LOCATION OF THE POOR: NEIGHBORHOOD VERSUS HOUSEHOLD CHARACTERISTICS

THE CASE OF BOGOTÁ

Juliana Aguilar

Tito Yepes

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Abstract

In Latin American cities there is a high correlation between the location chosen by poor households and their income level; however, it is difficult to identify to what extent they live there by choice –because it maximizes the returns to their efforts- or by restrictions that pull them to locations that make them poorer. We define the former case as unrestricted sorting in the urban economics context, while the latter is assumed to be the commonly used definition of segregation. Distinguishing between these alternatives is difficult because of the circularity between poverty and location. People can freely choose a location that makes them poor; else they can choose a location because they are poor. This circular causation or endogeneity puts policy making in a complicated spot since it questions the reach of placed-based policies to alleviate poverty and exposes the need to prioritize between these actions and those directed to improving households' portable assets. Hence, there is a disjunctive between investing in education -that can be ported if location drives poverty- an investing in local infrastructure. This paper begins establishing a mincerian profile of households' income level as the result of its portable assets and their returns. Then an Oaxaca-Blinder decomposition of the income equation over two locations –a periphery and the rest of the city- is used. Based on differences in returns to individual characteristics between the two alternative locations impact from space is separated from the impact from portable assets. The main hypothesis is that segregation exists when these returns vary across space while they should not. That is when households cannot profit equally across space even if they have comparable characteristics. Results show that segregation, as opposed to individual characteristics, explains one fourth to one third of the mean income difference between locations in Bogotá-Colombia. Further estimations show that access has a major role explaining the impact of location while housing and neighborhood characteristics play a relatively minor role. As such, results question the emphasis that local social policies pay to improve spaces while they could have a greater impact on welfare conditions giving more relevance to the portable assets of the poor.

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Acronyms

AMM	Alonso - Muth –Mill
CBD	Central Business District
COP	Colombian Pesos
DANE	National Statistical Department (*Departamento Administrativo Nacional de Estadística*)
POT	Territorial Ordering Plan (*Plan de Ordenamiento Territorial*)
UPZ	Zonal Planning Unit (*Unidad de Planeamiento Zonal*)

1. Introduction

Despite few exceptions that confirm the rule, Latin American cities have a signature of concentration of the poor in peripheries while affluent classes cluster in neighborhoods closer to centers of economic activity. These patterns of concentration are usually seen as a negative outcome of urban development and sometimes referred to as spatial segregation, socioeconomic spatial segregation or simply segregation.

The negative connotation of segregation follows the implicit assumption that the location chosen by the poor has a negative impact on their wellbeing. Therefore policies should follow them improving their place of residence, a process that feedbacks itself when new settlers cannot sort for places with positive impacts. Thus, it is believed that location drags the poor into poverty. Further, the debate on the efficient policies against poverty is usually mixed with the ethics discussion of whether society considers -implicitly- such living conditions of the poor as acceptable –for the society. Reality is that more light must be shed on the actual relationship between space and poverty in cities. In general little efforts are being made to understand whether people have actually chosen to live at the peripheries rather than being 'segregated'.

The multiple unexplored dimensions of segregation deter analysts and policymakers alike from a better understanding of behavioral decisions from both poor and non-poor urban dwellers. It may be possible that the poor are actually better off in the peripheries than elsewhere, which may explain why they cluster there. As such the policy implications are different because instead of serving them where they have clustered, they may be better served by ceasing the incentives driving them to the peripheries.

Questions, which have not been yet asked, could help to clarify the relationship between poverty and space: Is the clustering of poor in peripheries a reflection of poor households having low income, or have they turned low income earners because of the chosen location? Are location choices a result of the poor maximizing their welfare returns to their efforts, or are they the result of generating welfare losses for them? That is, are the poor constrained to places that reduce their income relative to what it would have been if they had locate elsewhere within the city?

This paper digs into the behavioral drivers of location decisions of citizens to give shape to a definition of segregation without getting into the ethics debate. It does not propose to drop such debate but, on the contrary, to enlighten it with a different set of implications. Specifically, it tries to shed some light on whether location (space) has a greater impact than non-spatial drivers of poverty in explaining differences in income. That is, assessing the underneath assumption that location drags the poor into poverty. It is assumed that the poor sort, which means that they consider and evaluate welfare outcomes from all possible locations and choose the alternative that maximizes their welfare given their budgetary restriction. Thus, if households can freely sort and they choose to live at the periphery, it is because they are better off there than elsewhere. Under this scenario, without distortions in the housing market, the budgetary constraint determines location decisions of the poor. However, if there are market failures keeping households from reaching higher consumption bundles households are being segregated by the characteristics of their location. The paper elaborates on the existence of such market failures. Further, since policies cannot dictate

where people must live, it is necessary to understand how they choose where to live so to understand the channels through which policies may have an influence.

The article jots down evidence for Bogotá (Colombia). In addition to this introduction, it follows five sections. The second section describes Bogotá's urban structure and discusses how local policy understands segregation. The next three sections develop the argument by answering three questions: i) "What is segregation?", ii) "Are the poor segregated?" and iii) "By which means are the poor segregated?". "What is segregation?" deepens into the definition of segregation from the policy perspective and proposes an approach based on the neoclassical economics. "Are the poor segregated?" presents the methodology to measure segregation and jots down the result for Bogotá. "By which means are the poor segregated?" delves into the spatial factors –market failures- that describe segregation. The sixth section concludes.

2. Bogotá's urban structure and local spatial policy

Reducing spatial segregation is one of the main objectives of social policies with a territorial emphasis in Bogotá. Though there is not an exact definition of segregation, references usually combine spatial concentration of the poor, having low living conditions and living far from the inner city.

In Bogotá's Territorial Ordering Plan (POT[1] for its acronym in Spanish)[2] concentrations of poor households take a negative connotation because of the deficient living conditions (Table 1 gives details on the POT[3]). These concentrations, located in the peripheries at the south and west of the city and in a lesser extent in the northern peripheries, are characterized by relatively lower access to public facilities and infrastructure, far from labor markets; and lower quality dwellings.

Further efforts to define and describe segregation in Bogotá have been developed by the last two local governments. A document developed by the city's Local Planning Office and the National University (Secretaría Distrital de Planeación y Universidad Nacional de Colombia, 2007) proposes index to measure two dimensions of segregation: one related to the socioeconomic conditions of households and the other compounding access to facilities, infrastructure and labor markets. While the first dimension makes reference to the households' portable assets, the second dimension only includes attributes of locations. The efforts put onto defining and describing segregation in Bogotá are worth noting since little had been done before; however, the role of space in this process is still unattended. Our paper contributes to fill in this gap.

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[1] *Plan de Ordenamiento Territorial.*

[2] POTs are the main tool to give spatial emphasis to urban planning in Colombian cities. It defines the terms of land use and urban expansion in the long term. Bogotá's first POT was designed in 2000 and later modified in 2003. During 2013 new modifications will be on debate.

[3] The review covers Decree 619 of 2000 and Decree 469 of 2003 and their respective Technical Support Documents. These two decrees are condensed in Decree 190 of 2004.

Table 1. Segregation as defined in Bogotá's POT

	Definitions	**Causes**	**Policy guidelines**
Current POT	- Spatial concentration of people with low-income. - Segregated population cluster in the peripheries. - Peripheries are far from economic center and usually constitute areas of urban expansion. - Characterized by sub-investment in facilities; lower accessibility to the city; low quality dwellings.	- Land scarcity in the inner city that drives up land prices, which low-income families cannot afford. - Inefficient low income housing programs - Fragmented road network. - Intense commercial land use of public space in residential neighborhoods. - Land speculation in the inner city driving up land prices in the whole city. Informal settlements benefit from substantially lower land prices. *Dynamics reinforcing segregation:* - better-paid and profitable activities also cluster far from peripheries following high-income groups. - Living costs are higher in the inner city.	- Promote new centers of economic activity closer to clusters of poverty - Improving on facilities of the peripheries within those new centers. - Develop even further land use regulations.
Proposed reform	- People facing restrictions in accessing jobs and urban services. - Low quality and availability of public space, facilities, and infrastructure services.	- A combination of a land market failure that allows free sorting to the non-poor while driving the poor to peripheries that observe lagging public investment.	- Increase low income housing supply in locations closer to economic activity, to urban services and to a more balanced mix of income groups. - Improve habitat in segregated neighborhoods observing deficit in urban services. - Legalization and regularization of informal settlements, improving habitat along. - Strengthening controls on land prices speculation. - Buffer negative impacts from segregation. - Expand facilities while expanding transport services into poorer neighborhoods.

