes of population redistribution in Brazil (multidimensional approach). As previously stated, spatial data is conditioned by the scale of analysis, so, besides official political-administrative boundaries, the aggregation and modelling functions of IMAGE Studio Software will also be used (multiscale approach) to establish a global picture and confront the MAUP challenge (Stillwell et al., 2014). The consideration of multiple levels of aggregation can help understand in what extent migrations flows in different scales contributed for the dynamics of spatial concentration and deconcentration of the population over the last decades.

Developed by the Queensland Centre for Population Research (QCPR) as part of the IMAGE Project ("Internal Migration Around the GlobE")[15], the IMAGE Studio software is a powerful methodological tool conceived to address key methodological issues related to international comparisons of internal migrations (Stillwell et al., 2014; Daras, 2014). Despite that, it is perfectly fitted to do migration analysis on subnational levels, for example, to compare patterns between regions or to do time-series comparisons considering the same country. One of its basic features is the computation of migration metrics regarding the four dimensions of migration (as proposed by Bell et al, 2002), including global statistical indicators of migration systems and local indicators, calculated for each Basic Spatial Unit (BSU). The use of different measures in the same dimensions is justified by the fact that each one has different uses, advantages and limitations. Besides that, IMAGE Studio contains spatial analysis and modelling tools able to produce substantive results to confront the Modifiable Areal Unit Problem[16], developed for this exact purpose. The software allows the exploration of flexible spatial boundaries and address the zonation and scale effects of MAUP in migration measures, which can be useful to understand how conditioned migration analysis in Brazil are by the chosen spatial units.

The aggregation algorithms of IMAGE Studio allow the grouping of BSUs in a stepwise manner, creating series of random spatial configurations called Aggregate Spatial Regions (ASRs). Through an iterative process, ASRs of varying sizes and shapes are created and, for each one, a set of metrics is computed to explore how migration indicators change accordingly to the scale and the way space is divided. Finally, an average value of these indicators is calculated for each level. The differences in the mean value of the indicators show the scale effect of the MAUP, while the variation around the mean in each scale reveals the zonation effect (Rees et al., 2016). In the case of this study, microregions were chosen as BSUs, for the reasons exposed in the previous sections[17]. A total of 15 scales were generated using the IRA-Wave algorithm (an improvement of the original IRA Algorithm),

[15] The Queensland Centre for Population Research (QCPR) is part of the School of Geography, Planning and Environmental Management (GPEM) of the University of Queensland (Australia). The Image Project, funded by Australian Research Council, involved several researchers of different institutions and was created to investigate the way in which internal migration varies between countries around the world.

[16] The same strategy was adopted on Stillwell et al. (2016) and Rees (2016).

[17] The use of microregions as the BSUs for the Aggregated Spatial Regions (ASRs) on the IMAGE Studio is also justified by operational reasons. Since it is an iterative process, the use of 5564 municipalities would demand an prohibitive amount of time and computer processing.

starting with 20 BSUs and finishing with 552, on incrementing steps of 38 BSUs (scale step). On each scale, 100 iterations were made, totalizing 1500 iterations.

In Chapter 5, a methodology was designed to address processes of interurban (de)concentration - more specifically, the impact of the changing patterns of migration in the structure of the Brazilian urban system since the 1980s. At first, a hierarchy of urban centres was established based on the functional classification of the research “Areas of Influence of Cities 2007” or simply “REGIC 2007” (IBGE, 2008), of the Brazilian National Institute of Geography and Statistics (IBGE). After that, the municipalities were aggregated in five categories (corresponding to their respective hierarchical levels) and origin-destination matrixes were built using “fixed interval” data of the censuses of 1991, 2000 and 2010. At last, the population exchanges between hierarchical levels were represented in figures showing the flows and net migration flows between them. Two additional figures were created to investigate the processes of population redistribution within the “core region” of the national settlement system (the “São Paulo-Rio de Janeiro axis”), an essential feature of the conceptual model.

In Chapter 6, the connectivity dimension of migrations, briefly addressed in Chapter 4, is deepen analyzed through the use of standard metrics and techniques of Network Analysis. The chapter starts with a brief introduction to Spatial Network Analysis and its differences with Social Network Analysis, the most common terminology in the Social Sciences. In the following, several indicators showing the changes in the topology of the Brazilian migration networks - that is, in the spatial structure of migration - are presented and analysed at the microregional level. These indicators were computed using both “fixed interval” and “last move” data, since the latter has the advantages of a longer temporal coverage (it can cover the whole decade prior to the censuses) and providing a greater sample.

At last, to conclude the empirical part of the thesis, several maps showing the spatial vectors of population (re)distribution in Brazil are displayed and analysed. To do so, “fixed interval” data of the last three censuses were used. Besides standard migration flows maps, an “interaction component” - regarding the strength of connectivity between the places of migration origin and destination – is also represented in a series of maps. The interaction component is the result of a normalization of origin-destination matrixes values, with the purpose to eliminate the effect of population volumes in a way that better reflects the spatial structure of migration (see details of this methodology in the respective chapter). It can be

useful for describing and analysing migration patterns over time, reveal migration sub-systems and explore the strength of spatial connections beyond the simple consideration of flows magnitudes. The representation of migration flows in national scale is challenging, because of the risk of overloading the maps with visual information. To deal with this problem, thresholds were established in a way that only the most representative flows and interaction components were represented. The interaction component and migration flows maps were produced for the level of states, mesoregions and microregions with different thresholds, but only the most representative maps are displayed and analysed (the trials are available in the attachment).

4 – THE CHANGING PATTERNS OF POPULATION (RE)DISTRIBUTION ON BRAZIL

4.1 The spatial redistribution of the Brazilian population until the 1980s[18]

Since the beginning of its occupation by the Portuguese in the sixteenth century, the demographic and economic history of Brazil was marked by temporal and spatial discontinuities (Martine and Diniz, p.207, 1997), characteristic of the first stage of the conceptual framework. Economic activities and population were dispersed throughout the territory, conditioned by the insertion of Brazilian raw materials and foodstuffs in the international market[19]. The outward-oriented economy hindered the development of the internal market and, consequently, regional articulation, as stated by Martine and Diniz (p.208, 1997):

> *"During most of its history, Brazil did not form a unified economic space or even a minimally integrated unit. On the contrary, the various export-oriented experiences produced a* highly decentralized demographic and economic mosaic*. Consequently, it would be inappropriate to speak of an interregional division of labour, or of an urban network, until well into the mid-nineteenth century" (our emphasis).*

The lack of significant relations of exchange, complementarity, dominance or subordination between Brazilian regions until the abovementioned period is a clear sign of the predominance of the zonal mode of spatial-territorial organization. Trade networks and other types of spatial connections were limited to intraregional spaces, formed mostly to attend the demands of new towns, developed as a consequence of specific export cycles. The onset of a more consistent process of urbanization and territorial articulation begun only in the end of

[18] This section is largely based on Martine and Diniz (1997), especially the analysis of the first decades of the XX century and before.

[19] The main Brazilian economic cycles include "brazilwood in the sixteenth century; sugar in the north-east during the sixteenth and seventeenth centuries; gold in Minas Gerais (with extensions into Goias and Mato Grosso) in the eighteenth century; rubber in the Amazon region in the late nineteenth and early twentieth centuries; and, coffee in the south-east region in the nineteenth and twentieth centuries" (Martine and Diniz, p.207-208, 1997).

the nineteenth century, on the basis of coffee production, when the state and city of São Paulo started to attract both internal and international migrants and grow in a very fast pace (Martine and Diniz, 1997). In the first decades of the twentieth century, it overcame the hitherto national capital of Rio de Janeiro as the most populated and developed city in the country[20]. Due to a cumulative causation process, the formation of an agglomeration economy in the city and state of São Paulo persisted well into the twentieth century,

> *"(…) as agriculture branched out to include foodstuffs for local and urban populations, as well as raw materials for a growing industry. This dynamic and market-oriented agriculture generated surpluses which were utilized to finance productive diversification in general (banks, railways, commerce), and industry in particular"* (Martine and Diniz, 1997).

The consolidation of capitalist relations of production in Brazil was pushed even further by the "import-substituting industrialization" caused by the World Wars and the 1930 economic crisis, which switched the focus of production from the external to the internal market and increased the demand for labour in cities (since industrial activities are typically "urban"). Besides the processes of demographic and economic concentration in the Rio de Janeiro-São Paulo axis, the shift in migration patterns in Brazil also indicates the transition to the second stage of the conceptual framework:

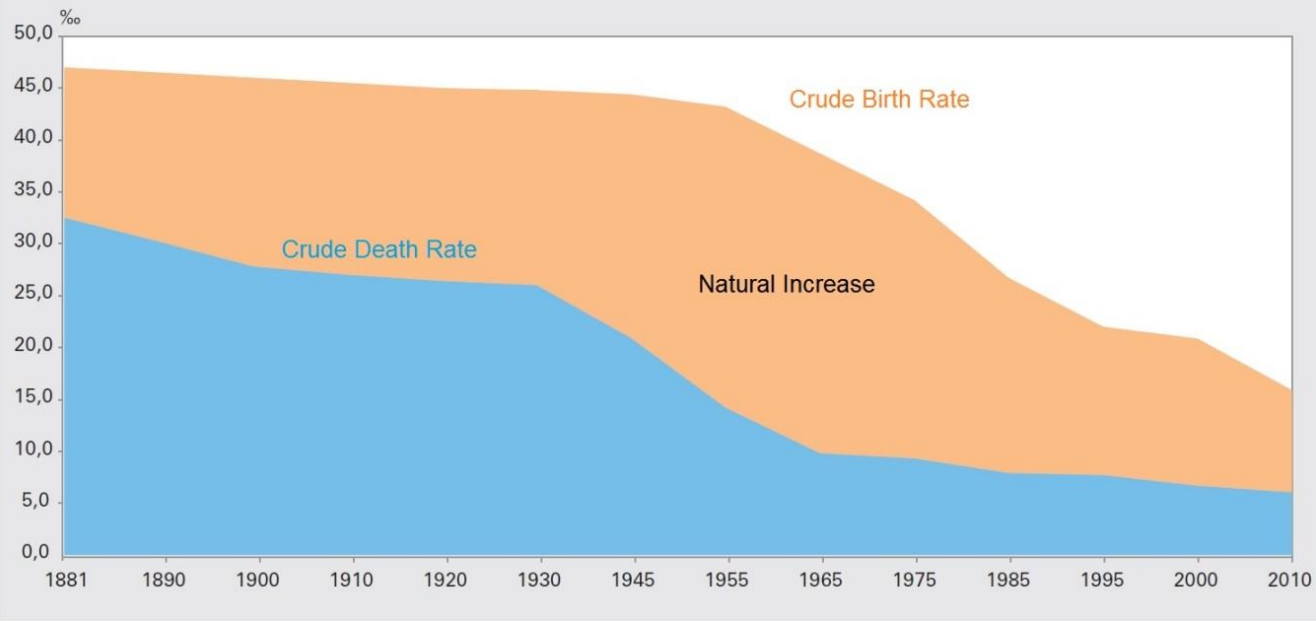
> *"Interregional and interurban migrations appear to have been at a minimum during the colonial and most of the imperial periods. However, the last decades of the nineteenth century were marked by considerable population mobility; in addition to substantial international migration, largely to the state of Sao Paulo, considerable interregional and intraregional movement occurred also directed to this state. Much of this ended up in urban areas"* (Martine and Diniz, p. 208, 1997).

A "rural exodus" cycle combined with a process of industrialization is a typical stage of the "mobility transition" proposed by Zelinsky (1971) and it was identified as a global trend since the very beginning of migration studies (Ravenstein, 1885). In Brazil, it was only made possible by the onset of the Demographic Transition (Figure 3) - after the onset of a consistent reduction in mortality levels in the 1940s, by the end of the 1960s, fertility levels

[20] It is worth reminding that this initial phase of concentration in only one or two regions is a characteristic pattern of spatial development, due to the scarcity of investment resources (Richardson, 1980).

also start to decline in a fast pace (Simões, 2016). This process was marked by significant differences between macroregions and urban and rural areas in what regards timing and levels of vital rates. As already stated, the spatial distribution of the Brazilian population is the result of regional differences in vital rates but mostly a consequence of migrations, especially after the 1970s, when a strong convergence in macroregions birth and death rates took place in the country[21].

Figure 3 – Evolution of the crude birth and death rates in Brazil, 1881-2010



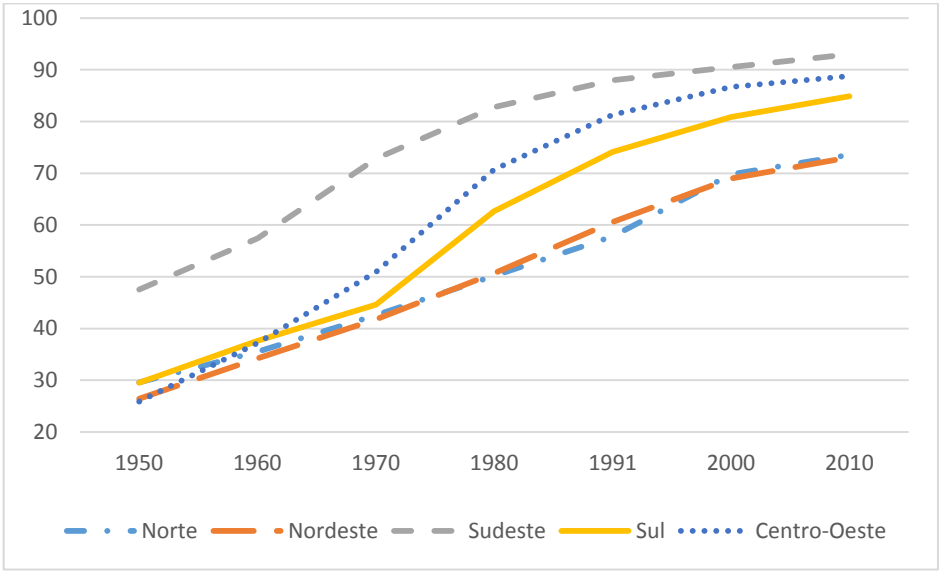
Source: Adapted from Simões (2016, p.47)

The “population explosion”, induced by the rapid mortality decline in the 1940s, set the conditions that allowed a massive migration movement towards urban areas and the expanding frontiers of Paraná and the Centre-West region. The fastest ever rate of population growth in Brazil was recorded in the 1950s - decade of the biggest difference between death and birth rates - when the country experienced an intense process of urbanization and metropolization, with particular reference to the substantial rural-urban population movements from the Northeast to the Southeast (especially towards the state of

[21] In 1970, the difference between the fertility rates of the Southeast and Northeast was almost 3 children per woman and the difference between the Southeast and North region, 3.6 children per woman. In 2010, these same differences were reduced to 0.3 and 0.7 children per woman, respectively.

São Paulo). Figure 4 shows how the urban population[22] exponentially grew from 1950 to 2010, going from 36.2% to 84.4%.

Figure 4 - Proportion (%) of the Brazilian urban population, 1950-2010



Source: SIDRA-IBGE. Demographic Censuses of 1950 to 2010.

It is important to mention that this trend of demographic and economic concentration was mitigated by efforts to interiorize the occupation of the Brazilian territory, like the relocation of the capital city to Brazilia (concluded in 1960), massive road-building programs (e.g., the Trans-Amazon Road, inaugurated in 1972), large-scale colonization projects and regionalized fiscal incentive policies, especially regarding the expansion of the livestock and mining sectors in the Centre-West and Amazon and the creation of a free commerce zone in Manaus (Martine and Diniz, 1997). However, despite the substantial investments in regional development policies until the 1970s, "*there seem to be definite limits beyond which the friction of space and accumulated historical disadvantages can be overcome by heavy government subsidies*" (Martine and Diniz, p.226 1997). In general, the relocations occurred far beyond the core region of the Metropolitan Area of São Paulo in response to public investments proved to be ineffective as a mechanism of population redistribution, showing limited multiplier effects.

[22] The official definition of "urban population" in Brazil used by the National Institute of Geography and Statistics is political administrative and refer to the population living in the municipality core and districts.

The accelerated population concentration in metropolises continued in the 1960s, resulting in the spreading and growth of slums, criminality rates and the conformation of deficient transport, educational and health systems, which illustrates a facet of the ambiguous relation between migration and development. It clearly shows that the progression of stages represented by the conceptual framework does not necessarily imply social welfare improvement, as implicitly suggested by the modernization theories of development. Although the movements of population supplied the demands for labour in the fast-growing Southeast economy, it was also responsible for the conformation of "*agglomeration diseconomies*" (notably in the metropolitan region of São Paulo), one of the triggering factors of the shift to the third stage of the conceptual framework ("intraregional deconcentration").

Several authors pointed out the process of productive restructuration initiated in the 1970s, especially concerning industrial activities[23], when a long cycle of urban, economic and demographic concentration reached a turning point. However, some scholars (Azzoni, 1986, Haddad, 1989 and Martine and Diniz, 1997) discussed if the productive restructuration of the 1970s was a generalized process of economic decentralization or just a limited spatial adaptation process in the most industrialized area of the country – in short, a "*concentrated deconcentration*" of industrial activities. The strengthening of the "network mode" of spatial organization justify this hypothesis, since the weakening of spatial restrictions made possible by technology allows the spatial separation of industrial production and management. In sum, what was been questioned by these authors is if, from a zonal perspective, the alleged process of deconcentration was just an extension of the hinterlands (areas of influence) of the big urban centres or, from a network perspective, if these processes were just an expansion of the big cities influence throughout the urban network.

At this point, is important to make a distinction between *deconcentration* and *decentralization* processes that, although related, are not the same. The former, more related to the scope of this thesis, refers more directly to the formation of new economic and demographic settlement patterns as an output of the congestion of central spaces. The latter can refer to the strengthening of secondary poles through administrative, political and economic actions and *do not necessarily imply spatial relocations* (Matos e Baeninger, 2004). That means that

[23] Agricultural production had already begun deconcentrating away from the state of Sao Paulo in the 1940s, helping "foster urban growth in previously unsettled regions" (Martine e Diniz, 1997). For a more detailed description about the economic restructuration occurred in Brazil after the 1970s, see Azzoni,1986; Diniz, 1993; Pacheco, 1996; Negri, 1996; Martine e Diniz, 1997 e Cano, 2011.

a process of population and urban deconcentration could happen without, necessarily, a correspondent process of economic decentralization of the same magnitude. This idea is supported by Martine e Diniz (1997), which argue that deconcentration from São Paulo has not led to decentralization of financial or administrative control and that *"centralized deconcentration*" would be a more accurate descriptive term to describe the output of the productive restructuration initiated in the 1970s. The impression of a less hierarchical system caused by deconcentration processes can mislead interpretation, since the new forms of "territorialisation" – more related to networks - defies the simple core-periphery spatial configuration. The research "Areas of Influence of Cities 2007" of the Brazilian Institute of Geography and Statistics (2008) seems to confirm this argument, since it points out to a highly centralized decision-making system in Brazil, showing the protagonism of São Paulo (followed by Rio de Janeiro and Brasilia) in the organization and management of the Brazilian territory and economy[24].

With the relative stabilization of mortality levels and the start of a widespread fertility decline in the 1970's internal migrations became the key driver of changes in population (re)distribution in Brazil. However, in the long-term, mortality and fertility can have a relevant indirect effect besides differential natural growth: the change in the age structure of the population and, thus, on its spatial distribution, because of the well-known age selectivity of migrations (the propensity to migrate in younger ages). It is important to mention that the Demographic Transition did not occur simultaneously or in a homogeneous manner throughout the Brazilian macroregions, which affects the potential stock of migrants on them. The North and Northeast shows a younger age structure and are "delayed" in the transition process, while compared to the Centre-West, South and Southeast regions, which have lower levels of fertility and mortality.

Coherently with Zelinsky's (1971) Mobility Transition model, migrations became predominantly between urban areas in the 1970s (Matos e Baeninger, 2004; Braga e Fazito, 2010). By this time, the majority of the population was already living in cities and the rural population stocks had been drastically reduced by the high volume of migrations in previous decades. Nevertheless, there is a well-known tendency of inertia in migratory movements and a significant rural-urban migration continued in this period. In this sense, stands out the

[24] Although this is an important discussion, the focus of this work is on the processes of *spatial* concentration and dispersion of the population, not (de)centralization of territorial and economic management.

population flows from the countryside to the cities in the Southeast and South regions and the already mentioned flows from the Northeast towards the urban areas of the Southeast, even though in lower volumes (Martine e Camargo, 1984; Camarano e Abramovay 1998; Martine e Diniz, 1997).

Considering that the spatial distribution of populations and the allocation of economic activities are highly correlated, the new locational requirements engendered by the productive restructuration heavily influenced the redistribution of the Brazilian population. As expected in the stage of "intraregional deconcentration", the state of São Paulo was the first to be affected by the spatial redistribution of industrial activities, with a relative decrease of the Metropolitan Area of São Paulo participation in the Brazilian industrial production and relative demographic deconcentration in the state of São Paulo (Diniz, 1993). However, there was a time lag between economic and migratory dynamics in the national scale, since the broader impacts of the economic deconcentration on population movements became evident only in the next decade, with the results of the 1991 Census (Martine, 1994; Martine and Diniz, 1997; Matos and Baeninger, 2004; Baeninger, 2011).

4.2 The spatial redistribution of the Brazilian population after the 1980s

The 1980s, decade of the worst economic performance in modern Brazilian history, was a period of inflexion of tendencies in what regards population (re)distribution. Up to this point, the postulates of the conceptual model perfectly applies to the Brazilian case, but the shift towards what would be the two last stages of the conceptual model is a controversial issue between scholars and must explored in depth. Did a process of *inter*regional deconcentration ("polarization reversal") occur in Brazil? Can the *patterns*, *processes* and *types of migratory movements* related to the "counterurbanization" concept be identified from this period onwards? How do they manifest? In which scales?

After the 1980s, the states of Minas Gerais, Rio Grande do Sul, Paraná and the Centre-West region, which became "channels" of the industrial deconcentration, presented an increased urbanization (Matos and Baeninger, 2004). Besides that, the emergence of new agglomeration economies outside the Rio de Janeiro-São Paulo axis lead to a redirection of part of migration flows and induced the retention of a potentially migrant population in those areas (Rigotti, 2006). Nevertheless, in the influential paper "*Polygonal development in Brazil: neither decentralization nor continued polarization*", Diniz (1993) argued that the process of

deconcentration occurred mostly within a “polygon of development”, restrict to selective spaces in the centre-south of the country. In other words, according to this author’s view, the fourth stage of the conceptual model – of “interregional deconcentration” - occurred only in a limited portion of the national territory (the most developed one).

In general, “colonization frontiers” showed a declining rate of expansion from the 1980s onwards (Martine e Diniz, 1997). Traditionally, the term “frontiers” is employed in a metaphorical sense in the Brazilian literature to refer to pioneer and expansion fronts of occupation of the countryside. Considering the occupation of new areas in previous decades, the lower availability of affordable land, the State’s lower capacity for technological support and investments on infra-structure (aggravated by the economic crisis), the weakening of the processes of frontiers expansion was to be expected. Moreover, the agricultural modernization and expansion of more capitalist fronts of exploration, less labour demanding (especially of unskilled labour), started to substitute traditional agricultural practices and reduce migratory flows towards these areas. Although frontiers expansion are more frequently associated with traditional forms of agricultural occupation (subsistence agriculture), in the face of recent developments, a broader concept of “frontier” was adopted in this thesis[25] in order to include more capitalist forms of exploration of relatively unoccupied and economically under-exploited regions, with potential for productive occupation.

