1. Introduction

The objective of the paper is to analyze the effect of accessibility to employment on population location patterns in the city of Salvador, Brazil, considering different urban transportation facilities. In particular, the paper also investigates the spatial distribution of whites and blacks in this city, based on the relationship between densities and accessibility, in a polycentric spatial configuration of location of employment centers. The research is situated in the empirical context of the urban economy and the economics of accessibility. The identification of the causal effect between population density and accessibility will be carried using a cross-section database by subareas of city traffic, controlling for historical, geographical and location components, as well as the respective application of the instrumental variable estimator. Different methodologies were used to calculate an accessibility indicator, a population density gradient and the generation of an instrumental hydrographic variable based on the location of the river bed of the city of Salvador to solve problems of simultaneity between accessibility and density population. The results showed that the factors of access to employment opportunities had a positive and statistically significant effect on the population density. This applies to blacks and whites, regardless of the technology used, car or bus.

2. The urban history of Salvador

Founded in 1549, Salvador was the first planned city and also the first administrative center of Brazil, being the capital of Brazil Colony until 1763. Its primitive nucleus was constituted on the margin of a great navigable bay, the All Saints Bay, and above a geological break that divided the city into Cidade Alta (Hight City) and Cidade Baixa (Low City). This space and its surroundings formed the main urban center of the city until the second half of the 20th century, when began the inversion of the social, economic and political axis for the areas of the Atlantic seaboard. The central and valued spaces of the municipality Salvador are filled by a predominant white population, which represents less than 1/5 of the total residents. On the other hand, the strong dependence on inefficient public transport makes workers in popular and peripheral regions far from the new centers of employment or the dynamic spaces of the traditional center. These regions concentrate the economic activity of Salvador, so that physical access to employment opportunities is unequal for different population groups in the city.
3. Theory of urban structure and spatial distribution of population

The theoretical reference for the investigation of the spatial distribution of the population within a city was based on the Urban Economy. The standard monocentric model assumes a homogeneous infrastructure link that perfectly covers a representative city. This type of network implies that the demographic density falls proportionally to the distancing of the CBD, without effects derived from the congestion of roads and the allocative optimization of space between residential constructions and road infrastructure. On the other hand, non-monocentric modeling has greater adherence to real examples of metropolises where there is more than one job center. Thus, the paper takes the standard theoretical reference of non-monocentric modeling, such as Fujita and Ogawa (1982) and Fujita and Krugman (1995), as well as the reference for suburbanization processes by Henderson and Mitra (1996) and two-dimensional urban structuring in non-monocentric approach presented by Rossi-Hansberg (2002).

From these references, we take Muñiz et al. (2008) as reference to model the urban spatial structure of Salvador. According to this author, the more recent polycentric models usually have a more complex theoretical structure than monocentric ones, where the opposing forces of agglomeration act for the formation and transformation of the urban spatial configuration from the approaches of decentralization and integration, in which the distribution off firms and families necessarily follow the distribution of jobs. The existence of transport costs for moving from home to work would explain this behavior of households. The basic idea of accessibility to employment as a determinant of density function is not controversial in the literature. However, there is no consensus on the specific measurement methodology. As a rule, it is reasonable to consider at least transport infrastructure and the spatial distribution of economic activity.

4. Methodology

In polycentric investigations the physical distance is usually used for the nearest subcenter as an explanatory variable. However, these formulations, as a rule, presuppose the homogeneity of transport infrastructure, which is not empirically reasonable. In order to evaluate the effect of transport differentials on urban spatial structure, this paper follows the proposed scheme of Garcia-Lopez (2012), supported by the literature of Anas and Moses (1979) and Baum-Snow (2007a). However, our density model replaces the vectors of the transport infrastructure for variables of accessibility to employment due to cumulative and congested opportunities. This accessibility format aggregates the components of transport and land use, considering the unbalanced distribution of economic activity and urban infrastructure in space. Thus, the following formulations will be used in the present work:

\[ D_{i,r} = f(\text{dist}_{cbd_i}, \text{etnic\_comp}, X_i) \]  
\[ D_{i,r} = f(\text{dist}_{sub_i}, \text{etnic\_comp}, X_i) \]  
\[ D_{i,r} = f(\text{access\_car}_i, \text{etnic\_comp}, X_i) \]  
\[ D_{i,r} = f(\text{access\_bus}_i, \text{etnic\_comp}, X_i) \]