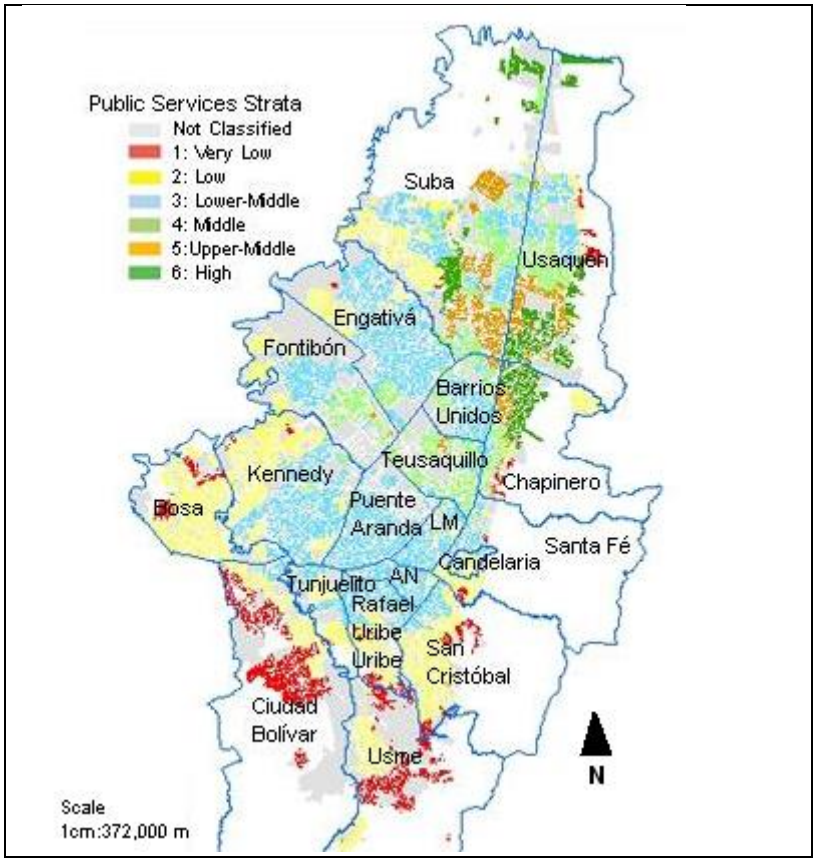
Source: Based on documents from the Bogotá Major's Office, Decreto 190/2004 and draft reform 2012.

All the elements incorporated in public policies as characteristics of segregation, describe Bogotá's urban structure. The structure is characterized by higher concentrations of poor households in the

south and western peripheries. These places are also equipped with less public infrastructure, are farther from the labor market and have houses with lower living standards.

Geography has played an important role defining Bogotá's urban shape. The Eastern Cordillera of the Andes mountain range borders the city by the east deterring urban growth towards the east. The result has been a semi-circular city expanding to the north, south and west. The Bogotá River limits the city in the west and the Sumapaz Paramo (moorland) borders the south. To the north, Bogotá extends over the plateau up to the smaller towns of Chia and Sopo. The city is divided in 19 administrative units called *localidades* (Sumapaz is the 20th *localidad*, a rural preservation area). Most of the households live at the western side of the city (in the *localidades* of Suba, Engativa and Kennedy), while the highest densities are found in the *localidades* in the west and south (Rafael Uribe Uribe and Kennedy) (see Map 1).

Map 1. Bogotá by localidades and public services strata



Source: Local Planning Office (2009) in http://www.sdp.gov.co/portal/page/portal/PortalSDP/Informaci%F3nTomaDecisiones/Estratificaci%F3n%20Socioecon%F3mica/Mapas.

AN: Antonio Nariño, LM: Los Mártires.

Most of the poor live on the west but the higher poverty rates are found in the south. Almost 50% of poor households live at five *localidades* in the west side of the city -Kennedy, Suba, Ciudad

Bolívar, Engativa and Bosa-, while central *localidades* such as La Candelaria, Teusaquillo, Antonio Nariño and Los Martires, accommodate a smallest fraction of the city's poor. However, the highest poverty rates are found in five southern *localidades* –Ciudad Bolívar, Usme, San Cristobal, Bosa and Rafael Uribe Uribe. In eight out of nineteen *localidades* poverty rates are above 20% and only in Teusaquillo the rate is below 10% (Table 2).

Southern *localidades* have the lowest mean and median income as well as the highest concentration of households with similar income. Table 2 contains the coefficient of variation (standard deviation divided by mean) by *localidad*, which shows the degree of concentration of households with similar income, a lower value of the coefficient is related to a higher concentration. *Localidades* with the highest income concentrations also have high poverty rates (Ciudad Bolívar, Usme, Puente Aranda and San Cristobal). However, the correlation does not stand for the rest of *localidades*, e.g. Rafael Uribe Uribe.