In the 1980s, a process of massive expulsion of the rural population took place in the Centre-West region, similarly to what happened to the South region in the previous decade (but, less expressive nationally, in absolute terms), with nearly 70% of its rural population migrating to cities. Even the North region showed a loss of rural population in the 1990s after a period of twenty years of migration attraction to its cities and rural areas (Camarano and Beltrão, 2000). Thus, a moment of expansion and subsequent stagnation of agricultural frontiers took place in the South, Centre-West and North regions, in that order, reflected in the decrease of rural populations and strong urban concentration[26]. As observed by Camarano and Beltrão

[25] Agricultural frontiers can be defined as regions endowed with natural resources that are not properly integrated to the national economic system because of locational factors, natural conditions, infrastructure, etc. (Redwood III, 1979 *apud* Sicsú and Lima, 2000, own translation). It must be highlighted that the occupation of frontiers does not occurs in a homogeneous way – it consists in a dynamic and multifaceted process, formed by different types of “fronts”: subsistence agricultural fronts, commercial agricultural fronts, speculative fronts, extensive and rudimentary forms of cattle raising (Muller, 1992 *apud* Sicsú and Lima, 2000) and forest and mining exploration (Sicsú and Lima, 2000).

[26] For further details about the expansion of the Brazilian frontiers in the XX century, see Sicsú and Lima (2000).

(2000), although apparently contradictory movements, the expansion of agricultural frontiers is associated with urbanization, both in moments of expansion and retraction. Agro-industrial development generates a demand for urban supporting services and, even in the case of agricultural frontiers retraction, cities will serve as poles of migration attraction, absorbing the dislocated rural populations. These stagnant or retreating settlement frontiers are postulated by Zelinsky's "Mobility Transition" and are associated with the fourth stage of the conceptual model.

The processes of industrial deconcentration also lost intensity and dynamism from the 1980s onwards, with the end of a cycle of investments and weakening of macroeconomic and regional development policies made by the federal government (Cano, 2011). However, urbanization and migrations do not follow linearly the installation of economic activities and important changes in population distribution happened after this period, with reflexes on the highly unbalanced pattern developed by the Brazilian urban network. Several studies pointed out a process of decompression of the urban system, a "*deconcentrated urbanization*", particularly referring to the growing importance of intermediate cities. For Matos and Baeninger (2004), the spatial spreading of industrial activities in the previous decades helped to consolidate the Brazilian urban network, increasing the bonds of interdependence and complementarity between different parts of the system. According to these authors, the relative deconcentration of the Brazilian urban system enabled the insertion of small and intermediate cities in the dynamics of the urban agglomerations, especially the metropolises.

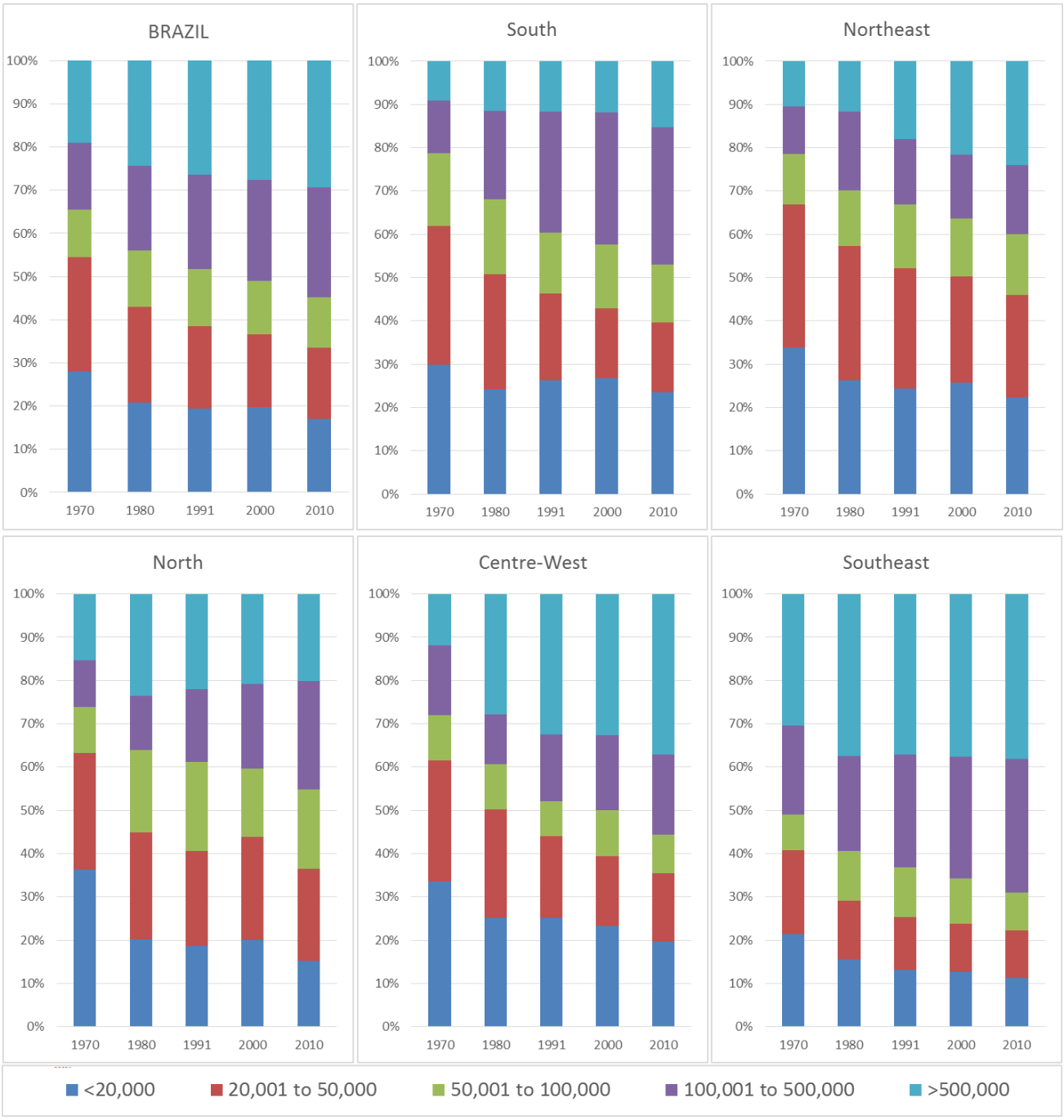
Figure 5 gives a general picture of the evolution of the Brazilian urban network, showing the proportion of populations according to the size of municipalities. Despite the huge differences between macroregions, some general trends can be identified. Regardless the strong reduction of the growth rates of metropolises (exhaustively mentioned in the literature), it is possible to see a general tendency of population concentration on cities of bigger sizes[27]. This trend was particularly strong in the Centre-West and North, reflecting the abovementioned agricultural modernization and localized industrial investments on these regions (Matos, 2000), even though a metropolization process similar to what happened in the Southeast is highly unlikely. The growing importance of medium sized cities (from 100,000 to 500,000 people) also calls attention, particularly in the South region, which shows

[27] It is worth mentioning that the population natural growth contributed to this trend and that the *proportion* of municipalities on each category did not change significantly (the biggest variation since the 1980s was the decrease of 3.11% in the municipalities with populations between 20,000 and 50,000).

the most balanced and dense urban network. In the Northeast, this class of cities did not show a significant variation, but the urban centres with more than 500 thousand people grew consistently in the last decades. The fact that a more balanced urban network is emerging in the two most developed regions in the country (Southeast and South) at the same time that a process of urban concentration is in progress in the Northeast and Centre-West (the North region is a special case) shows how different regions within the same national settlement system can be lagged in relation to each other, in what regards certain aspects of the conceptual model[28].

[28] While sub-national spaces can be at different stages of the Demographic, Migration and/or Urban transition, they cannot be at different stages of the conceptual model, since it regards the *national settlement system.*

Figure 5 - Proportion of the Brazilian and macroregions populations according to the size of municipalities, 1970-2010



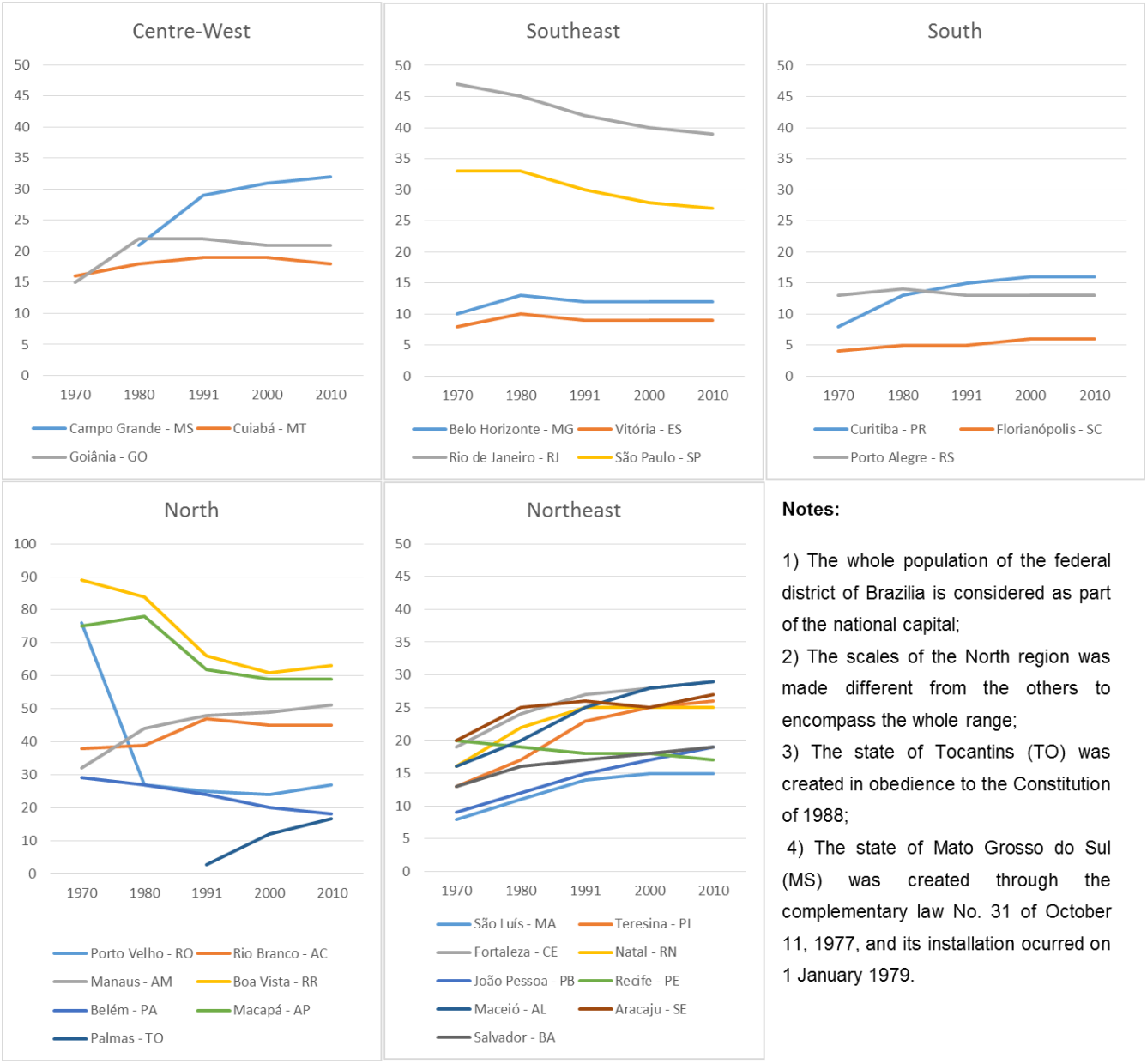
Source: SIDRA-IBGE. 1980, 1991, 2000 and 2010 Demographic Censuses.

The participation of state capitals in relation to states populations provides further evidence of changes in the processes of population redistribution in Brazil. Figure 6 shows a strong heterogeneity between macroregions. In the Southeast, the proportion of the population in the state capitals of São Paulo and Rio de Janeiro - the biggest municipalities in the country - decreased since the 1970s, suggesting a process of *deconcentration* within these states. More specifically, it reflects the process of *intraregional deconcentration* within the core

region, mentioned in the last section. The other South-eastern capitals, as well as the capitals of the South region, remained stable or did not show significant variations.

In the Northeast, which possess the lowest urbanization rate in the country and is traditionally an area of migration loss, the general tendency of the last decades was the increase of state capitals participation in the total population (with the exception of Recife, which showed a little decrease). It suggests a process of population *concentration* in the state and macroregional level (probably intensified by the increase of return migrations towards this macroregion, an important aspect of the new Brazilian migration patterns). It is worth reminding that these differences between what would be the core and periphery of the national economic and settlement system are foreseen in the conceptual model. At least initially, the stage of "polarization reversal" is associated with population deconcentration only in the core region itself but, "(…) *in other regions, polarization reversal almost always involves more spatial concentration with intraregional polarization toward regional cities*" (Richardson, p.80-81, 1980). No explicit tendencies are found in the other macroregions, except for a trend towards stabilization in the last three decades, which can be partially explained by the reduction of rural populations during this time and the sharp decline of rural-urban migrations ("rural exodus") during the 1980s. Besides that, although fertility decline does not produce a short-term impact on out-migration (given its age selectivity), by this time, around twenty years have passed since it first became evident in the country, affecting the number of potential migrants in traditional areas of migration loss.

Figure 6 - Proportion of State capitals population in relation to States populations, 1970-2010



Notes:

1) The whole population of the federal district of Brazilia is considered as part of the national capital;

2) The scales of the North region was made different from the others to encompass the whole range;

3) The state of Tocantins (TO) was created in obedience to the Constitution of 1988;

4) The state of Mato Grosso do Sul (MS) was created through the complementary law No. 31 of October 11, 1977, and its installation ocurred on 1 January 1979.

Source: SIDRA-IBGE. 1980, 1991, 2000 and 2010 Demographic Censuses.

These modifications in the urban system are directly related to changes in the *Brazilian migration patterns,* result of the articulation between migratory trajectories and the historical context on which they are structured to meet the demands of demographic, economic, social and political dynamics (Brito, 2002). Matos (2000) argues that they have been reflecting a process of population deconcentration, given the more scattered patterns of flows between urban areas, supported by an expanding and denser urban network. Nevertheless, it would correspond to a specific type of deconcentration, referred by Diniz (1993) as "*interurban*" deconcentration.

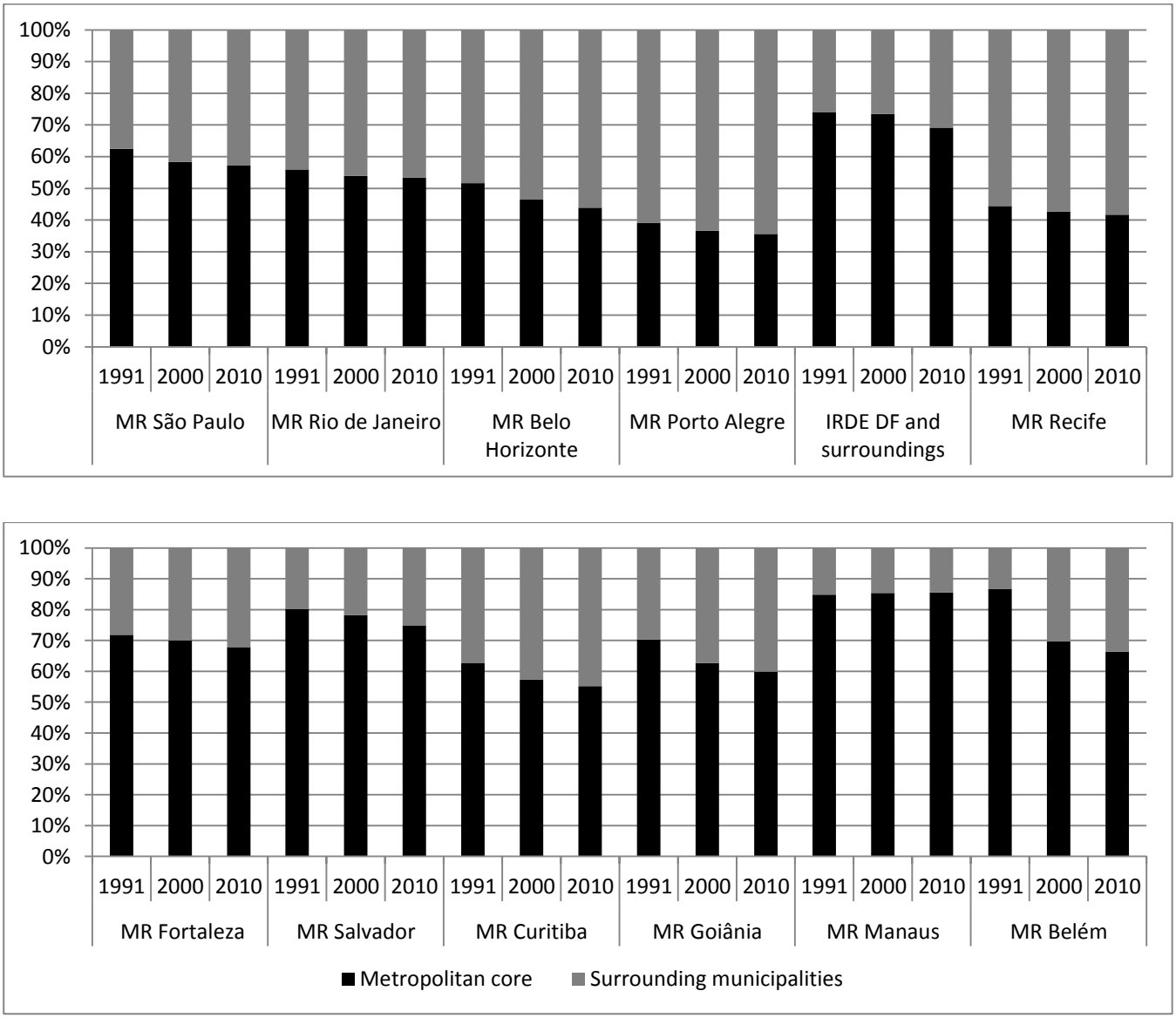
A second possibility of deconcentration referred by Diniz (1993) is the "*macrospatial*" deconcentration. In Brazil, significant changes in the relative distribution of population across macroregions are highly unlikely. There is a long-term stability in the past decades and, from the 1980s onwards, a decline in migrations between them was observed. Even *within* macroregions, Census data indicates a tendency of structural stability in the relative participation of states in relation to macroregions populations, especially from 1980 to 2010. Although the general distribution did not change considerably, it is worth mentioning the relative and absolute increase of the populations of the Centre-West - which participation in the national population went from 5.8 to 7.4% - and North region - which participation increased from 5.6 to 8.3% in this period. This growth occurred mainly due to the increase of urban populations and in spite of the changing forms of occupation and declining rate of expansion of agricultural frontiers in these regions. Despite the tendency of convergence in the past few decades, the higher levels of fertility in the North and Centre-West were also responsible for the differential growth of these regions. Martine (1994) hypothesized that the economic crisis was primarily responsible for the restrictions of population movements in the 1980s, arguing that employment was stagnant or declining throughout the national territory and, in a crisis situation, migrants tends to move towards closer and well-known areas. Nonetheless, the relative volume of migrants between macroregions continued to decrease in subsequent decades. Brito (2009) points out that, as a result of previous migrations and the natural growth of its populations, the biggest urban agglomerations already had a sufficient labor force surplus within its own boundaries, not requiring an external supply.

The third and last type of deconcentration raised by Diniz (1993) regards population redistribution *within* metropolitan areas, that is, an "*intra*urban" deconcentration[29]. In the 1980s, metropolises all over the country started to lose population for the surrounding municipalities and lose its power of migration attraction (Rigotti, 2011; Martine, 1994). Figure 7 shows the changing population distribution within the main Metropolitan Regions (MRs) of the country, according to the research "Areas of Influence of Cities 2007" (IBGE, 2008). The configuration of these MRs was standardized according to the municipalities belonging to them in the year of 2010 (so the graphic serves just as a reference of the overall changes in the aggregates). With the exception of the municipality of Manaus, which participation on its

[29] The term "counterurbanization" is also used to refer to this trend by some authors, but this meaning will not be adopted here. As mentioned in the previous section, this concept will be considered in Mitchells (2004) perspective – as a *pattern*, a *process* and a type of *migration movement.*

correspondent MR remained stable, the decrease in the relative participation of the metropolitan cores populations suggests a generalized process of "concentrated deconcentration" in the intrametropolitan scale in different regions of the country, not only in the core region.

Figure 7 - Relative participation of the metropolitan core populations and the population of surrounding municipalities, 1991-2010



Source: 1991, 2000 and 2010 Demographic Censuses. Prepared by the author.

In addition to changes in the intrametropolitan spaces, between 1970 and 1980, the pace of growth of metropolises was already lower than the average growth of the urban population, a tendency that continued in the following decades (Matos e Baeninger, 2004). Because of the general decrease in fertility, a reduction in the growth rate of all spatial units was predictable,

but the reduction observed in Metropolitan Regions was much stronger, marking a significant reversal of the previous predominant trend of concentration in few localities, particularly in the Southeast (Martine, 1994, p. 34). This inflexion is very significant and it is indicative of a "polarization reversal", but the limits of these changes must be carefully taken into consideration. The fourth stage of the conceptual model is characterized by a consistent process of interregional deconcentration and formation of new agglomeration economies beyond the "core regions" of the states of São Paulo and Rio de Janeiro. From this point onwards, descriptions and analysis of population redistribution processes at national scale will require more caution, with the risk to incur in non-qualified generalizations, given the diversity of processes of urbanization in the national territory and the multiplication of vectors of population redistribution (see Chapter 6). Nevertheless, in order to build a general picture, some remarks can be made.

The 1990s were marked by the consolidation of important changes. Fertility decline continued reducing the growth pace of potential migrants and of populations of consolidated urban areas (Rigotti, 2006). Brito (2009) suggests that the massive interregional transfers of population observed on previous decades were already no longer viable, not only from a social and economic point of view, but also from a demographic point of view:

> *"The previous migratory pattern prevailing in Brazil was typical of the first phase of demographic transition, when high fertility and falling mortality made possible high rates of population growth in large labour supplying areas, such as the Northeast and Minas Gerais. (...) At the current stage of demographic transition, where fertility has already reached replacement level, there is no possibility of generating, in the traditional regions of migration origin, the same population surpluses of the past and, consequently, its huge interstates transfers. Demographic conditions associates with economic and social conditions to make migration less likely and necessary than it was in the old paradigm"* (BRITO, 2009, p.15, own translation)

Therefore, it is highly unlikely that new big cycles of concentration (e.g., in the form of metropolization) will occur in other regions of Brazil. The formation of new agglomeration diseconomies in already consolidated areas of Minas Gerais and Northeast can be expected, but no big shifts in settlement patterns. In what concerns the current configuration of the Brazilian migration patterns, it is important to emphasize the presence of "overlapping temporalities" – past trends are not substituted, but coexist with new ones (different regions

can be at different stages of the Demographic, Migration or Urban Transition). There is an inertia in population movements, even with unfavourable conditions, partly an effect of the structural paths created by social networks formed between migrants in the places of origin and destination. As an example, the states of São Paulo, Rio de Janeiro, Goiás[30] and the Federal District remained as places of migration attraction to the states of the Northeast, even if with decreasing volumes (Brito, 2009; Baeninger, 2011).

In conclusion, the pace of redistribution of the Brazilian population is far from being intensive or have the same impact that the population concentration processes occurred between the 1940s and the 1970s. Besides that, it is important to reiterate that *there are processes of population concentration and deconcentration occurring simultaneously in Brazil* - that is why is so important to better qualify this discussion and make sense of the highly complex migration patterns that have been driving the processes of population (re)distribution in Brazil after the 1980s. In the following section, we explore shifts in migration intensity, impact, distance and connectivity (as proposed by Bell et al. (2002)) by applying conventional migration metrics in a broad spatial framework. Besides official boundaries, several scales of random aggregations of microregions (Aggregated Spatial Regions) will to be used address the Modifiable Areal Unit Problem (MAUP).