Where \( D_{i,r} \) is the population density (by race) in the traffic division \( i \), \( \text{dist}_{CBD_i} \) is the physical distance from \( i \) to the new CBD region (from Iguatemi central region to Tancredo Neves Avenue), and \( \text{dist}_{SUB_i} \) is the physical distance from \( i \) to the nearest subcenter. The variable \( \text{etnic\_comp} \) corresponds to the ethnic composition of zone/subzones \( i \), measured as the proportion of whites in relation to the total population of the same division. The terms of accessibility to employment are \( \text{access\_car}_i \) and \( \text{access\_bus}_i \), which indicate the number of
opportunities available to the residents of the traffic division \( i \) by private and public motor transport respectively. Finally, the vector \( X_i \) represents controls and time invariant features of each zone/subzones.

For the estimation of the density gradient in relation to the distance to some city subcenter of employment, the procedure of Muñiz et al. (2008) was used. The methodology for quantifying accessibility follows the idea proposed by Ingram (1971), which counts the total number of jobs attainable from an origin. This number is weighted by the existing impediment to travel, expressed through the time necessary for the commutation in each route of origin/destination. The construction of an index for public/private transport suits the purpose of this work, which requires an aggregate variable to estimate the effect of accessibility on the spatial distribution pattern of the population.

The analysis period was restricted to the year 2010, and a set of geographic, historical and location covariances were introduced in the function of the population density, as suggested by Garcia-Lopez (2012). Given the socio-spatial context of Salvador, the proposed model will be estimated for the general population and also for two different segments of the population, whites and blacks. As in Epifani and Nicolini (2015), an ethnic composition control was introduced in the density function to control possible factors related to racial segregation in residential areas. In order to deal with the problem of causal determination, the strategy of capturing exogenous variations of the accessibility indicator is drawn from hydrographic instruments related to the course of large rivers that precede the distribution of the population and the road network in Salvador.

5. Database

A database was prepared by subdivisions of traffic that allows contemplating different aspects about the municipality of Salvador. For the population cluster variables, microdata were used by census tracts of the Demographic Census 2010, produced by the Brazilian Institute of Geography and Statistics (IBGE). The values of accessibility to employment were generated from source-destination matrices of the Mobility Survey of the Region of Metropolitana de Salvador 2012, and traffic projections from Google Maps. The lowest physical distance numbers for some public good serve as a measure of location advantage and were generated from geographical coordinates available in Google Maps and traffic division centroids provided by SEINFRA (2012). In order to identify the presence of the beach in different analysis cuts, the Geopolis - Visualizer digital cartographic database (INFORMS/CONDER) was consulted. Finally, the dummy variables referring to the beginning of the occupation in each subdivision of traffic were projected according to the urban expansion map of Salvador available in Heinonen (2005).

6. Results

Estimates of accessibility for cumulative opportunities indicate that private transport in Salvador allows considerably better access to employment than public transport (buses), with/without congestion. The highest values of the index were concentrated in central regions, more strictly in the vicinity of the “traditional center” and “new center” of the city. In general terms, the parameters estimated to measure the effect of accessibility to employment on demographic density are positive and valid at acceptable levels of significance, regardless of the dependent variable employed. That is, a lower possibility of reaching a certain variety in jobs via car/bus should justify a lower demand for housing or concentration of people in more peripheral spaces. This effect was much greater for public transport. However, the identification strategy based on the use of
hydrographic instruments suggests that the effect of accessibility may be much larger and more balanced between the different transport technologies.

Regarding to the other variables, we highlight the ethnic composition control, which captures components linked to racial segregation. The variable showed a higher number of whites and a lower number of blacks per km², as the proportion of whites in the local population is higher. This observation has some importance because the ethnic composition variable has very strong correlation with income and average schooling, which were not included in the regressions. Research can help develop local public policies by providing new information on the level of access to vacancies between different population groups in the municipality.

References