Table 2. Households, poverty and income by localidad

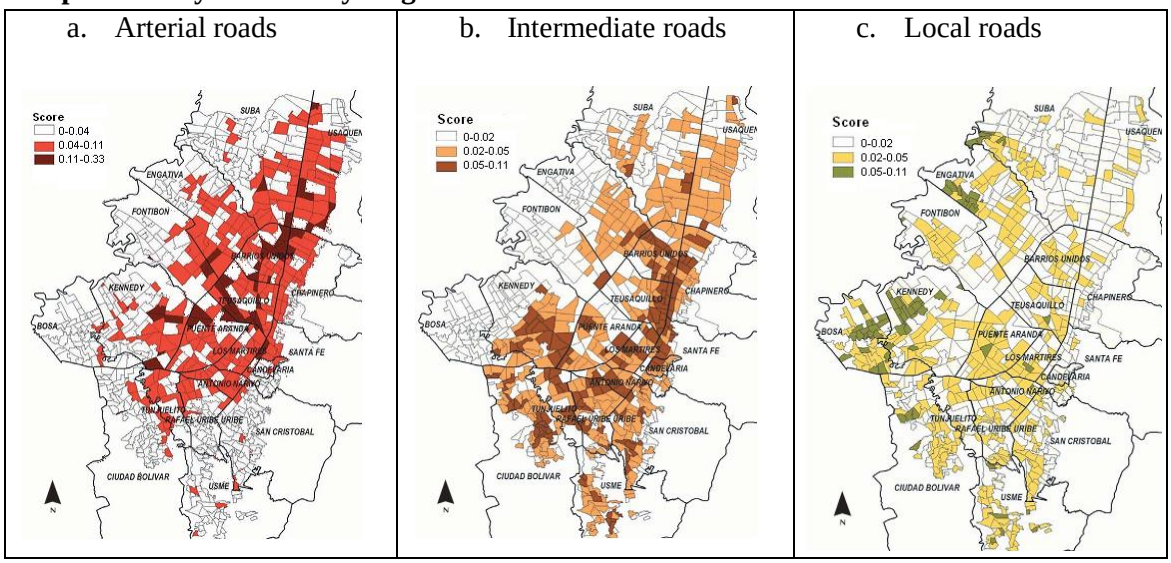
Localidad	Distribution of households										Poverty			Household income (Mll COP)			
	Households		Density*	Households by estrato (%)							Poor households	Poverty rate (%)	Poverty distribution (%)	Mean	Median	S.D.	Coefficient of variation
	Total	%	hh/km2	NC	1	2	3	4	5	6							
Ciudad Bolívar	169,545	7.8	5,001	0.00	55.74	40.67	3.59	0.00	0.00	0.00	60,390	35.62	14.2	1.17	0.90	1.00	0.86
Usme	102,380	4.7	3,380	2.26	41.09	56.65	0.00	0.00	0.00	0.00	36,308	35.46	8.6	1.21	0.97	1.10	0.91
San Cristóbal	109,282	5.0	6,631	1.29	4.41	81.64	12.66	0.00	0.00	0.00	35,960	32.91	8.5	1.30	1.00	1.10	0.85
Rafael Uribe Uribe	104,071	4.8	7,498	0.99	9.25	49.50	40.26	0.00	0.00	0.00	33,096	31.80	7.8	1.47	1.03	1.96	1.33
Bosa	160,446	7.3	6,702	2.30	7.53	87.43	2.74	0.00	0.00	0.00	42,181	26.29	9.9	1.37	1.11	1.36	0.99
Santa Fe	35,289	1.6	5,063	1.31	4.64	56.09	25.66	12.30	0.00	0.00	8,447	23.94	2.0	2.27	1.28	3.00	1.32
Tunjuelito	56,607	2.6	5,735	0.00	0.00	56.26	43.74	0.00	0.00	0.00	13,396	23.67	3.2	1.77	1.30	1.90	1.08
Los Mártires	30,035	1.4	4,614	0.00	0.00	9.80	84.62	5.58	0.00	0.00	6,339	21.11	1.5	2.12	1.34	2.87	1.35
La Candelaria	9,342	0.4	4,535	2.85	1.53	62.31	33.30	0.00	0.00	0.00	1,835	19.64	0.4	2.47	1.35	5.11	2.07
Antonio Nariño	30,987	1.4	6,350	3.21	0.00	9.35	87.45	0.00	0.00	0.00	5,835	18.83	1.4	2.17	1.46	2.66	1.23
Kennedy	288,293	13.2	7,471	2.21	0.00	49.89	45.79	2.12	0.00	0.00	46,940	16.28	11.1	2.02	1.54	1.80	0.89
Suba	318,381	14.6	5,077	1.29	0.00	39.00	32.94	15.07	10.90	0.80	48,476	15.23	11.4	3.21	1.77	4.18	1.30
Chapinero	58,710	2.7	4,461	1.78	6.42	3.81	6.31	32.21	10.25	39.22	7,831	13.34	1.8	5.86	3.41	7.49	1.28
Usaquén	155,240	7.1	4,078	1.42	2.29	8.75	23.46	31.62	14.41	18.05	18,389	11.85	4.3	5.55	3.30	8.23	1.48
Barrios Unidos	76,047	3.5	6,391	0.32	0.00	0.00	63.76	33.43	2.49	0.00	8,534	11.22	2.0	3.37	2.06	4.06	1.20
Engativá	244,942	11.2	6,827	1.15	0.00	23.16	73.88	1.81	0.00	0.00	26,727	10.91	6.3	2.57	1.90	2.57	1.00
Puente Aranda	77,887	3.6	4,500	0.00	0.00	0.00	100.0	0.00	0.00	0.00	8,320	10.68	2.0	2.31	1.70	2.31	1.00
Fontibón	104,048	4.8	3,127	2.21	0.00	17.83	49.59	29.47	0.90	0.00	10,691	10.28	2.5	3.65	2.15	4.32	1.18
Teusaquillo	54,341	2.5	3,830	0.00	0.00	0.00	12.93	80.74	6.33	0.00	4,925	9.06	1.2	5.02	3.49	6.01	1.20
Bogota	**2,185,874**	**100**	**5,282**	**1.34**	**7.88**	**37.99**	**36.54**	**10.64**	**3.17**	**2.45**	**424,622**	**19.43**	**100.0**	**2.61**	**1.50**	**3.92**	**1.51**

Source: based on EMP-2011.

*Only urban area. A household is poor when its per capita income is lower than $215.215. NC: Not classified. hh: household. COP: Colombian Pesos.

Arterial and intermediate roads are highly concentrated in the inner city near higher densities of economic activity, while local roads have followed urban sprawl. Map 2 shows density of roads at the neighborhood level measured as a fraction of net area in the neighborhood that is occupied by roads. Arterial and intermediate roads, which provide urban and zonal connectivity, are highly concentrated in the inner city with intermediate roads extending further to the south urban core. As a result, most of the peripheral area is left unserved. In these areas local roads (that enable entrance to houses) have a higher participation.

Map 2. Density of roads by neighborhoods



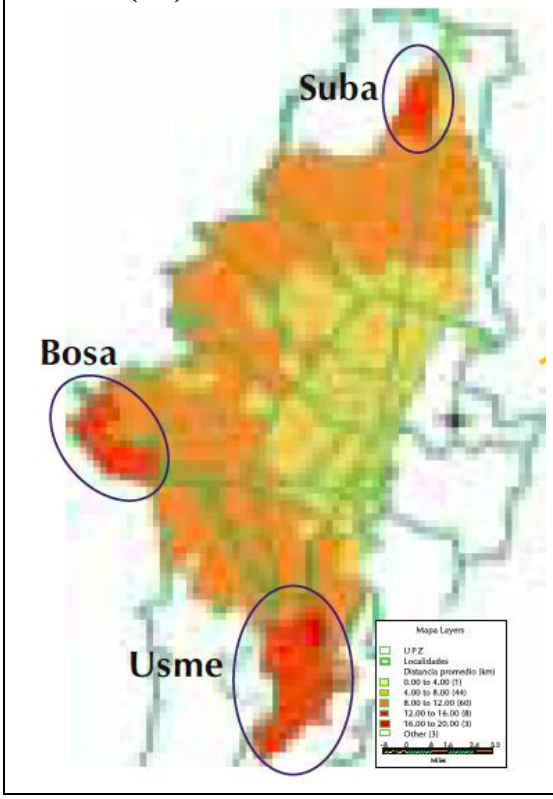
Source: Secretaría Distrital de Planeación y Universidad Nacional de Colombia (2007).
The score shows the share of a neighborhood's area occupied by roads of the referred type.

The time and distance of commuting also reflects the disadvantaged access of households living at the peripheries. Map 3 shows average distance and time of commutes of population by Zonal Planning Unit (UPZ for its acronym in Spanish)[4]. Red units show higher distances and times while light yellow and white units show the lowest values. Notice that, as expected, average commuting distances decay closer to downtown. However, time spend on commuting is higher in UPZ at the southern and the northwest corners comparing with locations similarly far from downtown. The time of commuting is influenced by the access to public transportation but also by the choice of transport. For example, this may explain why time spend on commuting do not vary extensively across income levels. The Survey of Mobility developed by the National Statistical Department (DANE) in 2005 showed that while people in the first income decile takes about 39 minutes commuting between their house and their work, people in the ninth decile takes 37 minutes and in the tenth decile 32 minutes.

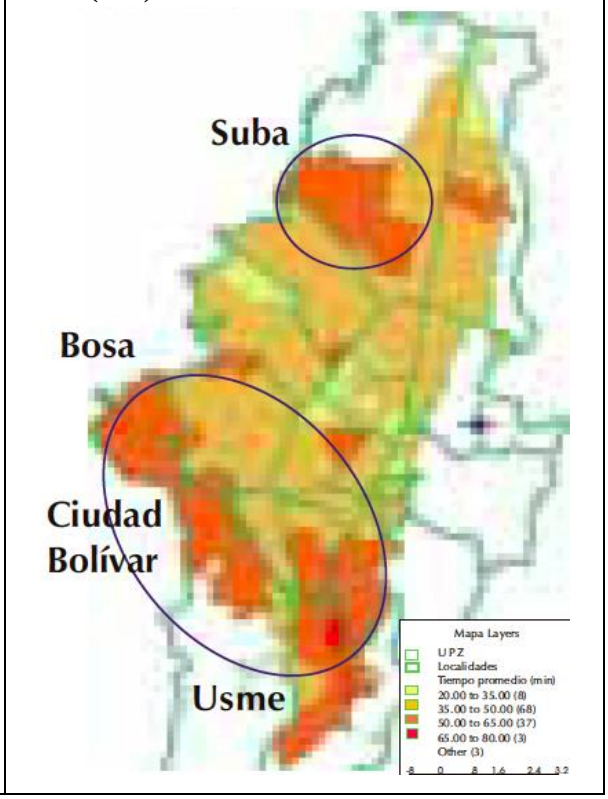
[4] UPZ are the 130 planning zones in which the city divided in the POT.