4.3 A multiscale and multidimensional analysis of the internal migration patterns in Brazil after the 1980s

Table 1 shows a set of global indicators of internal migrations in Brazil in multiple scales, regarding the dimensions of intensity, impact, distance and connectivity. These measures were computed in the IMAGE Studio software[31], using “fixed interval” data regarding the five-year periods prior to the censuses of 1991, 2000 and 2010. Since municipalities are the most disaggregated level possible for migration census data, the inclusion of this scale of analysis is important. However, only some basic measures of intensity and impact were computed in this level, because of the intrinsic data limitations mentioned in the previous chapter and the fact that, due to emancipations, municipalities boundaries (number and shape) changed

[30] Goiás and Santa Catarina were the only two states that showed an increase in net migration between 1986-1991 and 2005-2010.

[31] With the exception of the number and proportion of migrants *within* boundaries.

significantly in the last thirty years. The differences observed in the global indicators on the different levels of spatial aggregation reflect the *scale effect* of the Modifiable Areal Unit Problem (MAUP). To deepen this issue, the same measures were computed for random aggregations of microregions in different scales, as explained in Chapter 3.

Table 1 – Global indicators of internal migration on Brazil in multiple scales, 1986-1991 to 2005-2010

	States			Mesoregions			Microregions			Municipalities		
	1986-1991	1995-2000	2005-2010	1986-1991	1995-2000	2005-2010	1986-1991	1995-2000	2005-2010	1986-1991	1995-2000	2005-2010
Number of spatial units	27	27	27	137	137	137	558	558	558	4	6	6
Total Population	146,825,475	169,872,859	190,755,799	146,825,475	169,872,854	190,755,799	146,825,475	169,459,823	190,755,799	146,825,475	169,872,854	190,755,799
Intensity												
Total Migrants	5,012,254	5,196,087	4,643,745	8,227,946	8,684,791	7,932,281	10,248,725	10,854,138	9,925,123	27,366,915	30,630,187	30,014,505
Mean Migration Flow	7,140	7,402	6,615	442	466	426	33	35	32	-	-	-
Median Migration Flow	1,100	1,397	1,327	20	31	33	0	0	0	-	-	-
Max Migration Flow	248,599	277,306	215,005	71,395	89,896	70,673	71,360	87,660	64,133	-	-	-
Crude Migration Intensity	3.41	3.06	2.43	5.60	5.11	4.16	6.98	6.41	5.20	18.64	18.03	15.73
Migrants within the spatial unit	8,891,552	10,060,571	8,675,011	5,228,287	5,886,294	9,347,934	3,207,372	3,716,873	7,355,086	-	-	-
% of migrants within the spatial unit	63.95	65.94	65.13	38.85	40.40	54.10	23.84	25.51	42.56	-	-	-
Impact												
Aggregate Net Migration Rate	0.87	0.54	0.46	1.34	1.05	0.78	1.92	1.49	1.08	5.41	4.57	3.60
Migration Efficiency Index	25.37	17.62	18.81	23.83	20.49	18.75	27.56	23.27	20.83	29.04	25.32	22.87
Distance												
Mean Migration Distance	905.80	908.33	892.42	578.13	581.42	577.40	470.05	471.88	468.66	-	-	-
Median Migration Distance	762.12	762.12	762.12	326.21	332.03	330.74	219.11	220.46	217.92	-	-	-
Connectivity												
Index of Connectivity	0.99	1.00	1.00	0.64	0.72	0.73	0.18	0.21	0.22	-	-	-
Index of Inequality	0.63	0.62	0.61	0.59	0.62	0.61	0.46	0.46	0.46	-	-	-

Source: 1991, 2000 and 2010 Demographic Censuses. Prepared by the author.

4.3.1 Intensity dimension

The indicators of the *intensity* dimension attempts to capture the overall level or incidence of mobility (Bell et al., 2002). The most relevant aspect to be noticed is that, despite the growth of the Brazilian population between 1980 and 2010, the proportion of migrants decreased in all scales, as shown by the Crude Migration Intensity (CMI) – the total number of internal migrants in a given period as a percentage of the population (Figure 8). Although the *relative* volumes of migrants steadily declined, in *absolute* terms, there was a slight increase from 1986-1991 to 1995-2000 and an overall absolute decrease in the number of migrants from 1995-2000 to 2005-2010 (as shown in Figure 9). It is important to highlight that the sharper increase in the volume of migrants observed at the municipalities level in the period between 1986-1991 and 1995-2000 was affected by the significant growth in the number of municipalities, due to several emancipations occurred in the 1990s (growth of more than 18% in the number of spatial units).

Figure 8 - Crude Migration Intensity in multiple scales, 1986-1991 to 2005-2010

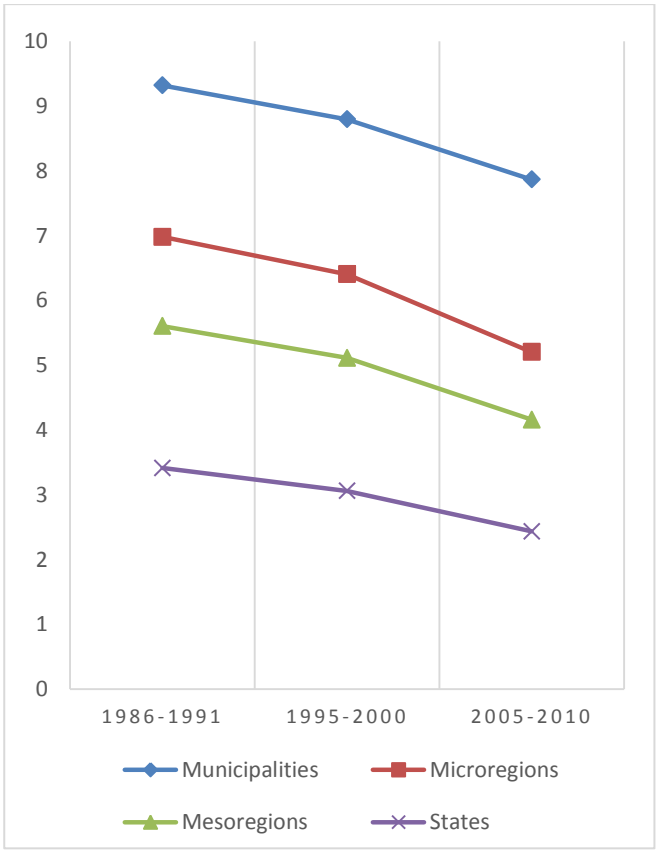
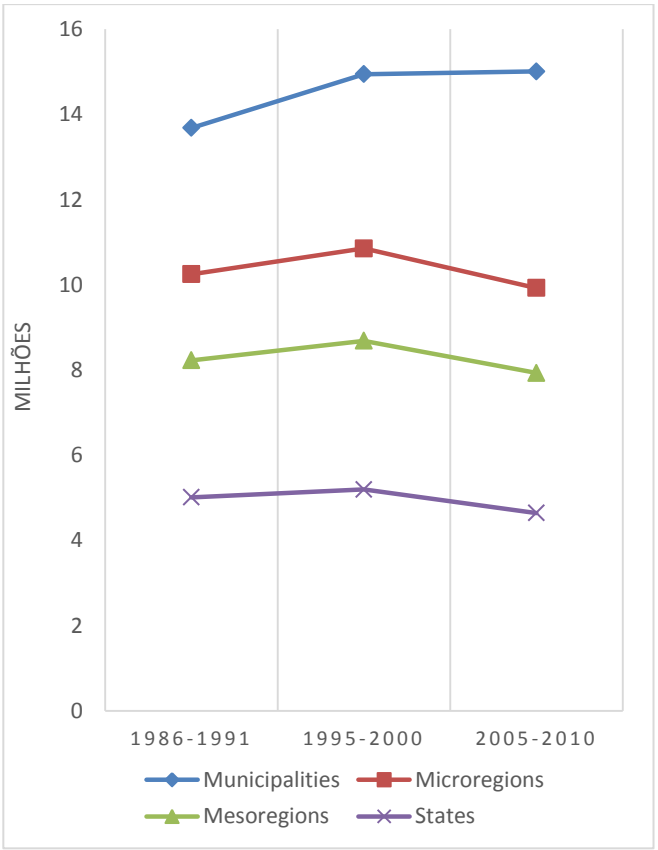


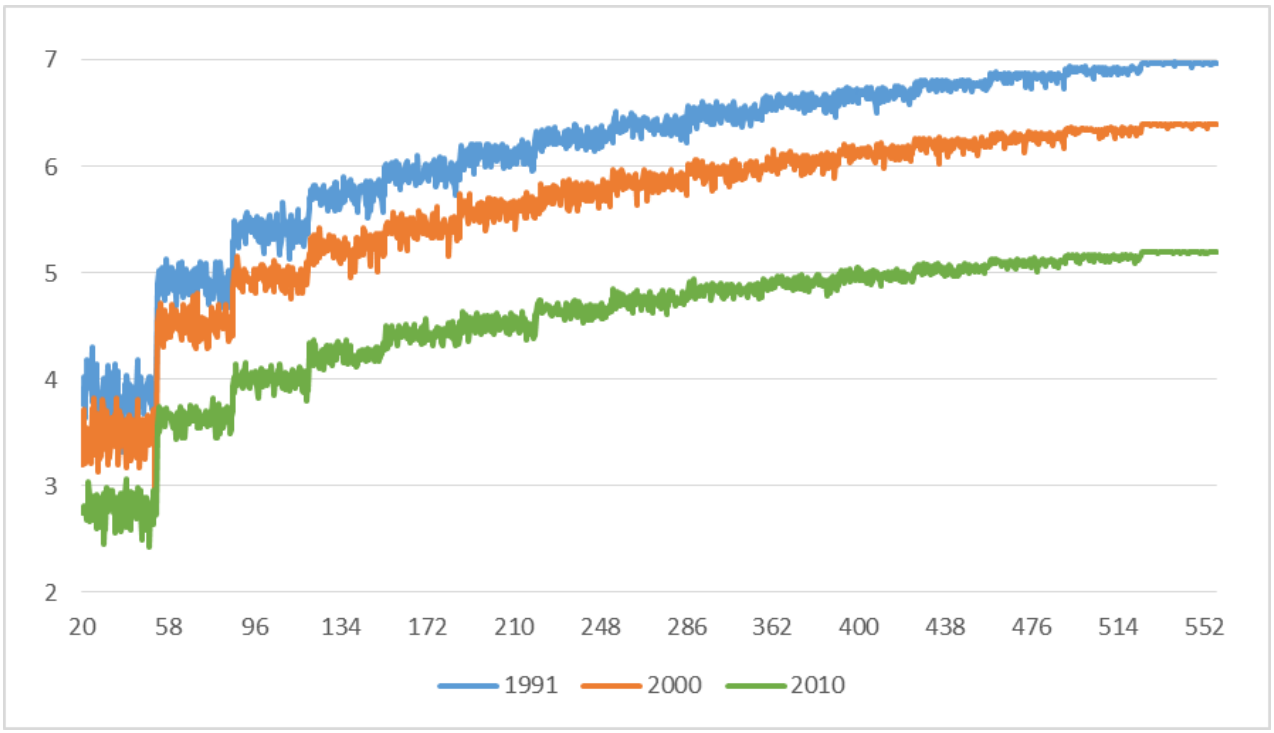
Figure 9 - Total number of migrants in multiple scales, 1986-1991 to 2005-2010



Source: 1991, 2000 and 2010 Demographic Censuses. Prepared by the author.

The CMI is scale dependent, that is, the larger the number of zones over which migration is measured, the higher is its apparent intensity (Rees et al., 2016). In order to show the scale and zonation effects of MAUP in the CMI, random spatial aggregations of microregions (Aggregate Spatial Regions or ASRs) were used to build Figure 10. The chart shows a logarithmic tendency of growth in the relative volume of migrants accordingly to the number of spatial units. The difference is particularly accentuated in the more aggregated areas, from where the curve develops towards a less steep pattern of growth. While the shape of the line represents the *scale effect* of MAUP, its thickness represents the *zonation effect*. The lower the number of ASRs, the higher the variance will be, because of the greater number of possibilities of BSUs aggregations (all the 1500 iterations, 100 for each scale, are represented in the chart).

Figure 10 – Crude Migration Intensity as a function of the number of spatial units, 1986-1991 to 2005-2010



Source: 1991, 2000 and 2010 Demographic Censuses. Prepared by the author.

The downwards dislocation of the CMI curve over time (Figure 10) shows a relative decrease in the volume of migrations in all scales since the 1980s. This relative decrease combined with the overall absolute decrease in the number of migrants in the last two censuses represent an important inflexion of historical tendencies and it is related to a conjunction of social, economic and, above all, demographic factors, as suggested by Brito (2009). Fertility levels fell from low in the 1990s to a point below replacement level in the 2000s,

corresponding to the fourth and fifth stages of the conceptual framework and of the Demographic Transition. Despite that, further investigation is required to understand if the correspondent economic and urban spatial patterns and processes of the last stages of the theoretical model - like the process of "polarization reversal" - are taking place in Brazil.

Naturally, the decreasing fertility trends of the last decades affected the volumes of potential migrants in the country and thus the overall levels of migration, with the reduction of the "population surpluses" in the traditional areas of migration origin. However, even considering multiple scales, it is not possible to affirm categorically that the Brazilian population is migrating less. One limitation of the "fixed interval" data is that it fails to capture multiple migratory movements within the five-year period prior to the censuses, as well as return migration within the five-year interval. Nevertheless, the difference between the "last move" matrix in the five-year period prior to the censuses and the "fixed interval" matrix indicates the number of short-term migrants[32] (those who leaved and returned to a determined place within the five-year interval prior to the census). Brito and colleagues (2012) showed that the proportion of interstate[33] short-terms migrants almost tripled from 1986-1991 to 2005-2010, representing at least one quarter of the total migrants in each state in the 2010 census, which supports the hypothesis that internal migrations in Brazil assumed a more reversible and oscillating character (Baeninger 2011).

By showing the volumes and proportion of migrants *within the boundaries* of microregions, mesoregions and states[34], Figures 11 and 12 also supports the hypothesis that migrations in Brazil are becoming more "regionalized" and occurring in shorter distances (these topics will be discussed in detail in the "distance dimension" section and Chapter 6). The charts indicate a sharp increase in the flows occurring within states, mesoregions and microregions especially between 1995-2000 and 2005-2010, the same period that the CMI and the total number of migrants *between* the spatial units on every level presented a reduction.

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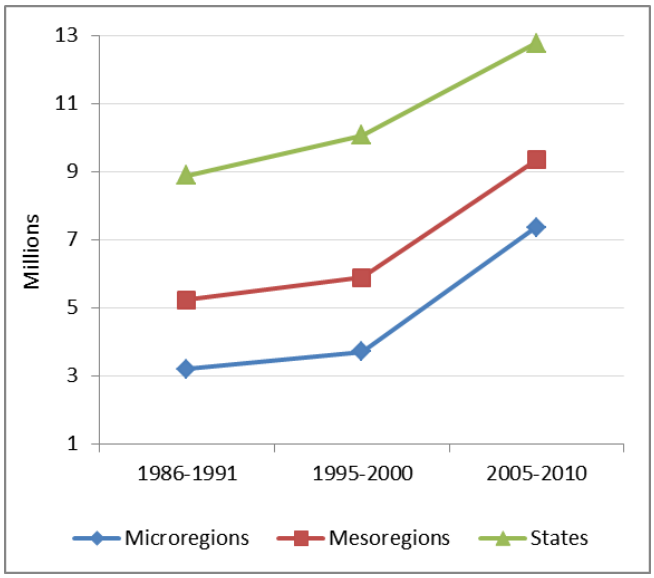
[32] Only migrants older than five years must be considered in the "last move" matrix, in order to cover the same age interval than "fixed interval" data. For details of this methodology, see Rigotti (1999).

[33] Unfortunately, the 2000 Census included the "last move" question only at state level, not allowing the calculation of short-term migrants for the micro and mesoregional scales between 1995 and 2000.

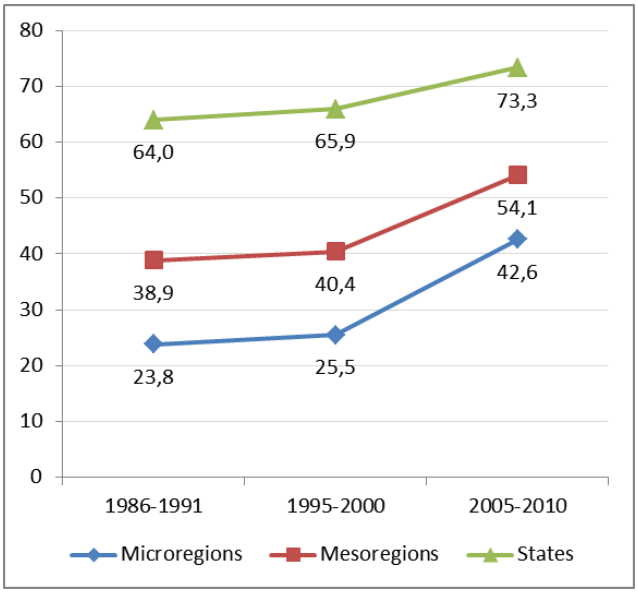
[34] Municipalities are the most disaggregated level of census migration data, so it is not possible to calculate migration *within* this level. Besides that, it is reasonable to assume that these movements are mostly driven for residential purposes, which is not the focus of this thesis.

Figure 11– Number of migrants within boundaries of microregions, mesoregions and states, 1986-1991 to 2005-2010



Source: 1991, 2000 and 2010 Demographic Censuses. Prepared by the author.

Figure 12 – Proportion (%) of migrants within boundaries of microregions, mesoregions and states, 1986-1991 to 2005-2010



Source: 1991, 2000 and 2010 Demographic Censuses. Prepared by the author.

4.3.2 Impact dimension

The indicators used to address the *impact dimension* are the Migration Effectiveness Index (MEI) and the Aggregate Net Migration Rate (ANMR). The MEI measures the relationship between net and gross migration and provides an indication of the importance of net migration in redistributing the population, showing how much of the internal migrations is "effective" from the point of view of quantitative change (Thomas, 1941 *apud* Cunha, 2014). It consists in the sum of the absolute value of the net migration balance of each spatial unit divided by the sum of total in and out flows across all spatial units, multiplied by 100. It varies from 0 to 100, with high values denoting that migration is an efficient mechanism of population redistribution and low values indicating that flows and counter-flows are more closely balanced (Bell et al., 2002).

Figure 13 shows the evolution of the Migration Efficiency Index in multiple scales over the last decades. The decrease of net migrations in all scales caused a sharp decrease in the "efficiency" of migration as a mechanism of population redistribution (despite the relative reduction of gross migration, the denominator of the MEI formula), especially in the

municipalities level. Even though the MEI is a standardized measure, the difference between this level and the others is marked. It shows that, the more disaggregated the spatial unit, more unbalanced in and out flows tend to be. The state level was the only to present a more erratic pattern, with an increase from 1995-2000 to 2005-2010. From the first to the second five-year period, the major decrease in this indicator suggests more balanced flows between states, one possible explanation being the increase of return migration. In the following five-year period, MEI shows a slight "recovery" at state level, reaching a value similar of the mesoregions.

Despite being an important statistical measure for comparative and evaluation purposes, the Migration Efficiency Index does not provides an indication of the overall impact of migration on the settlement system, since it does not consider the populations of the spatial units. To address this issue, Bell et al. (2002) recommends the Aggregate Net Migration Rate (ANMR), which measures the impact of migration on population redistribution, identifying the net shift of population between spatial units per hundred persons resident in the country (Rees et al., 2016). It is calculated by dividing the sum of absolute differences between origin and destination flows (aggregate net migration) for the total population and multiplying it by 100 or simply changing the denominator of MEI from the sum of gross migration flows to the population.

Figure 14 shows the evolution of the ANMR in multiple scales (ASRs) over the last three decades. The chart indicates low and weakening impacts of migration on population distribution and a tendency of convergence between scales. Nevertheless, a limitation of the ANMR[35] measure is that, since it is a product of the crude migration intensity (CMI) and the migration effectiveness index (MEI), the same value can be a result of high MEI combined with low CMI or the opposite (Rees et al., 2016). In other words, migrations can cause a high impact on the settlement system due to a big proportion of migrants in the population, even with relatively balanced flows between the spatial units or, alternatively, to a small proportion of migrants associated with very unbalanced flows. The fall of both migration intensity and effectiveness in Brazil suggests that the decreasing effect of migrations on the settlement pattern is due to the reducing proportion of migrants in the population *and* a greater equilibrium of flows and counter flows on the migration network.

[35] It is important to remember that the measures of impact do not concern the *composition of flows*, a very important issue for public policies design and urban and regional planning.

Figure 13 - Migration Efficiency Index in multiple scales, 1986-1991 to 2005-2010

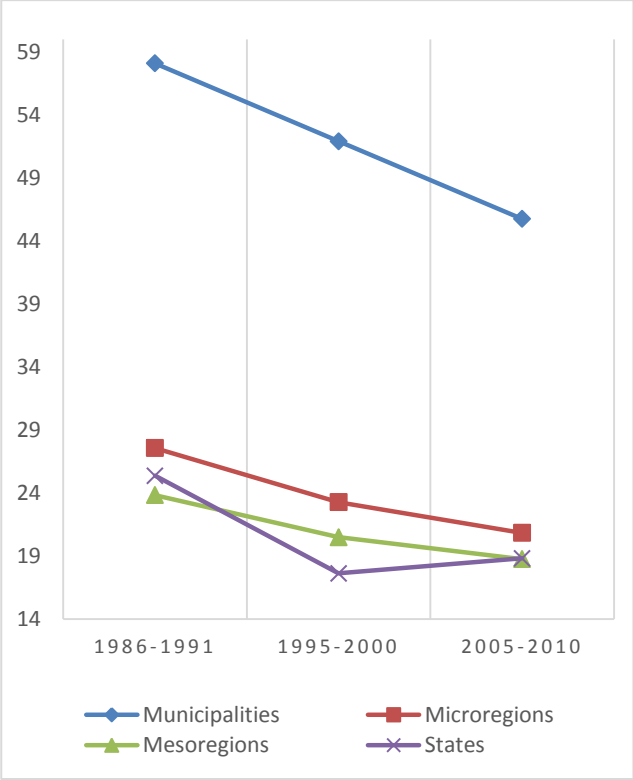
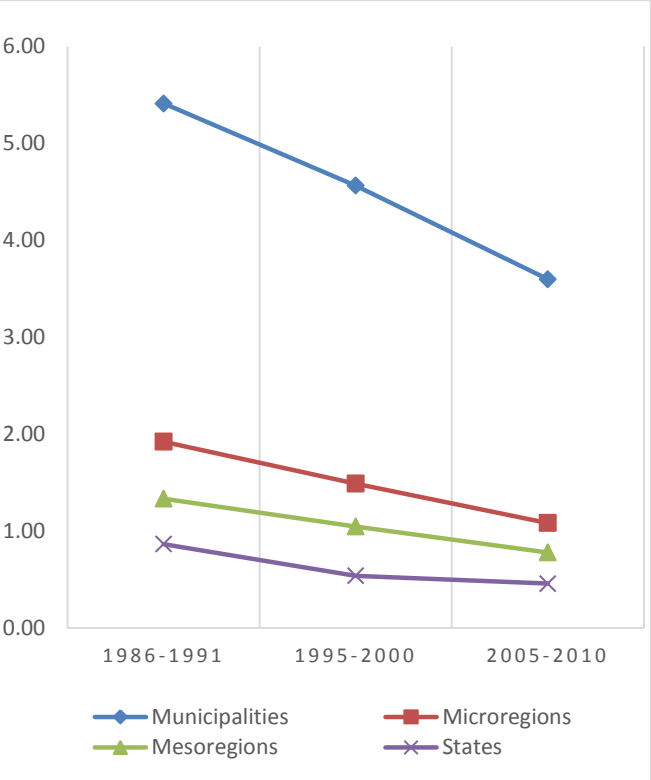


Figure 14 - Aggregate Net Migration Rate in multiple scales, 1986-1991 to 2005-2010

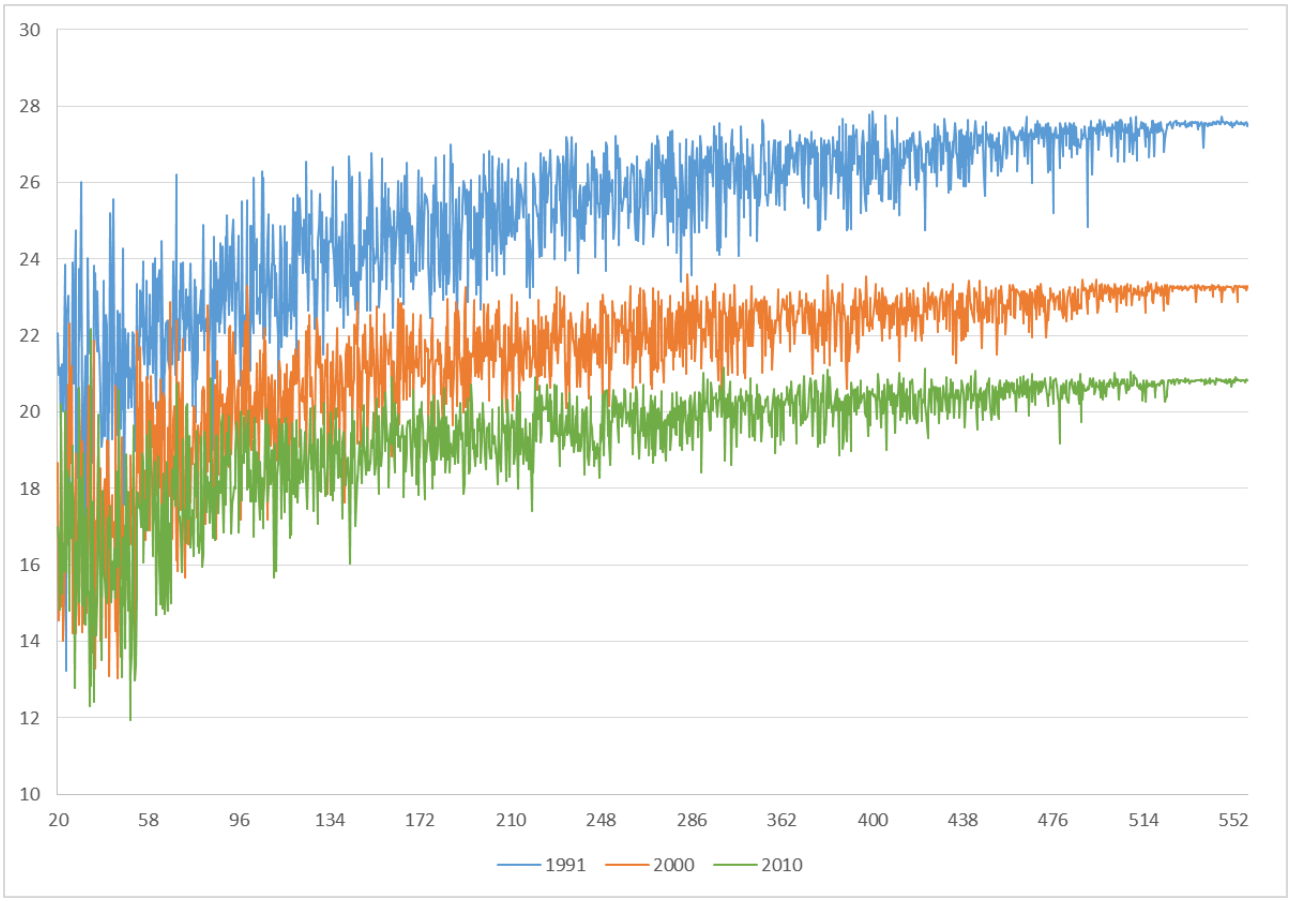


Source: 1991, 2000 and 2010 Demographic Censuses. Prepared by the author.

Figures 15 and 16 show, respectively, the MEI and ANMR as a function of the number of spatial units over time. The changes in the values of these measures according to the number of BSUs represent the scale effect of the MAUP (like in Figure 10), while the variation within each level of aggregation indicates the zonation effect. The impact of migrations increases according to the level of spatial disaggregation because, as the number of spatial units increases, more short distances migration movements are captured, affecting the CMI. In what regards the zonation effect, again, the lower the number of ASRs, the higher will be the variance because of the greater potential of variability in BSUs aggregations. Figure 15 shows that the degree of variation on migration effectiveness across scales seems to be decreasing over time. Both measures indicate a decreasing impact of migrations in all scales. According to Rees et al. (2016), this should be expected, since processes of population redistribution tend to be echoed across the geographic spectrum, that is, when there is a significant degree of population redistribution at one level, there is a tendency of a high degree of redistribution at other levels.

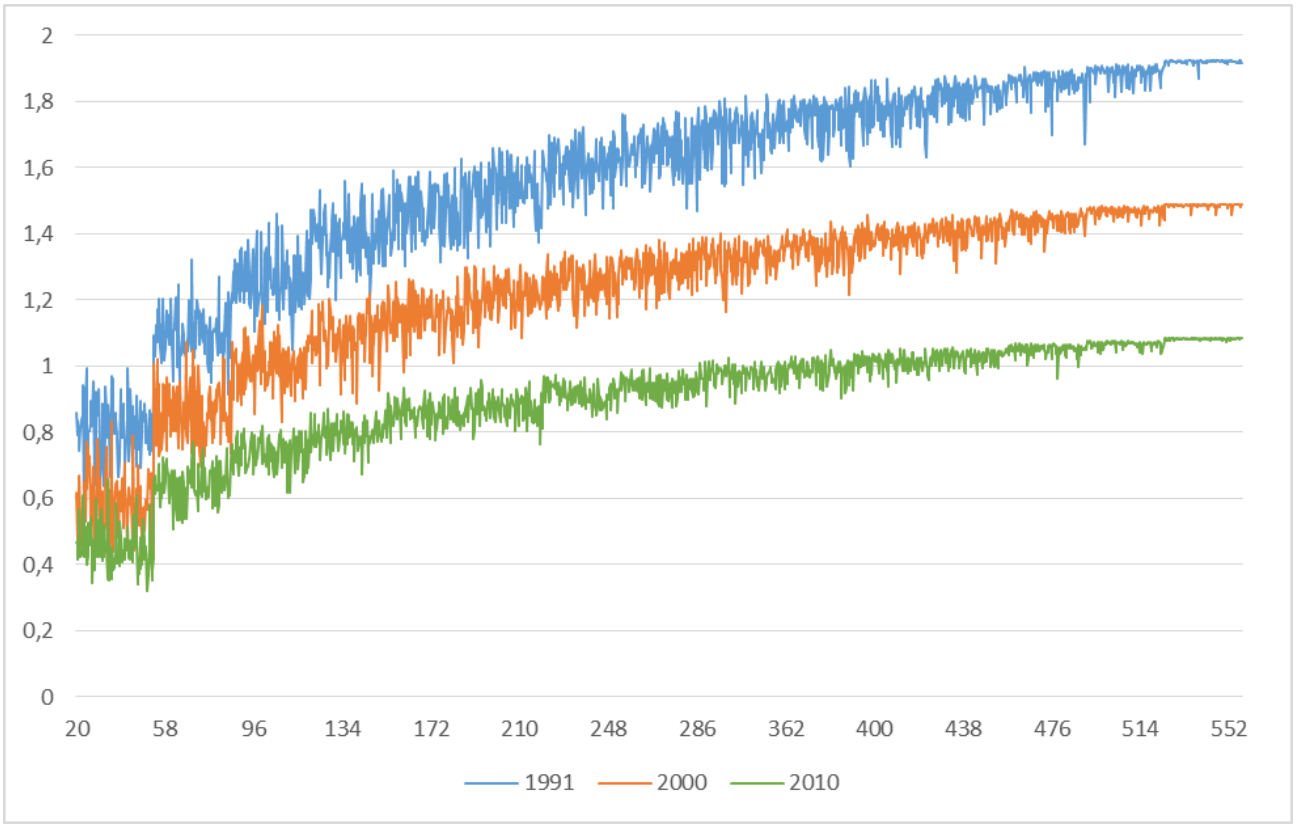
These trends, together with the already mentioned decreasing impact of mortality and fertility in the settlement system, make the current pace of population redistribution in Brazil far slower than the process of population *concentration* occurred by the middle of the last century. Moreover, a decreasing spatial impact of migrations corresponds to the two last stages of the conceptual model, which postulates an inversion of tendencies in the phase of "polarization reversal", on the basis of Rees et al. (2016) revision of the "differential urbanization" theory (proposed originally by Geyer and Kontuly (1993)). This turning point refers to the inflexion of the inverted U-shaped curve representing the relationship between migration impact and development.

Figure 15 - Migration Efficiency Index as a function of the number of spatial units, 1986-1991, 1995-2000 and 2000-2010



Source: 1991, 2000 and 2010 Demographic Censuses. Prepared by the author.

Figure 16 - Aggregate Net Migration Rate as a function of the number of spatial units, 1986-1991, 1995-2000 and 2000-2010



Source: 1991, 2000 and 2010 Demographic Censuses. Prepared by the author.

4.3.3 Distance dimension

There are many difficulties regarding the study of migrated distances, not incidentally, a typically overlooked dimension of migration. The first problem is the lack of appropriate detailed information, which forces researches to use proxies of migrated distances. A common approach is the measurement of Euclidian distances between the geographic centroids of the places of origin and destination. In the case of this thesis, the distances (in kilometres) between the centroids of the microregions of migration origins and destinations were used as a proxy, as shown in Table 2. Data shows a great stability across time, with more than half of the migrants dislocating distances until 300 kilometres in all periods considered. It is also worth mentioning that around a fifth of all migrants travelled really long distances – more than a thousand kilometres – to reach their destinations.

Table 2 - Migration intensities between microregions and CMI by distance, 1986-1991 to 2005-2010

Distance	Frequency			CMI			Percent (%)		
(km)	1986-1991	1995-2000	2005-2010	1986-1991	1995-2000	2005-2010	1986-1991	1995-2000	2005-2010
0-100	2,225,632	2,379,666	2,179,190	1.5	1.4	1.1	21.7	21.9	22
101-200	2,175,149	2,243,251	2,075,241	1.5	1.3	1.1	21.2	20.7	20.9
201-300	1,074,087	1,130,334	1,045,898	0.7	0.7	0.5	10.5	10.4	10.5
301-400	844,435	860,306	771,943	0.6	0.5	0.4	8.2	7.9	7.8
401-500	586,953	632,243	552,779	0.4	0.4	0.3	5.7	5.8	5.6
501-1000	1,299,231	1,395,336	1,273,546	0.9	0.8	0.7	12.7	12.9	12.8
1000+	2,043,187	2,212,928	2,026,345	1.4	1.3	1.1	19.9	20.4	20.4
Total	10,248,674	10,854,064	9,924,941	7.0	6.4	5.2	100	100	100

Source: 1991, 2000 and 2010 Demographic Censuses. Prepared by the author.

Despite the stability on distances moved showed by Table1, it is important to understand the limitations of this approach. One of the main problems with this strategy is that distances moved *between* spatial units are not necessarily longer than distances moved *within* the same spatial unit. Besides that, there is a great variability in shapes and area sizes, even when considering the same level of analysis, what creates a strong bias in the recorded migrated distances. The *municipality* of Altamira (PA), for example, is bigger than ten Brazilian *States* and the Federal District. For these reasons, macroregional comparisons of distances moved using this methodology would not be advisable for the Brazilian territory, since mesoregions, microregions and municipalities of the North region, for example, are much bigger than of the Southeast.

Table 1 showed the *mean* and *median distances of migration*, which quantify how far migrants are travelling in kilometres, in the whole spatial system. A strong MAUP scale effect was identified in these measures, with values increasing proportionately with the level of aggregation. The values seem stable across time but, again, this do not necessarily means that distances travelled in Brazil did not changed at all over the period considered. As already stated, the growing migration flows *within* mesoregions and microregions suggests a relative increase of intraregional and short distance flows.

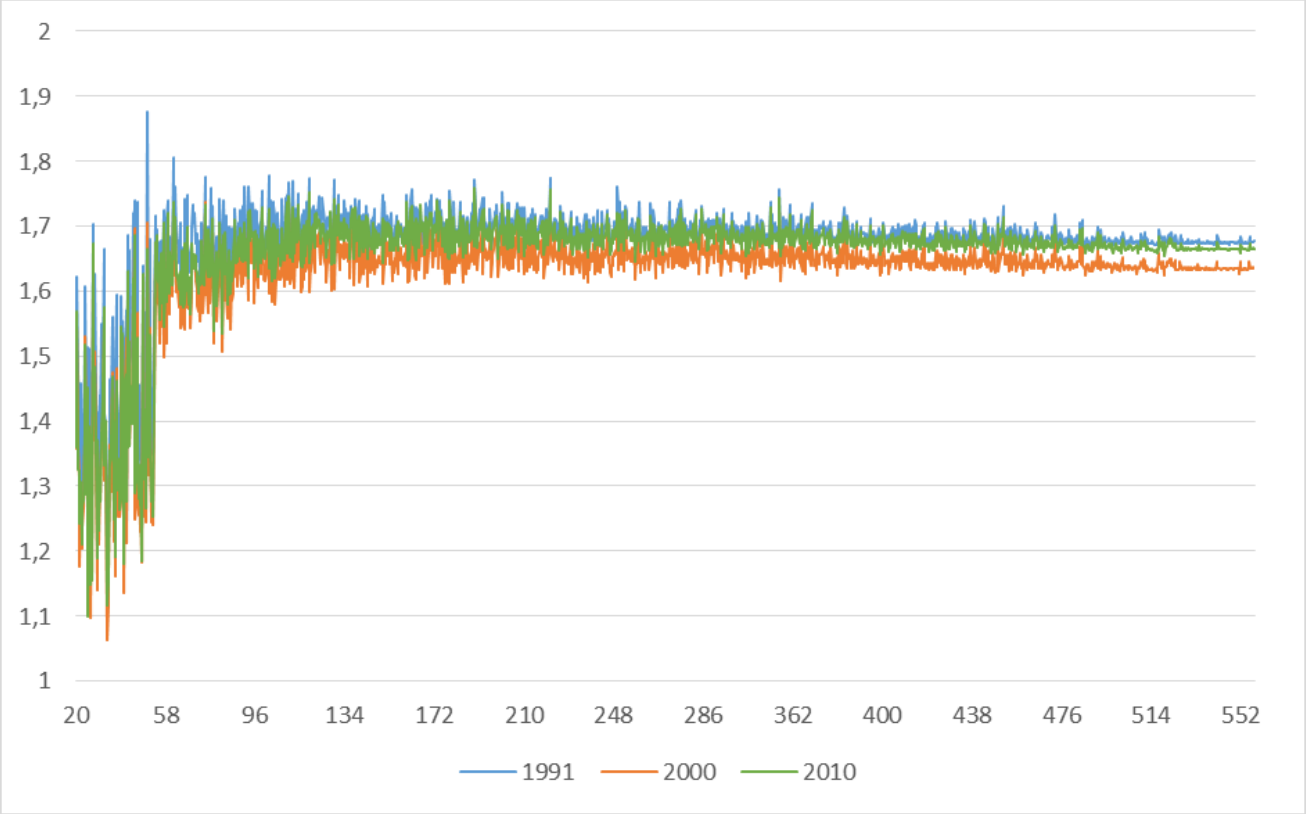
It is reasonable to assume that central tendencies measures do not provide adequate evidence about distances of migration at national level, disregarding the level of spatial aggregation, because of the great variability of data (as shown by the significant differences between mean and median distances, which indicates a highly uneven distribution). Thus, in order to complement the analysis and help investigate the frictional effect of distance in

migrations (that is, how much distance hinders dislocations), a Spatial Interaction Model (SIM) was computed on the software IMAGE Studio. Through this software, it is possible to compute the β value[36], a generalized distance decay parameter related to the "costs" associated with spatial dislocation, which tend to increase accordingly with the distance between two points (that is, the interactions tend to be inversely proportional to distance) - the higher the value of β, the stronger will be the distance decay effect.

Like in the intensity and impact dimensions, the aggregation features of IMAGE Studio were used to study the MAUP effects. The chart of Figure 17 shows that the frictional effect of distance, indicated by the β value, is very stable across time and across different spatial scales (ASRs), especially in the more disaggregated levels. In other words, the MAUP scale effect on the distance decay parameter is very low and the zonation effect, one more time, tends to decrease with the level of disaggregation. A tendency of stability in the frictional effect of distance across spatial scales was identified by Stillwell et al. (2016) in several countries, despite the large differences in migrated distances between them. As expected, the largest countries presented the largest distances travelled, especially those with low density, like Brazil.

[36] The Mean Migration Distance is used as the convergence criterion for the doubly constrained SIM of IMAGE Studio, which is defined as $M'ij = Ai\ Bj\ Oi\ Dj\ dij^{-\beta}$, where *M'ij* is the modelled flow between origin BSU *i* and destination BSU *j*, *Oi* and *Dj* are the observed totals of outmigration from BSU *i* and in-migration to BSU *j*, respectively, *Ai* and *Bj* are balancing factors computed endogenously that enable the flows in cells across each row and each column of the modelled matrix to sum to the known totals *Oi* and *Dj* respectively, and *β* is the generalised distance decay parameter associated with a negative power function which is calibrated automatically using a Newton–Raphson iterative search routine (Stillwell, 2016). For more information about the calculation of the β value and the SIM, see Stillwell et al. (2016), Daras (2014) and Stillwell (1991).

Figure 17 – Beta value as a function of the number of spatial units, 1986-1991, 1995-2000 and 2000-2010



Source: 1991, 2000 and 2010 Demographic Censuses. Prepared by the author.

Theoretically, with the growing importance of the network mode of spatial-territorial organization, the relevance of the distance friction effect in migration movements should be decreasing, because of the "time-space compression" phenomena. Technological advancements and its diffusion have been reducing the "costs" to overcome spatial barriers and distances. At present days, places located near each other can be less connected than places separated by longer distances, contradicting the "first law of Geography" of Waldo Tobler (1970), which postulates that "everything is related to everything else, but near things are more related than distant things". This is also coherent with Stillwell et al. (2016) findings, which found evidence that countries with high levels of development (considering urbanization, HDI and GDP) generally display lower levels of distance friction. Nevertheless, spatial distance still plays an important role in Brazil, as expected due its size and extremely unbalanced settlement pattern (highly uneven population density and distribution).

4.3.4 Connectivity dimension

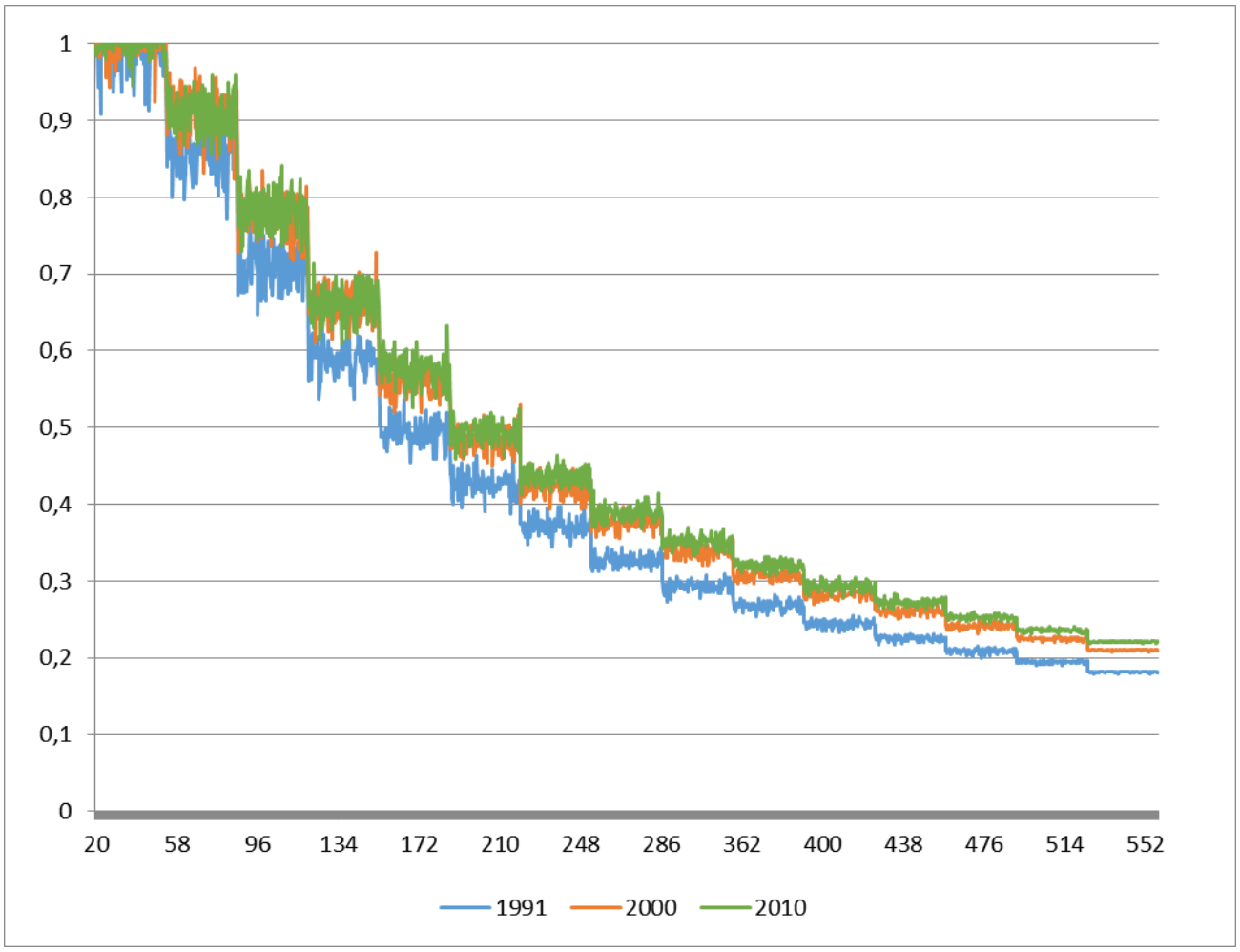
Connectivity is probably the most neglected aspect of migration, with very few exceptions[37]. This section consists in a first preliminary analysis of this dimension in *multiple scales*, based on two basic indicators: the index of connectivity and the index of inequality (Table 1). Given the importance of connectivity for the understanding of the changing patterns of population (re)distribution in Brazil, Chapter 6 will be exclusively dedicated to it. The theoretical and methodological framework of Network Analysis will be used to explore changes in the cohesion and density of migration networks at the microregional level, the most disaggregated scale of analysis that maintained the same boundaries during the last thirty years. Networks Analysis methods and metrics can indicate the strength of the links between spaces, patterns of connections and the role of spatial units within the migratory system.

The *index of connectivity* is the proportion of spatial units that are connected by a migration flow involving one or more persons, calculated by dividing the number of existing flows by the overall dimension of the matrix[38] (Bell et al., 2002). Considering the same country or region, the more aggregated are the spatial units, more connected the network will be (see Table 1). Like in previous sections, the index of connectivity was analysed in multiple scales (ASRs) to address the effects of MAUP. As seen in Figure 18, the stepwise decrease of connectivity accordingly to the level of disaggregation is coherent with the pattern observed in the Brazilian official boundaries. As expected, the zonation effect is more pronounced in the more aggregated levels (because of the bigger number of possible spatial configurations).

[37] Like Tranos et al. (2015), Maier and Vyborny (2005) and, in Brazil, Braga (2011), Fazito, (2005) e Soares (2002).

[38] Stillwell et al. (2016) identified a negative correlation between the β parameter (showed in the previous section) and the index of connectivity (known simply as “density” in traditional Social Network Analysis), when comparing these indicators across several countries. It can be expected that, the more connected are the units in a spatial network, less important will be distance friction effect.

Figure 18 – Index of connectivity as a function of the number of spatial units, 1986-1991, 1995-2000 and 2000-2010



Source: 1991, 2000 and 2010 Demographic Censuses. Prepared by the author.