Map 3. Commuting by UPZ of residence

Distance (km)



Time (min)

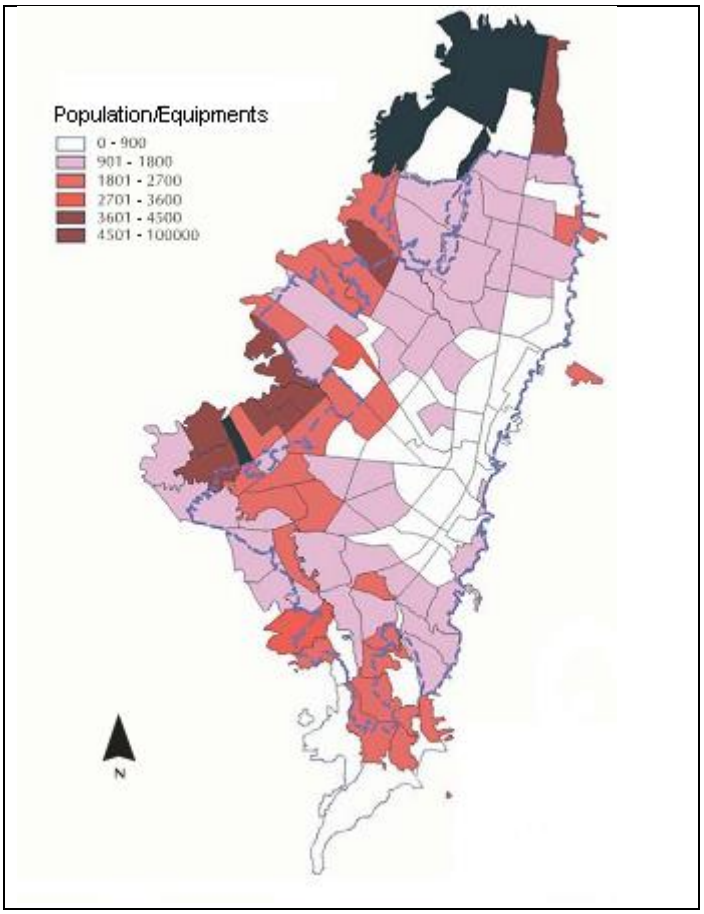


Source: Cámara de Comercio de Bogotá. Based on Survey of Mobility 2005.

Access rates to public services are high in all locations except for some neighborhoods in the peripheries. Access to save drinking water, sanitation, garbage collection and electricity are near full coverage but the capacity of sewer systems is below the city's demand. Access to the first three services mentioned is below 100% -but above 98%- in four *localidades* in the south: Los Martires, San Cristobal, Rafael Uribe Uribe and Usme. Electricity does not have full coverage in any of the *localidades* but rates are above 98% in all cases. The lowest rates are found in Los Martires (98.1%) and Teusaquillo (98.5%).

Provision of other urban infrastructure, such as recreational and cultural facilities, is higher in the inner city. Map 4 shows the average of people per unit of equipment for each UPZ. While the lighter spots are localized in the center of the map, the darker UPZs are in the peripheries. However, it should be considered that the index shows densities with respect to number of equipment and not to their area.

Map 4. Population per equipment (Average)



Source: Secretaría Distrital de Planeación y Universidad Nacional de Colombia (2007).

Poverty in Bogotá's urban structure matches many of the facts described as segregation by local policies; however, the mixture of elements can divert public policy from its true purpose, i.e. long term poverty alleviation. Facts describing the distribution of assets and population across the urban space jot down the urban structure, but the causes of such structure are not thoroughly explored. As will be further explained in the next section, location may act on urban structure through two channels: the characteristics of space attract or expulse households affecting their locational choice through their structure of preferences, but these characteristics may also affect the capability of households to generate income restricting the budget available to choose between locations. If these two channels are not differentiated, policies resulting from observed correlations can lead to undesired outcomes. For example, since the market failures leading the poor to locate where they locate are not addressed, place-based investments may just be amplifying the negative effects of space on households' generation capacity.

Further, when the causes of segregation are considered, policies focus on supply-side restrictions taking as given demand-side dynamics. The POT focuses on speculation with land prices that lead to land scarcity and high prices, public investment that usually lags from the growth of urban sprawl and an inefficient housing policy as the main causes of segregation. Hence, policies are directed towards improving land use regulations and providing infrastructure and equipment as well as housing solutions for the poor. However, demand-side dynamics are not explored, thus little can be said on how to prioritize policies.

To choose efficient policies, local governments need to delve deeper into demand-side dynamics. They should identify the channels through which space and poverty are related. Is the concentration of poor in peripheries a reflection of poor households having low income, or do they turn to have low income because of location? Are the poor where they are by choice, because these locations maximize the return to their efforts, or do their location make them poorer? That is, are they constrained to places that reduce their income relative to what it would have been otherwise?

2.1. What is segregation?

Segregation is usually understood as concentration of agents with similar characteristics in the same geographic unit (e.g. neighborhoods). The characteristics considered vary according to the purpose of study. For example, most of the evidence for the United Stated focuses on segregation by race, while in the Latin American context, and in particular Bogotá, socioeconomic characteristics play a major role in describing cities.

From an economic point of view, the composition of a neighborhood is a characteristic of the urban equilibrium. This equilibrium is the outcome of the location decisions of households, firms and builders. In turn, decisions are the result of optimization processes where households maximize utility given their budget constraint, and firms and builders maximize net profits from production. Optimization leads to equilibrium prices through a process known as sorting.

The standard urban equilibrium model poses the ideal scenario, which we will call free sorting, where the free market equilibrium is efficient. In this scenario households maximize over exogenous characteristics of space and their characteristics are also exogenous. The exogeneity implies that location does not have an impact on individual characteristics, nor individual characteristics influence the attributes of location. As will be explained in the following section, concentration of poor households in space is an expected result of free sorting.

However, as agents interact in the urban space, it is likely that externalities exist, thus, the urban equilibrium is not efficient. The standard urban model is weak in explaining the existence and permanence of cities. Considering that agents interact, that these interactions result in externalities and, in turn, these externalities motivate them to continue interacting give more suitable answers. This means that, even if households are maximizing subject to their budgetary restriction, location (through spillovers) might be impeding some households to reach higher welfare levels trapping

them to their current place of residence. Thus, in the presence of social interactions their ability to sort is restricted.

Notice that this is an alternative to explain the spatial concentration of similar households. Therefore, segregation might be the result of restrictions to the sorting process through laws, action or simply by making endogenous the households' ability to pay, or it can be the result of unrestricted sorting where preferences and budgetary restrictions are the sole factors influencing location decisions. Our proposal is to differentiate between these two causes and define segregation (with a negative connotation) as the result of restricted sorting. We will refer to negative segregation as segregation; otherwise we refer to it as concentration.

In this context, it is worth mentioning that the fact that living conditions are worse for the poorest households can be the result of restrictions that agents or space place on households to choose a more convenient location (i.e. discrimination), as has been claimed in public policy in Bogotá. Yet, it can also be the result of the distribution of public endowments in the urban space. Since places with worse living conditions are less demanded, they are cheaper, thus, affordable by lower income households.

In this section we go deeper into a new understanding of segregation by income. Our proposal follows a neoclassical construction. This means that there is a core scenario, where sorting is unrestricted. The basic urban model describes this scenario: competition is perfect and interactions are always interceded by prices. Sorting is restricted whenever reality deviates from the core model.

By shedding light on the factors that affect the sorting process, this section also helps to understand the relevance of segregation in explaining the urban outcome. The first part explains how the urban equilibrium is formed through a sorting process which we refer to as free. The next section argues that social interactions, as the main explanation for the existence of cities, have different impacts in different places of the urban space. The endogeneity of social interactions explains that the sorting processes might be restricted leading to segregation. Other factors that explain the location of households in space are also considered. Finally, the methodological problems for the identification of segregation are jot down.