Due to the relatively low number of states and the size of the Brazilian population, is not surprising that they are all connected. In what regards meso and microregions, both levels presented an increase in their connectivity over time, coherently with the postulates of the conceptual model. The biggest increase occurred from the first to the second five-year period: 8% in the mesoregional level and 3% in the microregional level. From 1995-2000 to 2005-2010, the number of connections in both levels increased only 1%, reaching, respectively, 73% and 22% of the total possible connections, indicating a trend towards stagnation. Even though the proportional increase of connections can seem small, it is important to remember that the relative number of migrants *decreased* in the period analysed (as shown in the section regarding intensity), what indicates the fragmentation of migration flows and, consequently, a more cohesive network. This finding is in accordance with previous literature, which pointed out this tendency of fragmentation of flows in Brazil since

the 1980's and the emergence of new "spaces of migration", able to attract and provide migrants (Baeninger, 2011; Braga e Fazito, 2010; Rigotti, 2008). If this is an indication of the emergence of new agglomeration economies outside the core regions, it can support the argument that Brazil is transitioning to the fourth phase of the conceptual framework.

Although useful, the index of connectivity is a problematic measure, since it ignores the magnitude of flows between spatial units. In this sense, the *index of migration inequality,* recommended by Bell and colleagues (2002) can be an appropriate complementary indicator. It corresponds to the difference between the observed distribution of interregional flows and an hypothetical distribution that assumes all flows in the matrix are of the same magnitude (it could be based on another hypothetical distributions, such as one derived from a spatial interaction model) (Bell et al., 2002). This index varies within the bounds of zero - which indicates that the two distributions are identical - and 1, denoting greater inequality. Table 1 shows that there is a significant inequality between the flows volumes, especially in the more aggregated levels of states and mesoregions, and this differences persisted over time. The measures of central tendency (mean and median migration flows) shown in Table 1 indicates that the volume of people exchanged between microregions tends to be small, despite the great variability of the data, with flows that goes from zero migrants until tens of thousands of migrants (the differences between mean and median migration flows also points out to a highly uneven distribution).

5 – THE CHANGING PATTERNS OF MIGRATION BETWEEN URBAN HIERARCHICAL LEVELS

The goal of this chapter is to investigate if internal migrations in Brazil are leading to a decompression of the urban system, as would be expected in the last stages of the conceptual model. Currently, internal migrations are the main mechanism of population redistribution in Brazil and it has been the main responsible for the growth of metropolises in the country since the onset of the process of urbanization in the end of the nineteenth century. By the 1970s, the majority of the Brazilian population was already living in cities and internal migrations had become predominantly between urban areas (Matos e Baeninger, 2004; Braga e Fazito, 2010), what reinforce the importance of studying the changing patterns of internal migration in parallel with the transformations of the urban system for a better comprehension of the processes of population redistribution in Brazil since the 1980s.

Since the original formulation of the "counterurbanization" concept by Berry (1976), it has been related, in a way or another, to the idea of deconcentration. As seen in Chapter 2, in Mitchell's (2004) proposal, it can refer to a deconcentrated *pattern* of population distribution, a *process* of change where a settlement system is transformed from a concentrated to a deconcentrated state or a type of *migratory movement* downward the urban hierarchy. Although they are all related, in this chapter, we will focus on the latter. By exploring the overall structure and changes in migrations patterns between different "functional spaces" - regarding the relative positions of cities in the urban hierarchy - it is possible to shed some light in the relations between urban, economic and demographic (de)concentration processes and address the relation between urban and migration networks. However, determine these functional spaces in urban system is not a trivial matter.

As regions play different roles in the national economy, cities have different functions in the spatial-economic system and occupy different positions in the urban hierarchy. The use of cities sizes are too simplistic to encompass the complexity of existing relations in an urban network, which can be of complementarity (interdependence), dominance or subordination and are frequently detached of population volumes. Hansen (1976), in his critical review of different approaches to study human settlement systems concluded the following:

> "*Any major effort to gain better understanding of spatial temporal development processes should have at the outset a framework of functional economic areas (…) flexible enough to take into account differences in degree of development among national (and even sub-national) economies as well as differences in degree of national economic planning*" (p.39-40).

In this thesis, the functional spaces were established on the basis of the hierarchical classification of the study "Areas of Influence of Cities 2007" or "REGIC 2007" (IBGE, 2008), the last edition of a traditional line of research on the Brazilian urban network made by the Brazilian National Institute of Geography and Statistics (IBGE). It consists in a framework of the Brazilian urban system, where cities are classified and ranked according to their centrality levels. To do so, REGIC 2007 approaches the urban network in two distinct ways, corresponding to the zonal and reticular modes of spatial-territorial organization: respectively, as a system of central localities in command of their hinterlands and as a system of articulated cities in a network (IBGE, 2008, p.18).

The hierarchy of urban centres and their areas of influence were defined through a number of criteria, related primarily to federal management (centrality of the Executive and Judiciary at the federal level), enterprise management (companies headquarters) and supply of equipment and services[39]. The goal was to identify the points in the territory from which decisions are issued and the command over the urban network is taken (IBGE, 2008). One important feature of this research is that the position of cities in the territory was taken into consideration for the classification of the administrative, juridical and economic centrality levels. This means that centres located in less densely occupied areas, in demographic or economic terms, despite having weaker centrality indicators than centres located in other regions, may assume the same level in the hierarchy (IBGE, 2008, p.11). A concept like "metropolis", for example, can refer to one thing in the South or North regions and a very different thing in the Southeast, which reinforces the importance of the use of functional spaces instead of merely population sizes.

For the purposes of this research, REGIC's classification was used to create an origin-destination migration matrix in order to explore the flows between urban hierarchical levels. First, each municipality was coded with its respective centrality level. Then, the aggregated

[39] For more details about the methodology, see the REGIC 2007 (IBGE, 2008).

inflows and outflows of each level were grouped and organized in a square matrix (N x N), with the hierarchical levels of migration origin in the rows and the hierarchical levels of migration destination in the columns. Before proceeding further, some important methodological remarks must be addressed.

The first observation is that the centrality levels classification for the whole period of analysis was standardized according to the last edition of REGIC. This means that the same urban hierarchy (referring to the year of 2007) was used in the five-year periods prior to the censuses of 1991, 2000 and 2010. This is a feasible approach, since a comparison with previous editions of REGIC showed a trend of structural stability in the urban hierarchy, especially in the upper hierarchical levels that, in general, remained the same (IBGE, 2008, p .17). The main changes are a product of the process of territorial occupation and usually refer to the lower strata of the urban hierarchy (IBGE, 2008, p.17). Although several emancipations occurred during the 1990s, municipalities were considered in large aggregates (hierarchical levels), in a way that properly captures the orders of magnitude of flows between categories. Despite that, some caution is required for the risk of overestimation of migration flows towards the lowest level of the urban hierarchy ("Local centres"), were normally new municipalities are situated.

Table 3 – Population and number of municipalities in REGIC 2007 urban hierarchical levels

Centrality Level	Frequency	Population			Population (%)		
		1991	2000	2010	1991	2000	2010
1) Metropolises	177	47,204,113	56,131,359	62,980,037	32.1	33.1	33.0
2) Regional Capitals	189	25,884,789	31,420,281	36,732,148	17.6	18.5	19.3
3) Sub-regional Centres	164	12,950,568	14,242,552	16,180,784	8.8	8.4	8.5
4) Zonal Centres	561	18,360,307	18,871,679	20,803,138	12.5	11.1	10.9
5) Local Centres	4,472	42,425,698	49,133,299	53,883,248	28.9	28.9	28.3
Total	5,563	146,825,475	169,799,170	190,579,355	100	100	100

Source of the basic data: REGIC 2007 and 1991, 2000 and 2010 Censuses. Prepared by the author.

Table 3 shows the five categories used to classify urban centres in REGIC 2007, the number of municipalities on each category and their absolute and relative populations. In the original document, each level was divided in two or three sublevels (with the exception of Local Centres), which were not considered in this work. For cities that constitute large urban agglomerations, the spatial unit of analysis was the *Population Concentration Areas* (ACP), defined as the following:

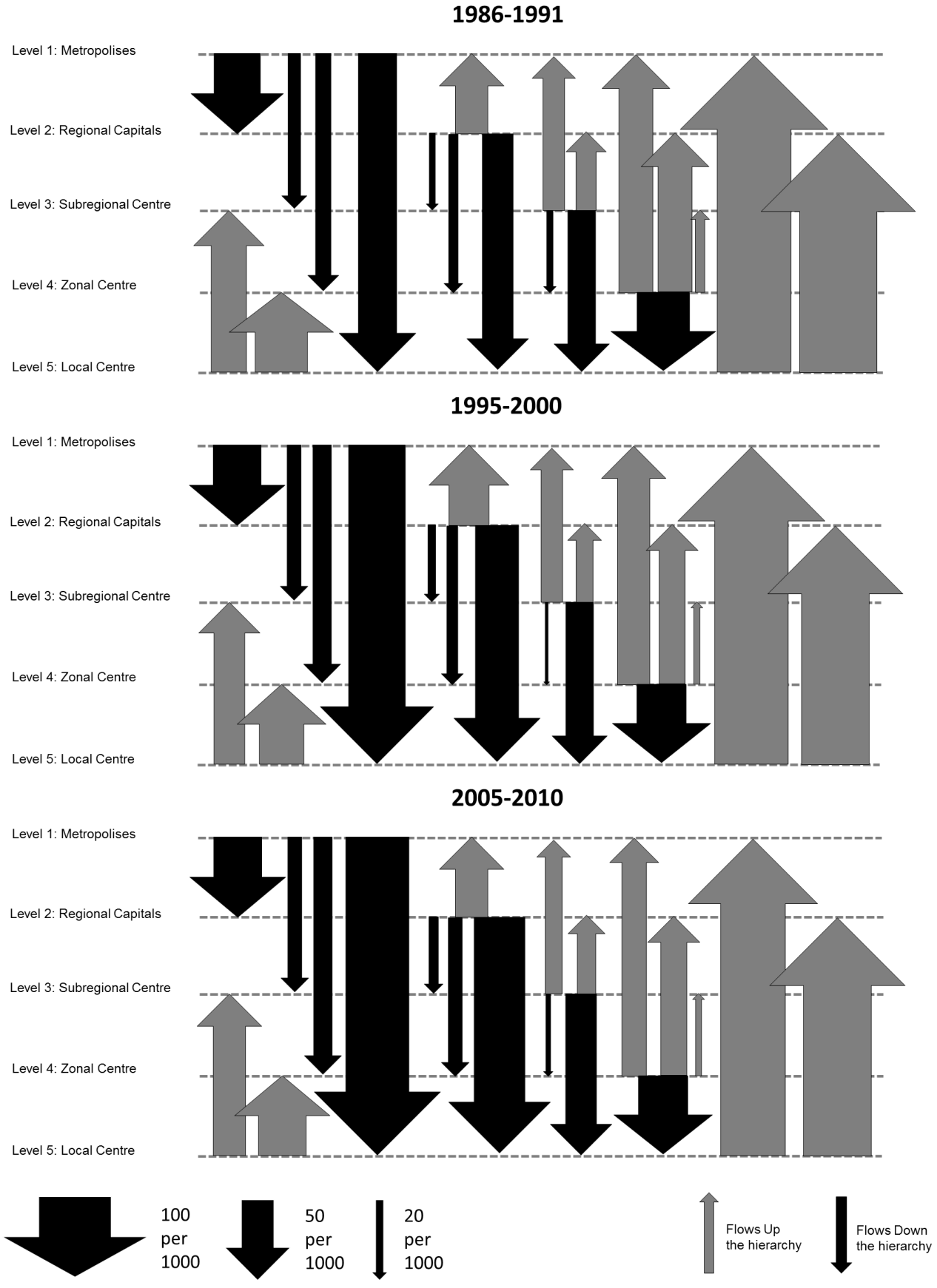
> *"ACPs are defined as large urban areas of continuous occupation, characterized by the size and density of the population, the degree of urbanization and internal cohesion of the area, given by the population movements to work or study. ACPs develop around one or more urban centres, in the case of conurbated centres, assuming the name of the capital municipality of the municipality with the largest population" (IBGE, 2008, p.11, own translation).*

A total of 5563 municipalities were contemplated in REGIC 2007 and 335 of them were grouped in 40 ACPs. Each one of these 335 municipalities was assigned with the centrality level of the ACPs to which they belong[40]. Since they were grouped in large categories (hierarchical levels), it would not be possible to differentiate movements occurred *between* ACPs from movements occurred *within* ACPs. For this reason, the migratory exchanges occurred within the same levels - the diagonal of the origin-destination matrix – were not considered, to avoid overestimation of flows within the upper levels. Despite this limitation, it is worth reminding that the main focus of this investigation are the changes in migration patterns *between* levels, in order to study if a process of deconcentration is in progress in the urban system.

Figure 19 shows the migration flows through the urban hierarchy in the five-year periods prior to the censuses of 1991, 2000 and 2010. Since *relative* volumes are depicted, the total area of the arrows is the same in the three periods. The most noticeable feature of Figure 19 is that, while migratory movements up the urban hierarchy decreased over time, the majority of downward flows increased, suggesting a "counterurbanization" trend in the sense of migratory movements downward the urban hierarchy, as proposed by Mitchell (2004). The changes are particularly significant in the extreme categories: while movements from Metropolises and Regional Capitals to Local Centres presented a sharp increase, the respective counter streams reduced over time.

[40] The 179 municipalities included in the first level (metropolises), e.g., are part of the ACPs corresponding to São Paulo (the Great National Metropolis), Rio de Janeiro and Brasília (National Metropolises) and Manaus, Belém, Fortaleza, Recife, Salvador, Belo Horizonte, Curitiba, Goiânia and Porto Alegre (simply Metropolises).

Figure 19 – Migration Flows through the Brazilian urban hierarchy, 1986-1991 to 2000-2010



Source: 1991, 2000 and 2010 Demographic Censuses. Prepared by the author.

While Figure 19 have the advantage of allowing the visualization of flows and counter flows simultaneously, Figure 20[41] shows the net result of these exchanges, that is, the net migration flows through the urban hierarchy. The arrows represent absolute values of net migration, which substantially reduced over time. Considering the migratory exchanges between all categories, the upper levels showed a positive net migration in relation to the ones below them (with the exception of the exchanges between Metropolises-Regional Capitals and Zonal Centres-Local Centres in the last two periods), what contradicts the before mentioned "counterurbanization" trend. Nevertheless, it is significant that the largest population increase due to migrations was not in the Metropolises level, but in the second highest level of Regional Capitals. Moreover, the biggest migratory gain downwards the urban hierarchy in the three periods considered is the result of the exchanges between Metropolises (1st level) and Regional Capitals (2nd level), which suggests a *relative deconcentration* of the urban system. Although Regional Capitals can be under the influence of Metropolises, they have their own hinterlands and are positioned outside the boundaries of the first level, due to the way urban centres are classified in REGIC 2007, what means that important secondary centres are being strengthened in the urban network (including state capitals not included in the first level but also urban centres of regional relevance).

From the 1970s onwards, the concept of intermediate cities based on the functional notion of intermediation or connection within the urban system (Amorim Filho e Serra, 2001, p.19) - closely represented by Regional Capitals in REGICs classification[42] - started to overcome the traditional definition based simply on population volumes. Intermediate cities started to be characterized as dynamic and strategic centres with the power to promote the articulation between metropolises and smaller cities and rural areas. In what regards migrations, more specifically, Amorim Filho and Serra (2001) and Correa (2007) support that the accelerated growth of metropolises since the middle of the last century imposed an additional function to this category of cities: its capacity to absorb part of the flows from smaller cities or rural areas

[41] These figures were inspired by Bell et al. (forthcoming).

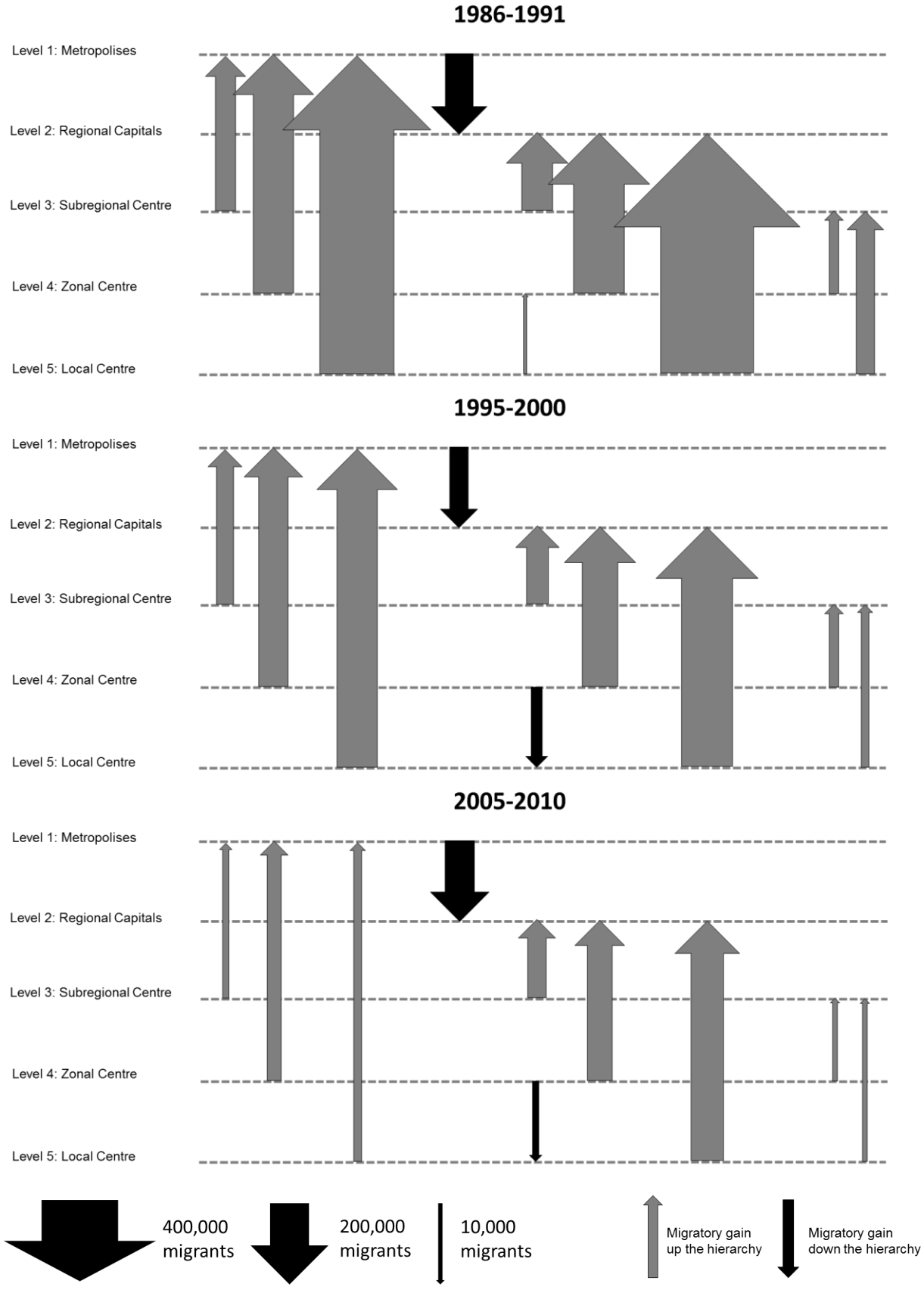
[42] Regional Capitals are defined as urban centres that have a regional area of influence and territorial management capacity immediately inferior to the metropolises, being referred as destination for a set of activities by a large number of municipalities (IBGE, 2008). Corrêa (2007, p.31) states that intermediate cities, in what regards its position in the urban system, is the equivalent to what is known as "Regional Capitals" in the scientific literature. Similarly, Andrade and Serra (1998), who used the 1978 edition of REGIC to identify intermediate cities in the 1970s, highlighted the strong identification between intermediate cities and the position of Regional Capital in the urban system (Andrade and Serra, 1998, p.23). Still, it is important to highlight that states capitals that were not included in the "Metropolises" category were included in this one.

through the provision of job opportunities could help to avoid the strengthening of social problems on large cities. This attribute would be one of the reasons why the topic of intermediate cities received so much attention since the 1970s, given that the national urban system was marked by deficiencies and a poor spatial distribution of dynamic intermediate urban centres, an obstacle for an effective interiorization and diffusion of development (Amorim and Serra, 2001).

Since the 1970s, with the formation of agglomeration diseconomies (especially in the Southeast) and consequent slowdown of the process of metropolization, intermediate cities started to grow in importance in the Brazilian urban network, as mentioned by several authors (Amorin Filho e Serra, 2001; Matos e Baeninger, 2004; Brito, 2006; Correa, 2007). By this time, some metropolitan regions consolidated as poles of attraction of migrants already showed signs of loss of attraction power in benefit of intermediate urban centres, as suggested by Figure 20. About the growing importance of intermediate cities in Brazil, Matos e Baeninger (2004) states the following:

> *"The beginning of the process of urban deconcentration in Brazil is, in fact, related to the predominance of urban-urban migratory movements, starting in the 1970s. This phenomenon has directly contributed to the diffusion of the urbanization process to the rest of the country, through a more dispersed and internalized urban network, where an unprecedented expansion of many medium-sized urban centres with important areas of influence". (own translation)*

Figure 20 – Net Migration flows through the Brazilian urban hierarchy, 1986-1991 to 2000-2010



Source: 1991, 2000 and 2010 Demographic Censuses. Prepared by the author.

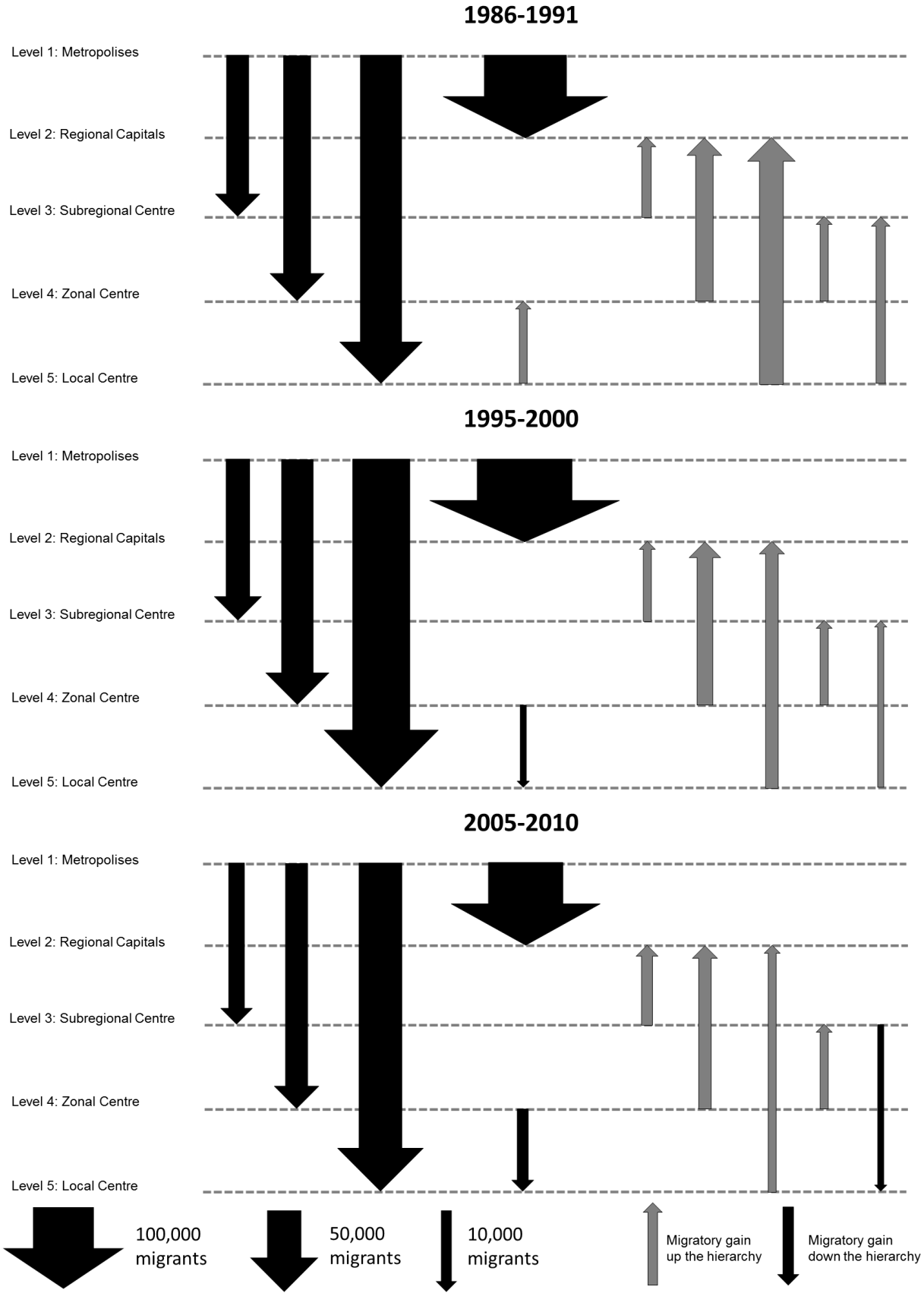
Although the conceptual model regards the national settlement system, the same figures showing population exchanges between urban hierarchical levels will be presented for the subnational spaces corresponding to the "core region", that is, the "São Paulo-Rio de Janeiro axis". Thus, figures 21 and 22 represent only migrations occurred within the states of São Paulo and Rio de Janeiro, respectively. In both, the most prominent migratory movements are from the highest level downward the urban hierarchy, as would be expected from the third stage of the conceptual model ("intraregional deconcentration") onwards.

The first level of Figure 21 – corresponding to the "São Paulo ACP" - lost significant amounts of migrants to all other levels in all periods considered, but especially between 1995 and 2000. In the following period, these losses were reduced, but the overall configuration of flows was maintained. Another feature of this graphic that stands out is the positive migration gain of the second level ("Regional Capitals") in all periods. The third level ("Sub-regional Centres") also showed a positive net migration but in a much lesser extent, suggesting the relative decompression of the urban network in the state of São Paulo. The overall pattern and directions were maintained through all periods, with two exceptions – the tendency of "Local Centres" to lose migrants to "Zonal Centres" and "Sub-regional Centres" was reversed (in the second and third period, respectively), reinforcing the counterurbanization trend in the sense of a migratory movements downward the urban hierarchy.

Figure 22, which refers to migrations occurred within the state of Rio de Janeiro, shows an even stronger "counterurbanization" trend (in relative terms, because the net migration flows are much smaller), but with some particularities in comparison with São Paulo. The first level, which corresponds to the ACP of Rio de Janeiro, showed increasingly migration losses in relation to all other levels, with the exception of the second. In the first two periods, the only migratory gain in the Metropolises level came from Regional Capitals and this tendency was reverted in the last period, reinforcing the tendency of deconcentration of the urban system of Rio de Janeiro. Between 2005-2010, the forth level of Zonal Centres was the only to show a migratory loss up the urban hierarchy (to the second and third levels). A highlight of this figure is the positive migratory gains of Local Centres (lowest level), which significantly increased overtime. Another stand out feature is the migratory gains of Sub-regional Centres (3rd level), mainly from the Rio de Janeiro ACP and even from Regional Capitals, the most prominent level in the case of the state of São Paulo.

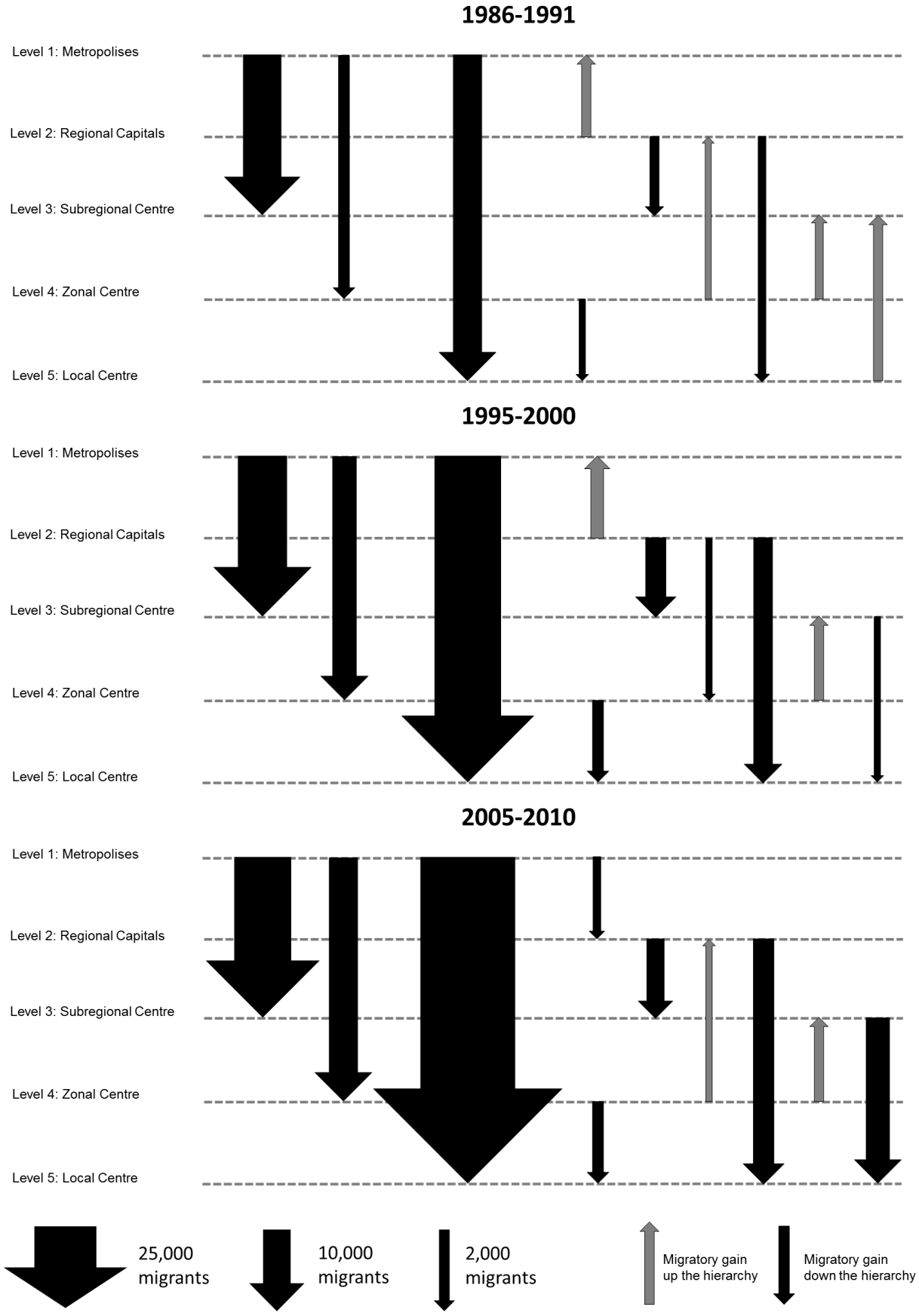
The differences observed between internal migrations in São Paulo and Rio de Janeiro shows that there is a regional heterogeneity in what regards processes of population (re)distribution even within the core region. Considering the overall patterns of flows in the Brazilian urban system and the patterns shown by the states that forms the “core region” of the national settlement system, it is possible to infer that a pattern of *concentration* in the superior levels of the urban hierarchy is predominant in the rest of the country. The prominence and high migratory gains of Regional Capitals is particularly relevant, because if new agglomeration economies are being formed outside the core region, it would indicate an ongoing process of interregional deconcentration, characteristic of the fourth stage of the conceptual model. The fact that the most important metropolises are growing at a slower pace in comparison with the rest of the country and the tendency of reduction of the proportion of metropolises cores populations also points out in this direction. The study of the spatial structure of internal migrations in Brazil can help to clarify these matters and it will be the focus of the next chapter.

Figure 21 – Net Migration flows through the urban hierarchy, São Paulo, 1986-1991 to 2000-2010



Source: 1991, 2000 and 2010 Demographic Censuses. Prepared by the author.

Figure 22 – Net Migration flows through the urban hierarchy, Rio de Janeiro, 1986-1991 to 2000-2010



Source: 1991, 2000 and 2010 Demographic Censuses. Prepared by the author.

6 – THE EVOLUTION OF MIGRATION NETWORKS AND VECTORS OF POPULATION REDISTRIBUTION IN BRAZIL

6.1 Brief Introduction to Spatial Network Analysis

> *"If recent views on the organization of territories indicate a reticular pattern, then the geographical science and regional studies urgently need tools that allow understanding networks from the perspective of relationships between places, helping to unveil the structures behind connections and the patterns and regularities that govern spatial interactions" (Braga, p.22, 2011, own translation).*

Network Analysis is an interdisciplinary theoretical and methodological framework, developed through contributions of Mathematics, Social Sciences, Biology, Computer Sciences and several other areas. It can be used to study a wide variety of structures, such as social, technological, spatial, biological and informational networks. Besides having a rigorous formalization and clear representation, network analysis allows the transcendence of scales in an integrated, dynamic and multidimensional approach (Hanneman and Riddle, 2005; Prell, 2012; Borgatti, 2013).

Networks are systems of relations, nodes and its positions. A network may be defined by its *structure* – nodes and links - and by its *dynamics,* the result of the interactions between nodes. They are modelled by geometric representations called "graphs" or matrices. Graphs are mathematical models formed by nodes, points or vertices - representing objects or actors within the system - and ties, links or connections - which represent the relationships in the system (Hanneman and Riddle, 2005; Prell, 2012; Borgatti, 2013). In the matrices used in Network Analysis, the nodes are arranged in columns and rows and the cells are filled with the values corresponding to the relations between nodes. This form of representation differs from traditional research, where observations (cases or actors) are usually represented in rows and the variables or attributes in columns. However, it is noteworthy that the network approach does not replace the traditional analysis of attributes, but tries to capture the "emergent properties" of relations (Soares, 2002) that do not exist in isolated actors, a dimension usually ignored in the Social Sciences.

Besides the problem of access and knowledge of Network Analysis tools, the lack of relational databases is pointed out by Braga and Fazito (2010) as one of the greatest barriers for the diffusion of Network Analysis in the Social Sciences. Nonetheless, since migration studies typically works with origin and destination matrices, the Network Analysis approach is particularly well-fit for the field. It can enrich traditional analysis of compositions and volumes of population flows and provide a deeper understanding of migration processes. However, the transposition of Social Network Analysis concepts for *Spatial Network Analysis* requires some cautiousness.

Spatial Network Analysis refers to the relations between a specific category of nodes, that is, the connections formed between places - in the case of this research, the places of origin and destination of migrants. The "actors" of spatial networks, unlike in social networks, are not agents with motivations and intentions. Therefore, it is reasonable to assume that the rules that govern the relationships in these networks will be different. On the other hand, it can be argued that the formation of ties between places is made by population flows and, therefore, migration networks can be considered as social networks formed in space. According to Braga and Fazito (2010), "it is no exaggeration to assume that the relationship between places reflect ties between individuals".

Network Analysis methods seek to study the nature of connections using relational data and tools to instrumentalize the network concept by representations and algorithms. Formal methods can give more “substance” to the investigation of migration networks, rather than the more common use of this concept as a simple metaphor (Soares, 2002). It allows more than simply quantify population flows, but *formalize the theories of migration networks* through statistics and mathematics. According to these theories, the establishment of networks connecting migrants with the people on their origin areas would increase the chances of success and decrease the risks and costs of migration. This means that the interaction and interdependence of different factors that reinforce each other tend to consolidate migration networks and related institutions, strengthening flows over time and space. Thus, the networks would constitute a form of social capital that could increase migration probabilities in origin areas through the self-sustaining and diffusing process of "cumulative causation" (Massey, 1993).

Network Analysis have the potential of creating a “bridge” between "agents" and "structures", dimensions frequently opposed in the migration theory literature. There is a long-standing

conflict between the “historical-structuralist" perspective - which defends that the formal constraints of macro-structures are the main determinants of migrations - and the “neoclassical” or “functionalist” approaches – which supports the preponderance of individual agents. Network Analysis can be an alternative to the reductionism of these perspectives, enabling the transcendence of scales, allowing the simultaneous apprehension of micro and macro perspectives in an integrated and dynamic approach. The simultaneous use of "ego-centred" and "whole network” analysis allows the simultaneous study of the complete system (the network structure) and its component parts (nodes). Since networks are overcoming continuous and contiguous spaces as the most prominent form of spatial-territorial organization, the study of changes in the topology of networks can shed light in the spatial structure of migration. This knowledge can be very useful for policy making and urban and regional planning. As stated by Braga and Fazito (2010), “the knowledge of the structure and organization of social networks can be valuable to interact with them, exploit their potential or even plan their development”.

6.2 Formal description of the Brazilian migration networks

The theoretical and methodological framework of Network Analysis assumes that networks have universal properties that can be described by some synthetic measures, such as size, number of connections, density, transitivity, clustering, reciprocity and others. In this section, we explore the analytical potential of these indicators to deepen the connectivity dimension and examine the evolution of the Brazilian migration networks since the 1980s[43]. Microregions are used as the basic spatial unit of analysis and, besides the “fixed interval” variable, “last move” data is also used in the construction of the migration matrices. Even though it were not available in the 2000 census[44] for the microregional level, “last move” data

[43] These analyses were inspired by the work of Braga (2011), who examined the evolution of the Brazilian migration networks from 1970s to 2000. Nevertheless, because of inherent limitations of the data hitherto available, the migration networks could not be build using the same census type of data and neither the same spatial units of analysis. In order to make an *indirect comparison*, the author used "fixed interval" data of the 1991 and 2000 censuses and "last move” data encompassing the five-year periods prior to the 1980 and 1991 censuses (to cover the same period of time). In the “fixed interval” migration networks, microregions were the basic spatial units of analysis and in the “last move” networks, "Minimal Comparable Areas" had to be used, because microregions had not yet been defined in the 1980 Census. In this thesis, the 1991, 2000 and 2010 migration networks could be analysed and compared directly, due to the availability of microdata of the 2010 Census.

[44] For more information on Brazilian census data and its changes over time, see Cunha (2012).

is more appropriate and representative of territorial connections formed by migratory flows. Besides omitting all migrants under age five years and not capturing intermediate migrations occurred in the five-year periods prior to the censuses, the “fixed interval” measure have a shorter temporal coverage, of only five years. “Last move” can cover the whole decade prior to the censuses and, since migration is a relatively rare event, it is reasonable to include the variable that provides a greater sample (even though the spatial structure of migration flows is not significantly influenced by the chosen type of data). The diagonal of the matrices was disregarded, because it represents movements made within the same spatial unit where the respondents lived by the time of the census.

As the calculation of most network metrics requires the dichotomization of data, a threshold was established to indicate the presence or absence of a link between microregions. Following the same criteria adopted by Braga (2011) in his analysis of the evolution of Brazilian migration networks from 1970 to 2000, only the connections between microregions formed by more than 30 migrants were considered significant. This value is close to the medians average of the migration matrices of 1980, 1991, 2000 and 2010, which means that nearly half of all cells of the origin-destination migration matrixes regarding these periods were omitted. The exclusion of the least voluminous flows was made to avoid an “artificial overload” of the number of connections in the dichotomized matrix and, consequently, the overestimation or underestimation of network metrics. Thus, the cells with values above this threshold were filled with the number 1; where no migrations took place or where they occurred below the established threshold, the corresponding cells were filled with the value 0 in the origin-destination matrix. All network metrics presented in this section were computed using UCINET, a software specialized in the analysis and modeling of social networks (Borgatti et al, 2013).

Table 3 shows a general description of the connections between microregions formed by migration flows. Since the number of microregions did not change since the 1991 Census, all networks have the same *size* (same number of nodes) and, thus, the same possible number of connections (calculated as n(n-1)). The *number of connections* is the number of links effectively established in the network, i.e., the pairs of microregions that exchanged over 30 migrants. The *general density* is the ratio between the number of connections and the number of possible connections. Braga and Fazito (2010) had already pointed out the paradoxical increase of the Brazilian migratory networks cohesion despite the relative decrease in the volume of migrants in their analysis regarding the period from the 1970s to

the 1990s. It is noteworthy that, even with an absolute decrease of 8,6% in the volume of migrants from 1995-2000 to 2005-2010, the network density from 1995-2000 to 2005-2010 was kept stable, at around 10%, according to the "fixed interval" data. This apparent low degree of integration is not surprising, taking into account the high number of microregions and the magnitude of the Brazilian territory As seen in Chapter 4, connectivity is scale dependent - the lower the number of spatial units, more connected will be the spatial network. In order to further evaluate the apparent shift of recent historical tendencies in what regards the cohesion of the Brazilian migratory networks, other metrics can also be used, as the Cluster Coefficient and reciprocity.

The *Cluster Coefficient* is the average density values of the neighbourhoods of all nodes in a network. In Network Analysis, neighbourhoods do not regard physical contiguity or Euclidian distances, but the existence of a direct connection, without intermediaries, between nodes[45]. The values shown in Table 4 were weighted according to the size of the local neighbourhood, i.e., nodes with larger neighbourhoods get more weight in the computation of the average density (the referential node or "ego" is not counted in the calculation). This measure is very useful to evaluate how local arrangements are more connected than the entire network and can be compared with the overall network density (Hanneman and Riddle, 2005). Table 4 shows that the neighbourhood density is much higher than the overall density of the network, which indicates a hierarchical network topology. The increasing degree of clustering over the analyzed period indicates a greater concentration around central nodes ("hubs"), which does not contradicts the idea of deconcentration of migration flows. The Cluster Coefficient is an average, regarding the network as a whole, and the aforementioned trends of network density suggests the "fragmentation" of flows (despite the reduction in the number of migrants), that is, the multiplication of spaces able to attract and provide migrants. If new "hubs" are being formed outside the core regions, it would be an indicative of a process of population deconcentration in the national level, characteristic of the fourth stage of the conceptual framework.

In directional networks, the *reciprocity* indicates the ratio of dyads (pairs of nodes) that have reciprocal ties and the total number of dyads ("dyad method"). This measure can also be used to analyze the cohesion of a network, since a greater number of dyads with reciprocal

[45] In this work, "neighbourhood" refers only to *first order* neighbours ("one-step neighbourhood"). This concept can be expanded to include neighbours of second, third order or more, that is, neighbours connected by a path greater than one.

links in a network suggest greater stability and strength of association between the nodes (Hanneman and Riddle, 2005). Regarding migrations, the formation of counter streams was referred in the literature since the very beginning of migration studies (Ravenstein, 1885). In the case of return migrations, it works as permanent channels of relations between places historically linked by population flows, configuring social networks through migrations (Braga, p.18-19, 2011). Table 4 shows a growing reciprocity in the connections between microregions, an indicator of bigger network cohesion, suggesting a decreasing polarization between places of attraction and repulsion (i.e., a smaller spatial inequality in what regards migration) and an increase of circularity. These findings are consistent with the statements of Baeninger (2011, 2012) about the new migrations dynamics in Brazil. This author supports that internal migrations assumed a more reversible character, which concerns both the areas of origin and destination, with increasing comings and goings, refluxes, re-emigration and other stages: "*The 21st century announces the expansion of migration spaces in Brazil, marked by the growth of areas of migratory turnover*" (Baeninger, p. 100, 2012).

Table 4: General description of the migration network connections between microregions, 1980-2010

	"Fixed interval" Migration			"Last Move" Migration	
	1986-1991	**1995-2000**	**2005-2010**	**1981-1991**	**2000-2010**
Size of the network	558	558	558	558	558
Possible connections	310,806	310,806	310,806	310,806	310,806
Number of connections	28,863	30,606	30,579	38,318	44,383
General density	0.093	0.098	0.098	0.123	0.143
Cluster coefficient (weighted)	0.276	0.284	0.290	0.316	0.341
Total reciprocity (%)	39.9	43.68	43.99	44	48.42

Source: IBGE, 1991, 2000 and 2010 Brazilian Demographic Census. Prepared by the author.

Another way to study the cohesion of a network is observing the triads - the fundamental core of cluster formation. Transitivity is a network property which assumes that, if A is connected to B and B is connected to C, there is a great probability that A will be connected to C. Thus, a 'transitive triad" is a group of three interconnected nodes (Hanneman and Riddle, 2005). Despite the small percentage of transitive triads (the ratio of the number of transitive triads and triads of all kinds) in all periods analysed (Table 5), in relative terms, the number of transitive triads showed a growth of 43.4% from 1991 to 2010, considering "last move" data. "Fixed interval" data provides a more detailed picture of this trend: after a growth of 18.9% from the first five-year period to the second, the number and proportion of transitive triads remained stable from 1995-2000 to 2005-2010, indicating that the growth in the number of

transitive triads was not linear during the period considered. The number of triads with at least two nodes connected presented similar tendencies: an increase of more than 20% from 1991 to 2000 ("fixed interval" data) - suggesting the reduction of structural holes[46] and "densification" of the network - and a relative stagnation from 2000 to 2010 (from 1991 to 2010, according to "last move" data, the increase in the number of triads with at least two nodes was 36.6%). One explanation for the big differences observed between "last move" and "fixed interval" data is that the former is the only one able to capture short-term return migration movements, that is, occurred within the five-year periods prior to the censuses.

Like in the analysis of density, it is important to remember the decrease in the number of migrants in this period, which means that the stability in the number and proportion of transitive triads is actually a sign that migratory flows are more fragmented than they were in the past (with means that the migration network is more cohesive). The *Transitivity* indicator measures the proportion of transitive triads in relation to the total number of triads that have only two connections. It remained essentially at the same level during all the periods considered and seems to confirm the abovementioned tendencies that the ties between places are stronger and more stable.

Table 5: Transitivity in the migration network between microregions, 1980-2010

	"Fixed interval" Migration			"Last Move" Migration	
	1986-1991	**1995-2000**	**2005-2010**	**1981-1991**	**2000-2010**
Total number of triads	172,808,136	172,808,136	172,808,136	172,808,136	172,808,136
Number of triads with at least two connections	2,555,018	3,076,228	2,992,696	4,208,629	5,748,184
Number of transitive triads	837,313	995,769	998,692	1,540,977	2,209,498
Percentage of transitive	0.48	0.58	0.58	0.89	1.28
Transitivity (%)	32.77	32.37	33.37	36.61	38.44

Source: IBGE, 1991, 2000 and 2010 Brazilian Demographic Census. Prepared by the author.

Table 6 shows the geodesic distances of the migratory flows between microregions. In network analysis, distance refers to the shortest path between two nodes, that is, the minimum amount of steps that separates them. Therefore, a widely used synthetic measure is the *average distance* - the arithmetic mean of all values of the matrix - which gives an idea of how close are the nodes in the network (Hanneman and Riddle, 2005). The average

[46] A structural hole in a triad occurs when one node is connected to two others, who are not connected to each other. As networks grow in size, they tend to become less dense and present more "structural holes", which distribution can be a source of "inequality" among nodes (Hanneman and Riddle, 2005).

distance remained stable over time, but the *diameter* of the network - the largest distance between the nodes of a network – decreased over time, a trend shown by “fixed interval” and “last move” data, indicating that the Brazilian migration network is becoming more compact.

The *geodesic paths* refer to the number of "efficient ways" connecting two nodes in a network, i.e., shows the redundancy of ties and how close the nodes are together - the higher the value, the greater the number of alternative options or paths connecting two nodes (Hanneman and Riddle, 2005). Thus, the average geodesic path between all nodes is also an indicator of cohesion and articulation within the network. Both “fixed interval” and “last move” data shows an increase in the average geodesic paths in the periods considered, suggesting better articulation between places, that can be translated in more transmission channels of capital, goods, services etc.