2.2. Free sorting and concentration of the poor in the peripheries

In this section we present the theoretical framework as developed by the neoclassical urban economics, which we will refer to as urban economics. The urban equilibrium in its simpler form describes what we call free sorting. Though sometimes far away from reality, this model helps to understand why uncoordinated choices can lead to the concentration of similar individuals.

The canonical model of urban economy developed by Alonso (1964), Muth (1969) and Mills (1967) (AMM model, hereafter) is built on two key elements: the existence of a central point in the city where all the productive and social interactions are carried out, known as the Central Business District (CBD); and the formation of bid-rents that play a main role in the optimization process of

agents and the formation of land prices of equilibrium. Bid-rents are the maximum rent that in equilibrium an agent would be able to pay for a location.

As any model in neoclassical theory, equilibrium is the result of the optimal decisions of agents. Households maximize utility given a budget constraint, and firms maximize their net profits. However, space adds a new factor to the bundle purchased by households, hence, both firms and households choose the location in space that allows them to maximize their profits. Since agents choose the quantity of land to be consumed but also where to consume it, land differs from any other good. The place of consumption acquires relevance because the price per unit of land changes across the urban space and, particularly, the distance from the CBD imposes commuting costs that restrict the agents' budget. In this scenario, equilibrium prices are reached through a search and selection process called sorting. Equilibrium prices are those that match the maximum land rent offered by households and firms (reflected in their bid-rent functions), and the land rents demanded by builders across the city space. In general, the characteristics of locations attract to or expulse agents from the CBD. These characteristics combined with a household`s preferences and budgetary restrictions, and a firm's production function and incomes determine their bid-rents for different places in the city.

In the simplest model, transport costs, which increase with the distance from the center, attract agents to live near the CBD, while the greater amount of land that can be consumed when moving away from the CBD push agents away from the center. For households the bid-rent per unit of land at each point of space is given by income minus optimal consumption in other goods and services minus commuting costs. For firms the bid-rent is the value of the production minus production costs minus commuting costs (i.e. equal to the neoclassical economic rent). Thus, as commuting costs increase with the distance from the CBD, the agent's willingness to pay per unit of land falls. Also, in a circular city, land supply augments with distance from the CBD. The urban equilibrium is reached when households and firms are indifferent across location; since agents are homogeneous, this is when commuting costs compensate completely the rent of all land consumed.

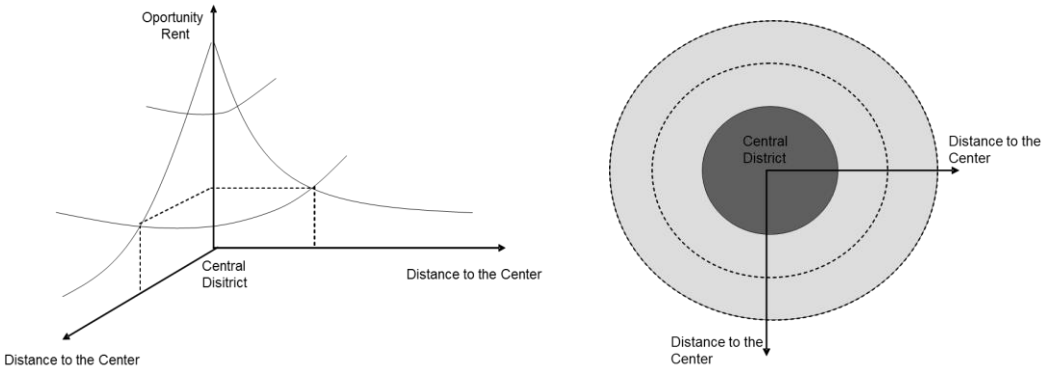
The AMM model has been extended to incorporate changes in demand like the heterogeneity of agents (they vary by income or family composition, or with an opportunity cost of time spent on travel), in exogenous factors (type of transport used) and in supply (substitution between capital and land or the introduction of public goods) to explain different configurations of households in the urban space (Fujita, 1989; Glaeser, 2007).

When agents' heterogeneity is included in the model, the agent with the steeper bid-rent function locates closer to the CBD because it makes a higher monetary bid per unit of land in that location[5]. For households, the slope of these curves depends on its ability to substitute land for other consumption goods, as well as their income. Similarly, the location of firms depends on their ability to substitute land with capital. Since the interest in this work is to understand how different distributions of households in the city are achieved, we do not address firm issues.

[5] This explains why the market equilibrium rent function is the upper envelope of the location equilibrium between groups.

The city that offers bid-rents decreasing from the center to the periphery becomes a circular city if there are no geographical obstacles and roads develop uniformly. In this city rents are high in the central district because land availability grows when one moves away from the center lowering the need to substitute. The left panel in Figure 1 shows the income gradient offered in two directions from the CBD. Bid-rents are equal at all locations equidistant from the CBD. The right panel in Figure 1 shows a cutting plane of the same model. In the vicinity of the central district the bid-rents will be higher and decreasing in concentric circles regarding the central district. A less intense gray indicates lower bid-rents.

Figure 1. Bid-rents and the City Structure



Source: Yepes (2009).

In general, the competition between households for the best location will lead to an increase in the bid-rents near the CBD along with a displacement to the periphery of those households that cannot substitute land for other goods of the consumption basket. These might be households with access to agricultural uses of land, households with a large number of members or households with a lower ability to pay. Given an income level, some households might be able to make a higher bid by demanding less land near the CBD when these properties replace land consumption with height. As the distance from the CBD increases, the bid-rent function becomes flatter since there is a higher demand for land per household.

When agents only differ in their income, the poorest will live at the periphery if the income elasticity of demand for transport is greater than the income elasticity of demand for land. The trend can be reversed if the wealthy access different transport technologies (car versus public transport) that reduce the time they spend on commuting. Including opportunity costs of traveling result in non-linear income elasticity, thus the richer locate near the CBD, the poorer in the following ring and middle-income households in the periphery. Differences in a household demographic composition have also been included, for example, the proportion of family members that work. The result is that households with a higher fraction of working members make higher bids-rents near the CBD because the opportunity cost of commuting exceeds gains from a bigger house.

Other models have incorporated multiple centers and an uneven distribution of attributes across the urban space. Other employment centers, other spatial attributes distant from the CBD –such as parks- and negative attributes of the center –such as congestion and pollution- might attract households to the periphery. Nonetheless, whatever the attributes of space, the basic principles still hold: by choosing their location households maximize welfare under a budget constraint, and in equilibrium the rents paid for land will change along with the bid-rent of the household with the highest bid. Hence, the urban structure is a function of the distribution of the attributes of space that attract or repel households, as well as of the heterogeneity of the preferences, income and commuting choice of agents.

Since households with similar socio-demographic characteristics have similar bid-rent curves, they choose similar places. Thus, it is not surprising that similar households live close to one another (at the same distance from the CBD). Concentration of low-income households is actually an expected result of the AMM model, i.e. free or unrestricted sorting.

2.3. The influence of social interactions on the urban structure

Certainly if the decision is to choose a location near or far given the budget constraint, being as close as possible will be the preferred option. But why would a household or firm decide to locate in the city in the first place? What are the reasons that attract or compel a household to compete for space? The AMM has been useful to understand the structure of cities and the incentives that determine the sorting process of households and firms. However, it provides no information on the reasons of the emergence of cities and their permanence in time; otherwise it assumes the existence of the CBD.

In recent years, the research on urban economics has advanced in the introduction of external economies in the equilibrium of firms (see Glaeser, 2007 for review). Developments have focused on agglomeration economies -external economies emerging from the closeness of firms locating in the same spatial neighborhood. Compared to a randomized localization, agglomeration enables firms to get higher productivity, thus, agglomeration economies are the source of productivity differentials that attract and maintain firms in cities; they also result in higher wages and, in turn, determine households' equilibrium. Although the structure of the city can continue to be circular as in the monocentric model, agglomeration economies provide a mechanism that reinforces the value of the center and keeps it as attractor for firms who search for productivity advantages from interaction.

However, this amplified AMM model has not advanced in incorporating the relevance of social interactions on households' localization decisions; it just assumes that households stay in the city because agglomeration economies promote higher wages. Hence, the fact that the closeness provided by the urban space generates benefits and costs from the interactions between households, and that these affect the urban equilibrium is not considered.