Table 6: Geodesic distances of the flows between microregions, 1980-2010

	"Fixed interval" Migration			"Last Move" Migration	
	1986-1991	**1995-2000**	**2005-2010**	**1981-1991**	**2000-2010**
Average distance	1,993	1,963	1,988	1,921	1,886
Diameter	4	3	3	4	3
Average geodesic paths	10,590	11,350	13,254	12,413	15,474

Source: IBGE, 1991, 2000 and 2010 Brazilian Demographic Census. Prepared by the author.

Connections between spaces are not established only through population flows, but through multiple types of connections, material and immaterial. But migration is much more than merely population movements in space, it is a mechanism of diffusion of knowledge, skills and values, the perfect proxy for the study of territorial connections. Networks created by migratory flows connect people, institutions and places and reflect large economic, social and geopolitical structures. Its increasing cohesion and stability reflects the strengthening of the network mode of spatial territorial organization, as postulated by the conceptual model. Besides that, if the “fragmentation” of migration flows and emergence of new “spaces of migration” are indicating the emergence of new agglomeration economies outside the core regions, it can support the argument that Brazil is transitioning to the fourth phase of the conceptual framework. In the next section, the spatial vectors of population (re)distribution will be studied in order to clarify if the Brazilian migratory network is strengthening and expanding significantly beyond the limits of the core region of the São Paulo-Rio de Janeiro axis.

6.3 The spatial structure of Brazilian migration networks

This section has the purpose to address the *absolute and relative* redistribution of the Brazilian population by exploring the spatial vectors of internal migration over time. Besides traditional migration flows maps, an "interaction component" - regarding the strength of connectivity between the places of migration origin and destination - will be visually represented in a series of maps at different spatial scales[47]. It is possible to standardize the values of an origin-destination matrix and eliminate the effect of population sizes in a way that better reflects the spatial structure of migration. To do so, a multiplicative component model, as proposed by Raymer and colleagues (2015), was adopted[48]. Through this methodology, is possible to generate the interaction component, which can be useful for describing and analysing migration patterns over time, reveal migration sub-systems and explore the strength of spatial connections beyond the simple consideration of flows magnitudes. Its calculation is made through a simple multiplicative decomposition, as shown below:

$$nij = (T)(Oi)(Dj)(ODij)$$

where n*ij* is the observed migration flow from origin *i* to destination *j,* T is the total number of migrants, O*i* is the proportion of all out-migrants leaving from area *i*, D*j* is the proportion of all in-migrants moving to area *j* and OD*ij* is the interaction component. By restructuring the formula, as presented below, it is possible to see that the interaction component can be interpreted simply as the ratio between observed and "expected" migrations flows. The "expected migration" between *i* and *j* is the amount of migration expected considering the total volume of migrants that leave area *i* and the total volume of migrants that reach area *j* in a certain period (in relation to the total volume of migrants), as if distances between places did not matter and as if all spatial units had the same probability of being connected to each other. The "expected migration" ignores the "distance decay effect", that is, the tendency of decline in the interactions between places as the distance between them increases. Thus,

[47] The interaction component maps and migration flows maps were produced for the level of states, mesoregions and microregions and are available in the appendix. Only the most representative maps were displayed in the thesis.

[48] Charles-Edwards et al. (2016) also used this approach to study internal migrations in Australia.

interaction components with values above 1 represent stronger interactions than expected and vice versa.

$$ODij = \frac{nij}{((T)(Oi)(Dj))}$$

It is reasonable to expect a great *spatial dependence* in the interaction component matrix because of the higher probability of migratory exchanges between places located near each other (that is, the interaction component between adjacent areas has the tendency to be higher than between distant areas). This empirical regularity is widely observed since the beginning of migration studies - in the pioneer work “Laws of migration”, Ravenstein (1885) stated that “the majority of migrants move a short distance”. It is also coherent with the “First Law of Geography” proposed by Waldo Tobler (1970), which postulates that "everything is related to everything else, but near things are more related than distant things”. That said, in order to partially compensate the spatial dependence on the interaction component matrix, maps excluding the connections between contiguous spatial units were also produced.

Before exploring the interaction component maps, an overview of the main Brazilian internal migration streams will be provided. Figures 23 shows the spatial configuration of the 400 biggest migration flows between mesoregions regarding the five-year periods prior to the census of 1991, 2000 and 2010. The most evident aspect showed by these maps is the importance of Metropolitan Region of São Paulo in the redistribution of the Brazilian population, followed by the national metropolises of Rio de Janeiro and Brasília. Important migration flows connects the Metropolitan Region of São Paulo to several locations in the Northeast, the state of Minas Gerais, the north of Paraná and within the state of São Paulo itself. The strong flows between the Metropolitan Region of São Paulo and the mesoregions containing the main state capitals of the country reinforce its role as the “Great National Metropolis” (IBGE, 2008)[49]. Despite the relative decrease in the number of migrants in the last decades and the absolute decrease shown in the 2010 Census, the migratory flows to and from the Metropolitan Region of São Paulo remained the most important vectors of population redistribution in the country.

[49] The microregion of São Paulo, the mesoregion of the Metropolitan Region of São Paulo and the state of São Paulo show the same pattern of polarization in their respective levels, which is not surprising, considering that São Paulo is, by far, the most populous metropolitan region of the country.

The Metropolitan Region of Rio de Janeiro follows São Paulo as the second most important place of migration origin and destination of the country, with a diverse set of far-reaching connections, with particular reference to Northeast mesoregions containing state capitals (what indicates the importance of urban-urban flows). It also shows significant migration flows with the surrounding mesoregions of Rio de Janeiro, adjacent states and the Federal District of Brasília, the other "national metropolis", according to REGIC 2007 classification (IBGE, 2008). Although Brasília has a much smaller population in comparison with the metropolitan regions of Rio de Janeiro and specially São Paulo, it stands out as an important place of origin and destination for far-distance migrants. Since these maps are representing migration flows in absolute numbers, it is not surprising that the mesoregions with the biggest populations also present some of the biggest migration flows volumes in the country. That is why mesoregions belonging to the North and Centre-west are not so prominent, since both macroregions have the lowest populations and demographic density of the country.

It is noteworthy that the biggest migratory flows in the country, in the three periods analysed, are two sub-systems characteristic of the second and third stages of the conceptual model - "spatial concentration" and "intraregional deconcentration" – respectively, the flows connecting the São Paulo-Rio de Janeiro axis with the Northeast and those flows directed from the Metropolitan Region of São Paulo towards other mesoregions of the homonymous state (a pattern also observed in the state of Rio de Janeiro, in a lower degree)[50]. The tendency of inertia in population movements shows that emerging patterns of migration tend to overlap previous ones, instead of simply substituting them. Therefore, the continuity of migration sub-systems, by itself, cannot serve as an argument against the development towards the following stages of the conceptual model. In the last few decades, several important changes have been taking place in the national level: the relative "decompression" of the national urban system and emergence of new agglomeration economies outside the São Paulo-Rio de Janeiro axis, the changing patterns of migrations regarding different dimensions (as seen in Chapter 4), the changing patterns of flows between urban hierarchical levels (as seen in Chapter 5), changes in migration networks topologies (as seen in the present chapter) and significant changes in the patterns of population redistribution in other regions of the country, as will be seen below.

[50] As seen in Chapter 4, there was a time lag between the productive restructuration of the 1970s and the resulting changes in migration dynamics, since the bigger impacts of the spatial redistribution of industrial activities on population movements became evident only in the 1980s.These same patterns can also be observed at the microregional level.

In order to better visualize the changes in the main vectors of redistribution of the country, Figure 24 shows the spatial configuration of the 400 biggest migration flows between mesoregions regarding the same periods than Figure 23, but excluding the states of São Paulo, Rio de Janeiro and the Federal District (where the top tree urban centres of the country are located, according to REGIC's 2007 classification (IBGE, 2008)). By removing these spatial units, other migration sub-systems become immediately visible. One of the most prominent is the migration flows connecting the states of the South with the states of Mato Grosso, Mato Grosso do Sul and Rondônia, some of the main agricultural frontiers in Brazil until the end of the XX century. Historically, the traditional form of frontiers occupation in Brazil is by the establishment of small properties with purposes of subsistence agriculture. However, these traditional "peasant fronts of occupation" started to be gradually substituted around the 1960s by more capitalist forms of occupation, with the implementation of large agricultural projects by big companies or medium-sized projects of migrant farmers from the South, which Sicsú and Lima (2000) call "capitalist family activity".

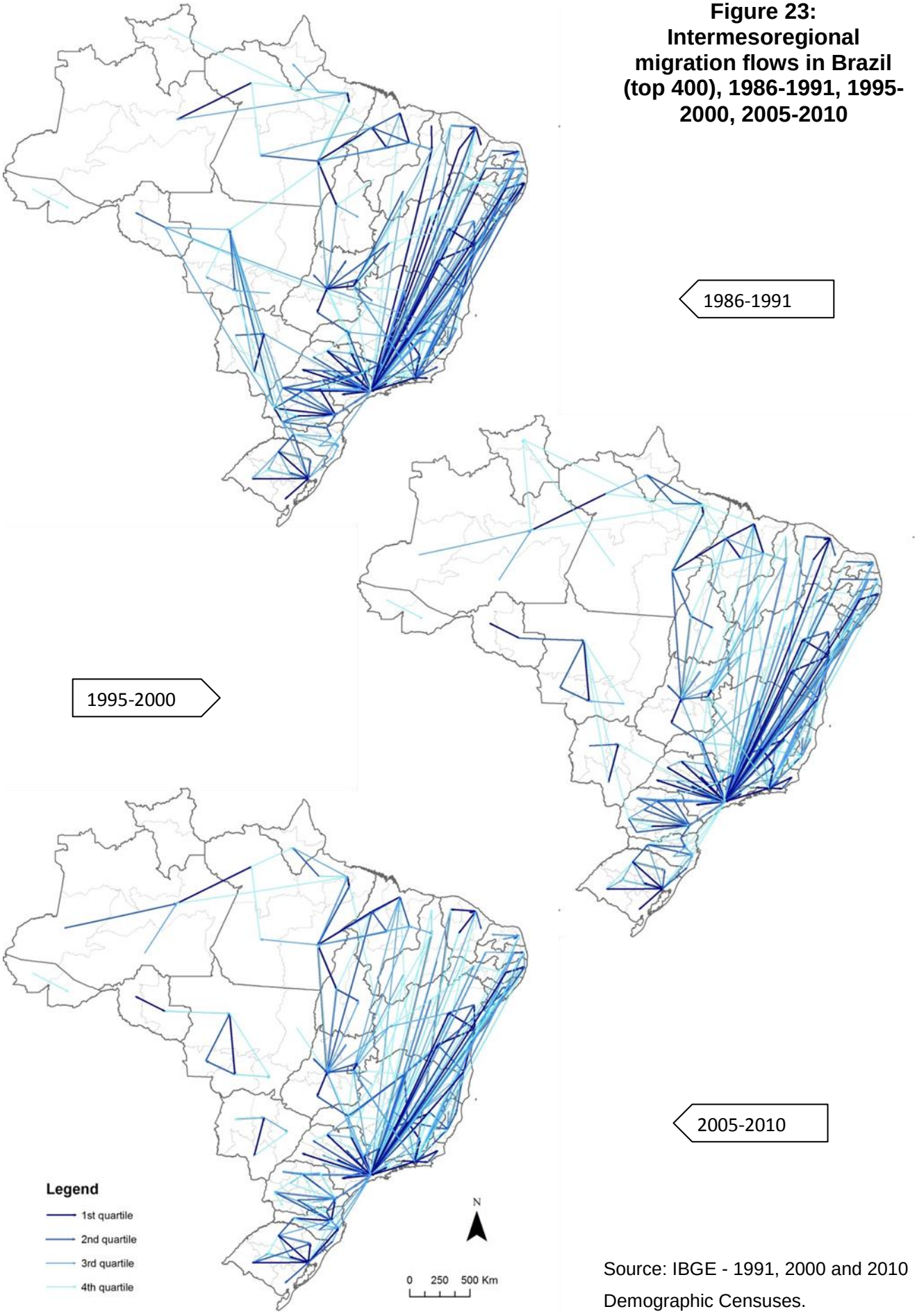
The abovementioned migration sub-system seems to be losing its force in the last decades, as more modern and capitalist forms of grain production and cattle raising in large scales - with reduced demands for labour force – begins to prevail. According to Sicsú and Lima (2000), with the frontiers expansion occurred in the 1970s and especially from the mid-1980s onwards (with the agricultural modernization and establishment of large industrial conglomerates on the Centre-West), the pace of occupation of new lands tends to be reduced, either by the lower availability of affordable land or by the State's lower capacity of support and direct investment in infrastructure, indispensable to enable the capitalist exploitation of the frontier. Besides that, with the slow increase of the population caused by the reduction of fertility rates, there is less demographic pressure in areas traditionally characterized as sources of migrants. These changes are coherent with the postulates of the conceptual model, which states the reduction of migrations to "colonization frontiers" (3rd stage) and even its stagnation or retraction (4th stage) as countries become more modern, urban and industrialized and the distinction of rural and urban areas gets more and more blurred[51].

[51] An important exception is the mesoregion of "Sudeste Paraense", where the mineral province of Carajás is located, which showed a large set of far-reaching and stable connections, especially with other mesoregions of the state of Pará, the neighbour states of Tocantins and Maranhão and the state of Goiás.

Another important highlight is the state of Goiás, which presented a diverse set of substantial connections with neighbouring states and distant mesoregions of the North and Northeast, in all periods considered[52]. Goiás and Santa Catarina were the only two states that showed an increase in net migration between 1986-1991 and 2005-2010. The growing importance of these regions in what regards population (re)distribution is suggestive of a process of interregional deconcentration since they are located outside the "core region" of the national settlement system ("São Paulo-Rio de Janeiro axis"). In this sense, the mesoregions containing the other state capitals were very prominent regionally. Due to regional heterogeneity in what regards mesoregions sizes and density of occupation, the range of connections varies enormously in what regards distance. The immense "Centro Amazonense" region, for example, where the state capital of Manaus is located, is in the macroregion with the lowest population density in the country and have far reaching connections, but mostly with neighbouring mesoregions or states (especially Pará and Rondônia). The polarization of mesoregions containing state capitals is much higher in the Northeast, where the urban system is more unbalanced than in the South, which have the most equilibrated urban network in the country (as seen in Chapter 4). In this macroregion, there is a high circulation between mesoregions and the flows are not so polarized by the state capitals.

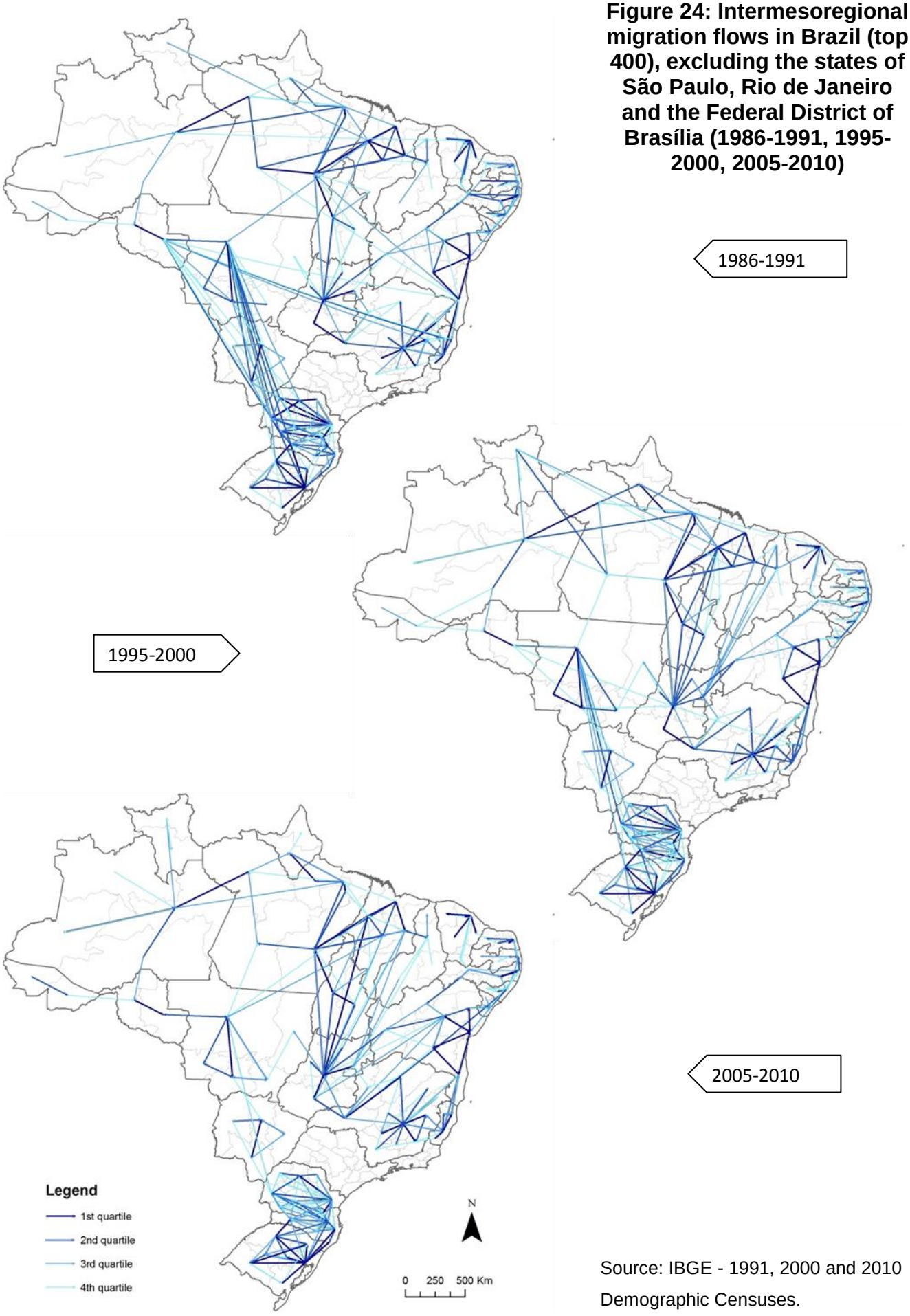
[52] However, the fact that the Federal District of Brasilia is located within its boundaries cannot be disregarded. Besides the "Centro Goiano" mesoregion, where the state capital is located, the mesoregions "Entorno de Brasília" (Brasília surroundings) showed the second most important exchanges.

Figure 23: Intermesoregional migration flows in Brazil (top 400), 1986-1991, 1995-2000, 2005-2010



Source: IBGE - 1991, 2000 and 2010 Demographic Censuses.

Figure 24: Intermesoregional migration flows in Brazil (top 400), excluding the states of São Paulo, Rio de Janeiro and the Federal District of Brasília (1986-1991, 1995-2000, 2005-2010)



Source: IBGE - 1991, 2000 and 2010 Demographic Censuses.

Given the strong focus on migration flows volumes, important migration sub-systems are frequently ignored in traditional migration analysis. The following maps show the interaction components between meso and microregions. Because they are dimensionless, the cells of the interaction component matrix have little analytical value by themselves but, considering the matrix as a whole, it is possible to visualize the main vectors of population redistribution (relative redistribution) in the Brazilian territory across time. One more time, the density of the migration networks was artificially established, in order to allow a clear visualization of the strongest interactions between the spatial units. Moreover, in order to avoid the inclusion of migration flows with negligible volumes, a threshold was established and all the interaction components representing flows below 500 migrants were suppressed, even if the interaction was strong. The represented interaction components and flows maps were divided into quartiles according to the strength of the connections (1st quartile represents the highest interactions).

Figure 25 shows the 400 strongest interaction components between mesoregions in the five-year periods prior to the censuses of 1991, 2000 and 2010, considering only flows above 500 migrants. Once again, the majority of flows are overlapped by its counter streams. The spatial dependence of migration interactions is clearly showed by the tendency of neighbouring mesoregions to establish stronger links. This trend seems to be reinforced over time, since several long distance interactions loss strength from the first to the last period, when flows seems to become more self-contained within certain regions, especially the South and Northeast. These two regions are contrasting not only in terms of socioeconomic development but also in what regards patterns of interactions, with the South showing a much less polarized structure and a more integrated migration system. This “regionalization” (Rigotti, 2006) tendency is even more visible in Figure 26, which shows the 200 strongest interactions disregarding those formed between adjacent mesoregions.

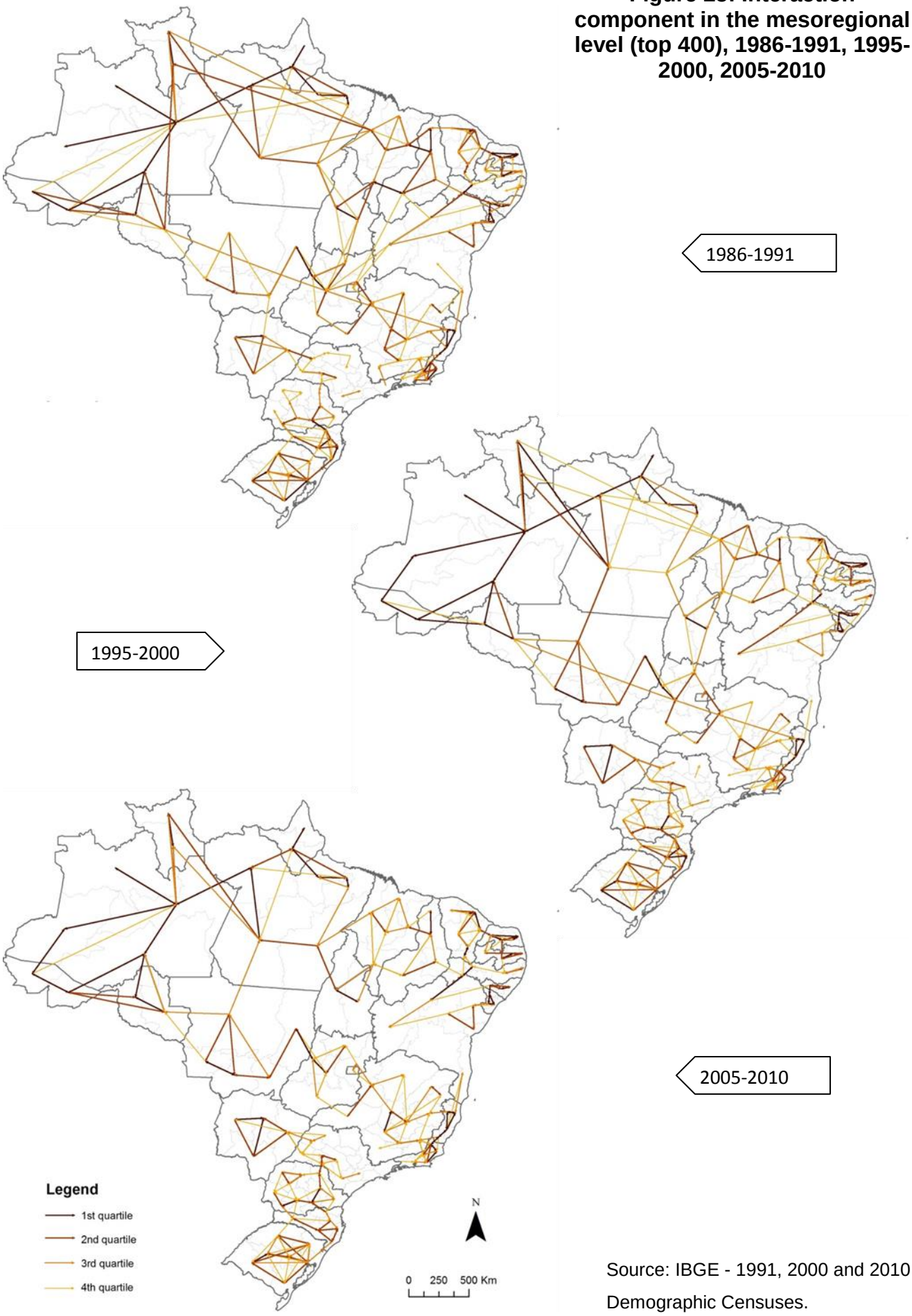
Figures 25 and 26 also show that areas with low indexes of connectivity (or simply “degree”) have bigger probabilities of creating preferential migration connections and, thus, stronger interaction components. The strength of some interactions in the North region, for example, can be explained by the little diversity of places of origin and destination related to states like Acre, Amapá and Roraima – the three less populated in Brazil – which contain a much lower number of connections than the states of the Southeast. For the same reason, the Metropolitan Region of São Paulo does not show lots of strong interactions - it is so connected with so many places that no privileged connections stand out.