Social interactions occur because households are incentivized to benefit from external economies and, at the same time, external economies are the result of social interactions. The benefits of social interactions are external economies because they are not generated within the process of individual decision of a household or a firm, but they still influence their decisions. Thus, the true social cost or benefit of an action is not reflected in the market prices, but affects the structure of individual decisions. Particularly, the benefits (costs) of social interactions can be understood as attributes that decrease (increase) the relative value of the central district, therefore, they alter the urban equilibrium.

The equilibrium of urban land prices necessarily links the presence of externalities in consumption. Some of these externalities affect the choice of location by changing the attributes of space, decrease or increasing the relative value of the CBD. For example, higher densities might be accompanied by congestion or pollution, also households with family, ethnic or similar bonds may benefit from living close to each other. In Bogotá, childcare has proven to be a strong determinant of the urban shape since new households weigh the benefits from locating near family members that can take care of children under five (Yepes, 2009). Also, some households prefer to be closer to their families than to the CBD or to be near playgrounds as clubs or sports centers.

Social interaction defines the structure of cities, not necessarily to dominate the agglomeration of firms, but to compete as spatial concentration forces. In assessing the relative location of other homes in the city, the urban structure is transformed by the existence of these externalities as bid-rents curves become flatter or steeper in relation to the central district. That is, the central district loses some of its attributes when there are positive externalities in consumption due to social interaction.

Further, social interaction might also affect the parameters or the characteristics of households' choice of location, making then endogenous to the sorting process. For example, income may become endogenous if living near similar individuals affects differently income generation capacity.

Neighborhood effects literature has drawn evidence and has modeled how these externalities affect individual outcomes, but its relationship with the urban structure has not been thoroughly attended. For example, this literature concludes that a child may perform poorly in school if it is in a neighborhood with violence, or human capital externalities (if they exist) may result in higher returns for those near individuals with higher human capital. But it does not examine how these externalities might be influencing localization decisions. The study of neighborhood effects extends to a wide range of literature, from convergence properties in evolutionary game theory to urban poverty traps, and explores externalities that cover violence, healthcare and education (Durlauf, 2007). Some of the research has incorporated the choice of residence to the identification of neighborhood effects to get rid of the self-selection captured by neighborhood effects otherwise (e.g. Bayer and Timmins, 2007). But investigations have not worked the other way around, i.e. exploring the effect neighborhood effects have restricting a change of residence.

On the other hand, there are theoretical results about the effect of social interactions on the market's aggregated results. Glaeser and Scheinkman (2000) generalize neighborhood effects models and show that when agents' optimization decisions are influenced by social interactions, they generate a

multiplier effect or multiple equilibria that create the excess variance of endogenous aggregate variables relative to fundamentals. For example, they explain why there is a greater variance of the socioeconomic characteristics of households in the city than within their spatial units. Particularly, when there is self-selection (e.g. individuals choose their neighborhood) the homogeneity of the group makes more likely the presence of multiple equilibria. To this extent, social interactions influence the urban equilibrium.

In brief, social interactions and their resulting external economies are market failures that affect the urban structure. Social interactions give a complementary explanation of why the poor live together and in the peripheries. When they optimize to choose their place of residence, they incorporate the exogenous effects of social interactions as attributes of the locations; this includes both attributes of space, as congestion, and attributes of the community, as family bonds. Further, social interactions may result in positive or negative effects of space over the characteristics and budgetary restrictions of households.

It is worth mentioning that not only supply and demand-side externalities differentiate the urban structure from that expected in a free sorting scenario. Other exogenous factors, such as geography, institutions and place-based policy incentives, give additional attributes to space and, thus affect location decisions.

- Geography and roads development deviate the urban shape from its initial circular shape. In Bogotá, the eastern mountain range on the east side and the Bogotá River on the west side restrict the growth of the city in these directions.
- Public policy may influence demand by making some places more attractive than others through investments in public goods. It may also generate monetary incentives through subsidy schemes. Regulations, such as zoning, have a direct influence on housing provision.
- If institutions are not equally strong across locations, poorer households might be pushed to locate in more risky places or locations with blurred property rights. This is the case in many areas in Bogotá. Since 1980s the expansion of the city has been pulled by informal settlements, which are later recognized as part of the city.
- Other supply-side restrictions as transaction costs may also be present. Transaction costs of moving, including searching and monetary costs, might help explain why a household stays in its residence despite being better off in another location. However, our approach focuses on demand-side market failures.

In conclusion, the concentration of poor individuals in specific locations can be achieved through two channels. It can be the product of free sorting, where similar individuals, take similar decisions and, therefore, end up living together. But it can also be explained by restrictions posed by space to the sorting process that trap household to their current places of residence. The latter is what we propose to understand as segregation.

Though all types of market failures affect the urban shape not all of them restrict sorting creating the incentives to concentrate households with similar income characteristics. Specifically, external economies that affect the urban equilibrium by changing individual characteristics restrict sorting,

while those affecting a location's characteristics are incorporated as an attribute of space in the optimization process, thus they affect the urban shape but do not change the households' decision-making structure.

From a household's perspective, segregation indicates that interactions with and within certain location are influencing its outcomes and, in turn, these outcomes are influencing its ability to sort. In particular, the sorting is free when budgetary restrictions are exogenous to the process, specifically, when the income of households only depends on its portable assets. However, if income is influenced by location, the budget restriction is endogenous to the sorting process. This implies that initial conditions (place of residence) restrict the ability to sort of some households.

3. Are the poor segregated?

Though theoretically the paths leading to concentration of low-income households can be distinguished, drawing evidence on segregation poses a great challenge. The challenge consists in assessing how much of the observed concentration is due to free sorting –i.e. individuals sorting according to their budgetary restriction and choosing over the non-portable assets that characterizes a location; and how much is explained by the endogeneity of households' income. In other words, since households select themselves into neighborhoods it is difficult to identify if concentration of agents with similar characteristics is a result of similar agents choosing similar locations because of the exogenous characteristics of the location, or if the similarity arise from externalities that affect the households' characteristics making them more similar. As posed by Bayer and Timmins (2007) it is not possible to separate the first objectively observable nature (free sorting) from the effects of social interaction (restricted sorting).

Though there is not a standard approach to this problem, previous works have used varied techniques to identify the existence and importance of social interaction in the housing market. Bayer and Timmins (2007) uses instrumental variables to control for endogeneity. Another body of literature analyzes the equilibrium properties of the sorting mechanism (several works by Bayer, McMillan, Rueben and Timmins). Other works have used data at the household level to obtain the demand curve for housing; this sheds light on the sorting process and, in theory, helps to identify the degree of diffusion of social interactions. Another approach has recognized mechanisms exogenous to these decisions, as childcare for new households (Yepes, 2009).

To identify the importance of segregation in explaining poverty in Bogotá, we propose a different approach that does not solve the double causality between income and choice of location, but weighs the influence of space, as opposed to portable assets, on the differences in income levels across the city space.

We understand that income segregation is present when locations affect the structure of income generation given individual assets. Here we do not intent to prove the channels through which this may happen, but to emphasize that the way households sort across locations may explain only part

of the income differences across households, thus, segregation might not play a major role in explaining concentration.

The methodology is developed in the next subsection. Afterwards, the results for Bogotá is presented.

3.1. Methodology: The Oaxaca-Blinder Decomposition

A mincerian approach is used to characterize the differences of income levels across households in space. It is assumed that the level of income is the result of combining education, working, and demographic characteristics of households, these are referred to as portable assets since households can carry them to different locations. In turn, the characteristics of space are non-portable assets. Non-portable assets affect the manner in which portable assets combine to generate income, thus, they define the "income production structure" of households. If this structure varies across locations, then space is a significant factor to explain income differences, which means that segregation exists.