If we look into a more disaggregated scale, due to the spatial dependence of interactions, the links between spatial units appear excessively scattered in the map (a manifestation of the scale effect of MAUP). Nevertheless, by applying the procedure of removing adjacent regions, new sub-systems can be identified, as shown in Figure 27, which presents the 500 strongest interactions between microregions (once again, considering only flows above 500 migrants). At this level of analysis, the polarization of state capitals, especially in the Northeast becomes even clearer. From the first to the last period, there was a decrease of far distance interactions in the North and Centre-West, result of the changes in the occupation of the Brazilian frontiers. On the other hand, a set of far reaching connections linking microregions of São Paulo and Minas Gerais (and in a lesser extent Goiás and Rio de Janeiro) with the Northeast started to stand out in 2005-2010.

The migration flows and interaction component maps represent very clearly what Baeninger (2011) considers the two main redistributive vectors of population redistribution in the country: the first would be the "*metropolitan migratory dispersion*", marked by large volumes of return migrants from the Southeast to the Northeast and, in an intraregional level, by significant flows from metropolises to the countryside[53], what would characterize a counterurbanization *process* in Mitchells (2004) conceptualization. The second vector would be the "*migratory internalization*", characterized by the increase in short distances flows and greater retention of migrants in the states and regions.

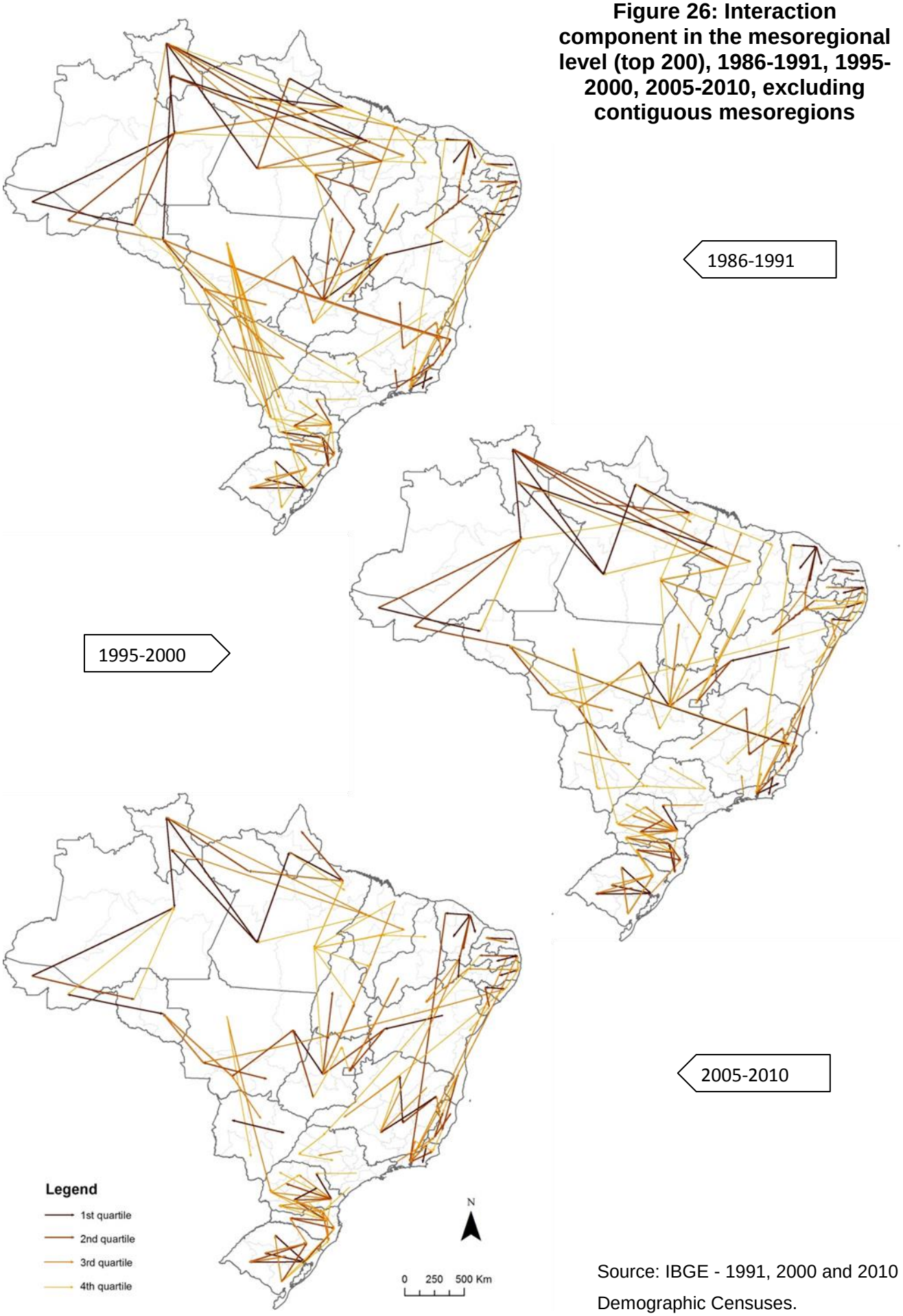
[53] Since the majority of migrations are from the urban-urban type, Rigoti (2008) calls the attention for the importance of the microregions containing state capitals in the process of population redistribution, since the big metropolitan areas and urban agglomerations are the most important areas of origin and destination of migrants.

Figure 25: Interaction component in the mesoregional level (top 400), 1986-1991, 1995-2000, 2005-2010



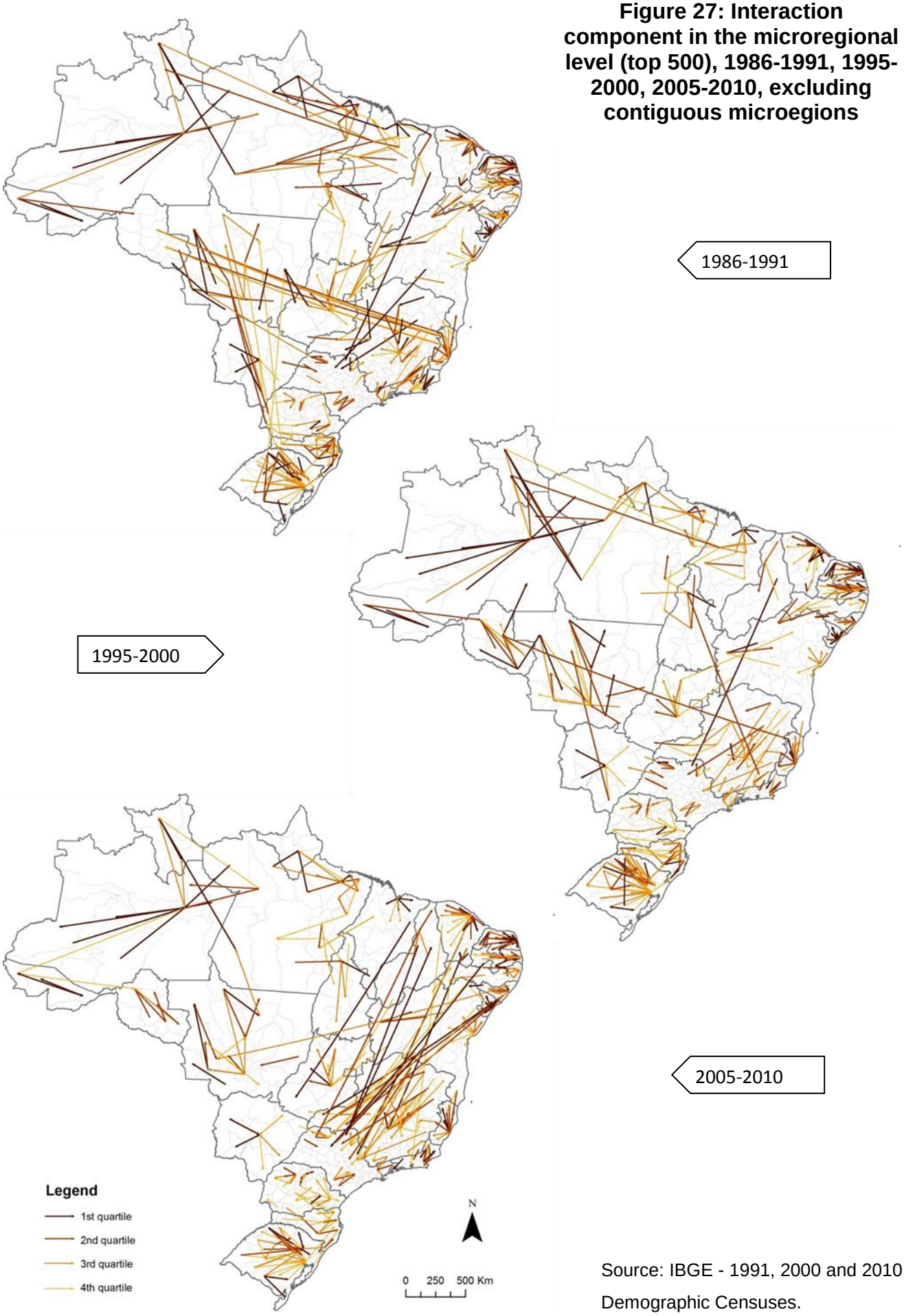
Source: IBGE - 1991, 2000 and 2010 Demographic Censuses.

Figure 26: Interaction component in the mesoregional level (top 200), 1986-1991, 1995-2000, 2005-2010, excluding contiguous mesoregions



Source: IBGE - 1991, 2000 and 2010 Demographic Censuses.

Figure 27: Interaction component in the microregional level (top 500), 1986-1991, 1995-2000, 2005-2010, excluding contiguous microegions



Source: IBGE - 1991, 2000 and 2010 Demographic Censuses.

This section showed that the interaction component can be a powerful approach for migration studies and can be used independently or complementarily to the analysis of migration flows magnitudes, since they are not mutually exclusive. They represent different aspects of migrations, respectively related to the intensity and connectivity dimensions, and the best approach would depend on the goal of the research. The interaction component can be easily calculated and can be used to identify sub-systems with relatively low volumes of migrants, even in extremely large and heterogeneous countries like Brazil. In traditional cartographic representations, regionally representative migration systems involving spatial units with low populations and demographic density tend to be neglected. Nevertheless, as seen in the interaction component maps, migration streams very important to understand regional processes of population redistribution, for example, in the North and Centre-West (which have the lowest density and population volumes in the country), could be shown in the maps.

7 - CONCLUSION

This thesis aimed to provide a theoretical and methodological basis for the discussion of the processes of population (re)distribution in Brazil, with particular reference to the changing patterns of internal migrations since the 1980s. The investigation of the transformations in the national settlement system in a country with the magnitude of Brazil - the fifth largest country in the world in terms of population and area - is extremely challenging and requires a great analytical effort. Besides that, the main mechanism of population redistribution – internal migrations – are becoming increasingly more complex, assuming a more reversible and oscillating character in the beginning of the XXI century (Baeninger, 2011). The lack of consistent theoretical and methodological frameworks, able to address migrations on its multiple dimensions and link processes of concentration and dispersion occurring in different scales and regions is a serious gap in the literature. One reflection of this problem is that migration literature in Brazil is scattered in a myriad of case studies using different scales and methodologies.

Since the middle of the last century, Brazil went through major economic and demographic transformations, becoming an urban and industrialized nation, rather than a rural and agricultural society characterized by high levels of fertility and mortality. In order to make sense of the impacts of these changes in the national settlement system, a theoretical model encompassing different spatiotemporal processes was proposed. It consisted in a descriptive framework linking sequential changes in patterns of population (re)distribution with broader spatial cycles of urban and economic concentration and dispersion. The new patterns of migration in Brazil have a highly intricate cause-effect relationship with current tendencies of territorial restructuration – the effects of the productive restructuration occurred in the 1970s, the capitalist expansion of agricultural frontiers, changes in the urban system, etc. - and the conceptual model has proven to be a valuable analytical tool. By studying the Brazilian case in the light of the model, it was possible to attribute a broader meaning to the empirical results and the literature review.

The conceptual model also served as a reference for the design of methodological strategies, which included some leading edge techniques in migration studies. Starting in Chapter 4, several metrics regarding the four dimensions of migration (a framework proposed by Bell et al., 2002) was used to outline a broad and systematic diagnosis of migrations in Brazil at national level, over the last three decades. A multiscale approach was adopted and, besides using IBGE's official boundaries, the software IMAGE Studio was used to generate random aggregations of microregions (ASRs) and its correspondent migration metrics, in order to discuss how the zonation and scale effects of the Modifiable Areal Unit Problem (MAUP) affects migration analysis in Brazil. The approach at national scale is useful to capture general tendencies and create a broader picture, but the wide variations in the zonation effect showed how spatial statistics regarding much aggregated areas can be misleading, since the approach of big geographical areas can mask important variations.

In Chapter 5, the functional hierarchy of the research REGIC 2007 was used to create origin-destination migration matrixes regarding urban levels with the purpose to address population concentration and dispersion in the national urban system. The growing importance of "Regional Capitals" at national level suggests a process of restructuration of the urban system, although the pace of these changes is slowing down. This category regards intermediate cities and state capitals located outside the "core region" of the national settlement system. So, despite the process of population concentration in cities of bigger sizes, the inflexion of historical metropolization tendencies suggests a relative decompression of the urban system. The same method was applied for internal migrations occurred within the boundaries of São Paulo and Rio de Janeiro - the "core region – which showed a very distinct pattern of deconcentration (movements downwards the urban hierarchy), as would be expected for the third stage of the model ("intraregional deconcentration") onwards.

Chapter 6 aimed to deepen the analysis of the typically disregarded connectivity dimension, by the use of standard Network Analysis metrics and the use of a technique of multiplicative decomposition proposed by Raymer *et al.* (2015). This technique allows removing the effect of population volumes through the calculation

of an “interaction component”, an indicator of the strength of migration interactions between spatial units. The analysis of the vectors of population redistribution in Brazil using standard flows maps alongside interaction components maps proved to be very useful to identify and study migration sub-systems. The maps showed a highly concentrated migration system and a great spatial heterogeneity between regions, proving that if a pattern of deconcentration is happening in one scale, it is not necessarily happening in others. More broadly, considering Mitchell’s (2004) conceptualization of the processes of population redistribution, it is possible to state that the national settlement system has a highly concentrated urban *pattern*, presents strong evidences of counterurbanizing *processes* and “counterurbanizing” migration *movements.*

The interpretation of the national settlement system evolution in the light of the conceptual model pointed out to the presence of overlapping “territorialities” and “temporalities” in Brazil. The first regards the overlap of different modes of spatial territorial organization, that is, the coexistence of processes of “territorialisation” in the form of zones or networks. The latter refers to the overlap of certain aspects related to different stages of the conceptual model. The Brazilian territory is characterized by strong regional heterogeneities and different sub national spaces can be at different points of the Demographic, Migration and/or Urban transition. Although the model refers to the national settlement system has a whole, it assumes the existence of regional differences. In order to properly evaluate the adequacy of the model for the Brazilian case, the stages transitions should not be interpreted as sequential spatial cycles that are uniformly overcome across time, but as a set of transitions that can be lagged in relation to each other.

In sum, considering the literature review and the empirical results of this thesis, it is very clear that Brazil went through the three first spatial cycles described in the conceptual model, but is there supporting evidence that Brazil reached the fourth cycle? Are there indications that the national settlement system is in a path towards the last stages of the framework? Considering the central position of São Paulo in what regards the economy and its prominence in the migration networks at national level, it would be a risky statement to say that a “polarization reversal”

took place in Brazil. However, recent trends points out to several features related with the fourth and even the fifth stage of the model.

In what regards the Demographic Transition, in the 2000s, fertility rates fell below replacement level (Simões, p.72, 2016), an aspect related to the last stage of the model. In what concerns the Migration Transition, since the 1970s, internal migrations had already become predominantly between urban areas (Matos e Baeninger, 2004; Braga e Fazito, 2010). Besides that, due to the expansion of more capitalist forms of production in the Brazilian agricultural regions, these areas do not attract population as they used to (as shown by the changes in the main vectors of migrations in Brazil, on Chapter 6), suggesting a trend of stagnation or even retreatment of some settlement frontiers, as postulated for the fourth stage. Moreover, from 1995-2000 to 2005-2010, the number of migrants decreased in relative *and* absolute terms, a feature associated with the last stage of the model.

Richardson (1980) states that, outside the core region, the stage of "polarization reversal" "(…) *almost always involves more spatial concentration with intraregional polarization toward regional cities continuing over a long period of time*" (p.80-81, 1980). This is consistent with the trend of population concentration in cities of bigger sizes in all macroregions, not only the Southeast (as seen in Chapter 4). Besides that, the differential growth of the Centre-West and North (which participation in the national population went from 5.8 to 7.4% and from 5.6 to 8.3% between 1980 and 2000, respectively) also indicates a process of interregional deconcentration, even though the general balance of population distribution between macroregions did not change substantially in the past few decades. Nevertheless, the *urban* populations of these two macroregions also grew at higher rates than the rest of the country (there is a continuous growth of the urbanization rates nationally, but the pace of this increase is slowing down). In the Northeast – macroregion with the lowest urbanization rate of the country and historically an area of migrations loss - the tendency of the last decades was the increase of state capitals participation in the total population of the states (with the exception of Recife), also indicating a process of concentration in the "periphery" of the national settlement system, related to the fourth phase of the framework.

As the network mode of spatial-territorial organization increase its importance, the spatial system seems to become more functionally and economically integrated, reflected by the expansion and densification of the urban system and increasing cohesion and stability of migration networks in the last decades (indicated by the increasing reciprocity of migration movements and increasing connectivity, as seen in Chapter 6). The “fragmentation” of migration flows and emergence of new “spaces of migration”, able to attract and expel migrants, suggests the formation of new agglomeration economies outside the core region. “Countermetropolisation” tendencies (decrease in the relative participation of the metropolitan core in relation to the surrounding municipalities populations), initially observed in São Paulo, are being replicated in metropolises all over the country (in the metropolitan regions of Belo Horizonte, Porto Alegre, Recife, Fortaleza, Salvador, Curitiba, Goiânia e Belém and the Federal District and surroundings)

Returning to the topic of Polarization Reversal, even if the processes of interregional deconcentration occurred only in a restricted portion of the country, would it be completely unreasonable to apply this concept to the Brazilian case? According to Richardson (p.82, 1980), *“the pace and form of PR is likely to differ from country to country depending upon the existing settlement, geography, development "style" and culture".* Considering the magnitude of the Brazilian territory, the extremely unevenly distribution of the population, the current stage of the demographic transition and the current trends of internal and international migrations, it would be really unrealistic to expect that the population would be evenly distributed throughout the Brazilian territory someday, reaching a new stage of “spatial dispersion”. In other words, considering the population redistribution in *absolute terms*, it is highly unlikely that a “polarization reversal” will occur in Brazil. Nonetheless, there are signs of a *tendency of interregional deconcentration* in Brazil, the core idea of the PR concept[54].

[54] About the “development style” of Brazil, it is worth mentioning that the planned economy in the period of the military dictatorship in Brazil (1964-1985), which resulted in the expansion of settlement frontiers in isolated regions, artificially induced the growth and occupation of the “peripheral” macroregions of Centre-West and North (as well as the construction of Brasília, inaugurated in 1960).

Even though the model does not perfectly fit all aspects of the Brazilian case, this is not a reason to completely disregard an instrument that have the potential of providing a better comprehension of the processes of population redistribution in the country, offer a broader meaning to empirical data and a more integrated and holistic view of the national settlement system development (by connecting a multiplicity of complex phenomena occurring at different times and in different regions of the country). As already discussed, the proposed model was a reference with no deterministic or universal pretensions - the idea was to evaluate how well the framework encompasses real world aspects and how useful it is to elucidate the Brazilian case, not if it is real or false in an absolute sense.

Far from being an ultimate statement about the processes of (de)concentration in Brazil, this thesis is part of a collective effort of researchers to elucidate the new patterns of migration and human settlements in Brazil, an essential discussion regarding urban and regional planning and public policies. Inevitably, the present work has a partial view and several limitations, being more directed towards a multidimensional and multiscale diagnosis than causal explanations. Thus, beyond the challenge of understanding and modelling migration patterns in Brazil, there is an even bigger task of understanding the causes of their constitution and transformations in a systematic way, considering the migration process at different scales. Even though the literature review and the conceptual model shed some light on the reasons of the changes in patterns of population redistribution, explaining and modelling the causes of migrations at different scales and regions of Brazil goes beyond the scope of this thesis.

According to Baeninger (2011), the “classical interpretations” of Brazilian migrations, based exclusively on economic performance, reached its limits and, in the beginning of the XXI century, internal migrations assumed more complex patterns, with the detachment of the relations migration-industrialization, migration-agricultural frontiers, migration-employment and migration-social mobility. Migration researches must face the challenge of investigating migrations not as an isolated phenomenon, but as a complex and continuous process driven by the interplay of socioeconomic, cultural, environmental, political and demographic factors. The movements of population in space cannot be simply reduced to any of

these dimensions. Despite that, unilateral approaches of migrations are extremely common, because of the excessive compartmentalization of disciplines and lack of dialogue between researchers of different areas. If the goal is the construction of predictive models or the formulation of long-term public policies, a multidisciplinary approach is imperative. The multifaceted nature of migrations should not discourage efforts in this direction.

There are still many gaps in the literature regarding the processes of population (re)distribution in Brazil. Case studies, although important, often fail in terms of contextualization, relying on atomistic interpretations of migration patterns, focused, for example, on local housing or regional labour markets. This type of approach do not allow the apprehension of a broader picture of changes in population movements, led mostly by structural drivers, as demographic changes and transformations in the national space economy. Studies in depth about (de)concentration processes in more disaggregated spatial units, connecting regional tendencies in a broader context would be an important contribution for studies on spatial mobility in Brazil (for example, interregional comparisons regarding migrations between the different levels of the urban hierarchy and commuting flows within metropolitan areas). Particularly important are those studies regarding migration composition, because of the increasing selectivity of migrations in what regards education, income and age, probably the main limitation of this thesis.

Before finishing, some final remarks must be made. As seen mostly in Chapter 4, the productive restructuration occurred in the 1970s was the starting point of an inflexion of tendencies of population (re)distribution in Brazil. Even though these changes are related to the relocation of industrial facilities and changes in locational preferences for the establishment of new economic activities, it does not imply a process of economic or political *decentralization*. The research REGIC 2007 shows that the financial and decision-making processes in Brazil are highly centralized in São Paulo, followed by Brasilia and Rio de Janeiro and there is no evidence of changes in this sense. It shows that demographic deconcentration and economic deconcentration, although related, are not the same thing. With the growing importance of the network mode of spatial-territorial organization, founded

on deep structural and technological changes, management can be easily detached from industrial facilities and the *loci* of production, in general.

As a final remark, this thesis will be concluded with a reflexion brought up by Martine and Diniz (1997), who criticize the underlying assumption that condemn all forms of spatial concentration and considers deconcentration as something necessarily positive, as if *"territorial equity is tantamount to interpersonal equity"* (p.226, 1997). The premise that industry must be deconcentrated in order to stimulate population deconcentration - which seemed to guide much of regional policy in Brazil - must be more carefully examined. Even though there are limits to concentration and the fast metropolization occurred in Brazil did not happened without great social and private costs, it does not mean that deconcentration is necessarily a good thing – the context matters and the limits to concentration are extremely variable.

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