To shed light on the degree in which segregation influences the urban structure we use the Oaxaca-Blinder mean decomposition (OB decomposition hereafter). Previous works have used mean decomposition methods to explain disparities between urban and rural areas (Ravallion and Wodon, 1999), and between regions and within regions (López-Acevedo and Skoufias, 2010) but, to our knowledge, it has not been used to explain intra-city welfare disparities

The Oaxaca-Blinder decomposition allows to explain differences in income between two groups, $\Delta\bar{Y}$, by differences in two components: the distribution of observed and unobserved characteristics, Δ_x, and the structure of income generation, Δ_s (i.e. $\Delta\bar{Y} = \Delta_x + \Delta_s$). Hence, for two different locations A and B, the decomposition method assumes that $Y_{g,i} = m_g(X_i, \varepsilon_i)$ where g = A, B, and $m_g(.)$ Is a function that depends on observable, X_i, and unobservable, ε_i, individual characteristics.

The linear Oaxaca-Blinder (OB) method assumes that living standards in any given geographic area are a linear function of the characteristics of households (X) and the returns to these characteristics captured by the parameters β (Eq. 1),

$$Y_{g,i} = \sum_{k=0}^{K} X_{g,i,k}\,\beta_{g,k} + \varepsilon_{g,i}, \qquad g = A, B \qquad \text{(Eq. 1)}$$

Where $\boldsymbol{X_{g,i,k}}$is the covariate k of household i in location g, and $\boldsymbol{X_{g,i,0}} = 1$ for all g and i. k=0, 1, …, K and K is the total number of independent variables. The households characteristics used in these estimations are non-geographical attributes such as age or education level, thus the marginal effects -the estimated β parameters- are assumed to reflect the underlying differences in institutions, access to infrastructure, and topography that change between locations. Based on this specification, the

differences in the average expected income between two geographic areas, $\Delta\bar{Y} = \bar{Y}_A - \bar{Y}_B$, may be decomposed into three components: a covariates effect that summarizes differences in average household characteristics between the two geographic areas (holding the returns to characteristics constant), a space effect summarizing differences in the returns to characteristics due to location (holding average household characteristics constant) and an interaction effect that captures the interaction between differences in covariates and their returns. The decomposition (Eq. 2) is the result of adding and subtracting $\sum_{k=0}^{K} \bar{X}_{A,k}\,\beta_{A,k} + \sum_{k=0}^{K} \bar{X}_{B,k}\,\beta_{B,k} + \sum_{k=0}^{K} \bar{X}_{B,k}\,\beta_{A,k}$ to the difference in expected incomes.

$$\Delta\bar{\boldsymbol{Y}} = \underbrace{\sum_{k=0}^{K} \bar{\boldsymbol{X}}_{\boldsymbol{B,k}} \left(\hat{\boldsymbol{\beta}}_{\boldsymbol{Ak}} - \hat{\boldsymbol{\beta}}_{\boldsymbol{Bk}}\right)}_{\hat{\Delta}_s:\boldsymbol{Space\ effect}} + \underbrace{\sum_{k=0}^{K} (\bar{\boldsymbol{X}}_{\boldsymbol{Ak}} - \bar{\boldsymbol{X}}_{\boldsymbol{Bk}})\, \hat{\boldsymbol{\beta}}_{\boldsymbol{Bk}}}_{\hat{\Delta}_x:\boldsymbol{Covariates}} + \underbrace{\sum_{k=0}^{K} (\bar{\boldsymbol{X}}_{\boldsymbol{Ak}} - \bar{\boldsymbol{X}}_{\boldsymbol{Bk}}) \left(\hat{\boldsymbol{\beta}}_{\boldsymbol{Ak}} - \hat{\boldsymbol{\beta}}_{\boldsymbol{Bk}}\right)}_{\hat{\Delta}_I:\boldsymbol{interaction}} \quad \text{(Eq. 2)}$$

Where $\bar{Y}_{g,i}$ is the mean expected income of group g, $\hat{\beta}_{gk}$ are the estimated coefficient from the OLS regressions, and $\bar{X}_{gk}$ is the mean of characteristic k of group g.

The OB decomposition has been written in several ways, each weights the interaction effect differently. A general formula for weigh D is shown in (Eq. 3)

$$\Delta\bar{\boldsymbol{Y}} = \underbrace{\sum_{k=0}^{K} \left[\boldsymbol{D}\bar{\boldsymbol{X}}_{\boldsymbol{A,k}} + (\boldsymbol{1}-\boldsymbol{D})\bar{\boldsymbol{X}}_{\boldsymbol{B,k}}\right] \left(\hat{\boldsymbol{\beta}}_{\boldsymbol{Ak}} - \hat{\boldsymbol{\beta}}_{\boldsymbol{Bk}}\right)}_{\hat{\Delta}_s:\boldsymbol{Space\ effect}} + \underbrace{\sum_{k=0}^{K} (\bar{\boldsymbol{X}}_{\boldsymbol{Ak}} - \bar{\boldsymbol{X}}_{\boldsymbol{Bk}}) \left[\boldsymbol{D}\hat{\boldsymbol{\beta}}_{\boldsymbol{Ak}} + (\boldsymbol{1}-\boldsymbol{D})\hat{\boldsymbol{\beta}}_{\boldsymbol{Bk}}\right]}_{\hat{\Delta}_x:\boldsymbol{Covariates}}$$

(Eq. 3)

The choice of D plays a crucial role on results. Though it has been thought that the omitted group choice poses an identification problem, Fortin *et al*. (2011) point out that it is more a conceptual problem. This problem can be resolved by comparing the OB decomposition to program evaluation methods. Specifically, $\hat{\Delta}_s$ is compared to the Average Treatment effect on the Treated where $\bar{X}_{Ak}\left(\hat{\beta}_{Ak} - \hat{\beta}_{Bk}\right)$ can be interpreted as the contribution of returns when covariates change from cero to $\bar{X}_{Ak}$. In our estimations, we take average individual assets for the whole population; thus, D is the share of individuals in A in the total.

We use Bogotá's Living Standards Survey for 2011 (EMB-2011 for its acronym in Spanish). The survey collects information for 16,508 households from a total of approximately 2.2 million and is statistically significant by *localidad* and public services strata.

3.2. To what extent does segregation affect households' localization decisions in Bogotá?

Since segregation is mainly transmitted through a reduction in income generation capacity that impacts the budgetary restriction of a household, income is our variable of interest. We assume that income differentials between locations are explained by differences in portable assets, but also by differences in their returns that, in turn, depend on the income production structure in each location. Segregation exists when these structures are significantly different, in such a way that two

households with equal portable assets, but living at different locations, will observe different income levels.

We assume that the city is in equilibrium since households have sort to maximize welfare choosing its consumption basket including housing and its amenities; further, the equilibrium implies that households sort -are able/willing to consider alternatives- regardless of whether they actually move. By taking into account alternatives and choosing their current place of residence staying where they are also contributes to the formation of the urban equilibrium.

Now, if location explains a major part of the income differential between those locating in less desirable places compared with the rest of the citizens, then one can conclude they are segregated. Basically households are not reaching a higher consumption basket because their place of residence is affecting their ability to pay for it. Further, if returns to individual assets are thought of as attributes from space and households sort for them, the poorest households would be observing lower bid-rents incentives, and will be trapped in those places with the lowest returns.

The key to weigh segregation is to identify peripheral *localidades* where households are believed to be segregated. Since the formation of the urban equilibrium requires that households compare among all available options when they optimize, peripheral *localidades* are compared to the rest of the city. The rest of the city represents the place where households might not be segregated from the better opportunities of the city. In order to avoid an arbitrary selection of *localidades* of the poor periphery, we test different combinations. We use five definitions of periphery as described in Table 3, some basic statistics are also shown. The first four groups take the 3, 6, 9 and 12 *localidades* with the highest poverty rate. The fifth group considers households that locate in *localidades* in the frontiers of the cities, which matches most of the neighborhood with public service strata one and two. This can be verified in Map 1 (red and yellow dots).

Table 3. Peripheries

Cluster		**Poverty rate** %	**Concentration of Poor** %	**Concentration of Households** %	**Mean income** COP
Group 1	Ciudad Bolívar, Usme, San Cristobal	34.8	31.2	17.4	1,216,092
Group 2	Ciudad Bolívar, Usme, San Cristobal, Rafael Uribe Uribe, Bosa, Santa Fe	31.8	51.0	31.2	1,346,264
Group 3	Ciudad Bolívar, Usme, San Cristobal, Rafael Uribe Uribe, Bosa, Santa Fe, Tunjuelito , Los Martires, La Candelaria	30.6	56.0	35.5	1,420,833
Group 4	Ciudad Bolívar, Usme, San Cristobal, Rafael Uribe Uribe, Bosa, Santa Fe, Tunjuelito , Los Martires, La Candelaria, Antonio Nariño, Kennedy, Suba	24.0	79.9	64.7	1,961,894
Group 5	Strata 1 and 2	29.0	68.4	45.9	1,367,158

Source: based on EMB-2011. COP: Colombian Pesos

Table 4. OB Decomposition, Aggregate results (%)

Periphery	Portable assets		Location		Expected income	
	Difference	***Share***	**Difference**	***Share***	**Difference**	**Mean test**
Group 1	41.40	*70.27*	17.52	*29.73*	**58.92**	***
Group 2	43.05	*67.08*	21.13	*32.92*	**64.18**	***
Group 3	42.56	*66.51*	21.43	*33.49*	**63.99**	***
Group 4	43.16	*71.11*	17.54	*28.89*	**60.69**	***
Group 5	50.68	*65.77*	26.37	*34.23*	**77.05**	***

Source: based on EMB-2011.
*** p<0.01, ** p<0.05, * p<0.1

In the case of Bogotá results show that, though significant, segregation is not the main explanation for concentration of low-income households. Location explains one quarter to one third of income differential between those living at the poorest peripheries compared to the rest of the city. The average income is nearly sixty percent lower in the peripheries with such difference being statistically significant. Table 4 shows the results of the OB decomposition. The weight of location changes almost 29 percentage points between clusters; however, it does not overpass 35% in any of the definitions of periphery used. The characteristics of the households and their correlation with income can be found in Table 5.

Table 5. Income and portable assets

Demographics			*Work*		
Size	0.002	(0.008)	Labor force	0.395***	(0.014)
Sex of head	0.181***	(0.030)	*Labor status head (Omitted group: Wage earner)*		
Single	-0.144***	(0.029)	Independent	-0.128***	(0.022)
Age (Head)	0.021***	(0.005)	Without payment	-0.295	(0.196)
Age^2 (Head)	-0.000***	(0.000)	*Occupation Head (Omitted group: Executive)*		
Education			Finance and Management	-0.153***	(0.055)
Levels Head - Omitted group: None			Natural sciences	0.325***	(0.082)
Preschool	-0.029	(0.219)	Health	-0.137**	(0.057)
Primary	0.410***	(0.099)	Social and other sciences	-0.165***	(0.052)
Secondary	0.667***	(0.099)	Art, culture and sports	-0.210***	(0.053)
Technical	1.059***	(0.101)	Sales and services	-0.185	(0.123)
Graduate	1.607***	(0.106)	Mining or extraction activities	-0.286***	(0.059)
Postgraduate	1.962***	(0.114)	Transport and equipment operation	-0.299***	(0.055)
			Manufactures	-0.258***	(0.052)
Constant	12.125***	(0.154)	Observations	11,716	
			R-squared	0.369	

Source: based on EMB-2011.
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.

These results imply that, on average, the income production structure for households does not vary considerably across locations. Hence, it is very likely that a household of the poor periphery will find a location where it will be at least as good as it is in its current location. Nonetheless, it has actually chosen its current location because, given its budget, it is better off there than elsewhere.

Further, the share of location in explaining income differentials is positively biased by differences in unobservable characteristics, thus it can be expected to be lower. Specifically, the quality of education is one of the main concerns when comparing returns to these portable assets. But it is positively correlated with income, thus, if observable, this characteristic will just amplify the gap in portable assets.

The occupation and age of the household head are the portable assets for which returns change the most between the center and the periphery. Education also has a considerable impact. Table 6 presents the disaggregation of the differences in returns between center and periphery by portable assets. The share explained by each characteristic varies widely between the different definitions of peripheries; however, demographics explain a higher share of these differences than education or work related characteristics.

4. By which means are the poor segregated?

Segregation is not the main source of income disparities across locations, however, it explains a notable fraction between one forth and one third of the differences. From a policy perspective, these results show that placed-based investments are not the priority but should be considered. There are various mechanisms through which space and income generation capacity relate. For example, longer distances from markets reduce labor opportunities, lower provision of public goods reduces benefits, and living near similar individuals or having low exposure to different kinds of individuals may place lower/higher returns to human capital. Recognizing these mechanisms gives further guidance to prioritizing among local policies and, at the same time, shed a bit more of light into understanding how space and poverty interact. In this section we first identify the impact of space over income generation capacity and then assess its relation with the attributes of space that might explain it.

In past sections we argued that segregation is present in the urban dynamics when income generation structure varies substantially between locations, in other words, when, given the portable assets provision, the expected income varies. We measure the impact of space as the difference in expected income in the place of residence compared to the rest of the city. In particular, the impact of space to households i is

$$I_i = y^e_{i|j} - y^e_{i|j}$$

where $y^e_{i|j}$ is the expected income (in logarithm) in household i in its current place of residence j, and –j reference all other places. Then, if i lives at the center j is center and –j is periphery. Because

expected income is measured in logarithms, I_i is the percentage income difference between locations.

Table 6. Differences in the returns to portable assets, Disaggregation

	Group 1		Group 2		Group 3		Group 4		Group 5	
	Diff.	**Share**	**Diff.**	**Share**	**Diff.**	**Share**	**Diff.**	**Share**	**Diff.**	**Share**
Demographics	**7.40**	**23.99**	**19.21**	**129.10**	**21.85**	**-663.23**	**-17.32**	**35.28**	**5.66**	**-74.55**
Size	0.65	2.11	0.56	3.77	0.66	-20.07	-2.01	4.10	9.99	-131.56
Sex of head	-4.01	-13.01	3.26	21.89	2.56	-77.60	-6.59	13.43	5.26	-69.26
Single	-1.40	-4.53	-1.08	-7.26	-0.78	23.77	-2.89	5.89	-0.61	8.08
Age (Head)	-6.13	-19.88	6.31	42.43	8.40	-255.02	-29.46	60.01	-34.72	457.16
Age^2 (Head)	18.30	59.30	10.16	68.27	11.01	-334.32	23.64	-48.15	25.75	-338.96
Education	***23.58***	***76.42***	***1.48***	***9.95***	***-3.82***	***116.06***	***-50.99***	***103.87***	***-26.74***	***352.06***
Levels of Head Omitted group: None										
Preschool	-0.01	-0.03	-0.09	-0.63	-0.07	2.03	-0.07	0.15	-0.15	1.92
Primary	4.07	13.20	-1.70	-11.44	-2.62	79.51	-7.45	15.18	-9.11	119.96
Secondary	10.83	35.09	-0.40	-2.69	-2.85	86.54	-14.18	28.88	-12.35	162.57
Technical	3.38	10.97	0.94	6.32	-0.07	1.97	-9.12	18.57	-2.62	34.45
Graduate	4.84	15.70	2.84	19.10	1.87	-56.78	-10.19	20.76	-0.34	4.46
Postgraduate	0.46	1.49	-0.11	-0.71	-0.09	2.79	-9.98	20.33	-2.18	28.69
Work	***-6.69***	***-21.66***	***-7.16***	***-48.12***	***-13.68***	***415.11***	***-16.97***	***34.57***	***-11.51***	***151.57***
Labor force	0.29	0.94	-3.36	-22.56	-3.38	102.64	-15.79	32.17	-10.73	141.33
Labor status head Omitted group: Wage earner	***4.85***	***15.70***	***3.40***	***22.87***	***2.53***	***-76.65***	***2.98***	***-6.06***	***6.32***	***-83.17***
Independent	4.60	14.91	2.93	19.70	2.14	-64.89	2.88	-5.86	5.95	-78.39
Without payment	0.25	0.80	0.47	3.17	0.39	-11.75	0.10	-0.20	0.36	-4.78
Occupation Head Omitted group: Executive	***-11.82***	***-38.30***	***-7.20***	***-48.43***	***-12.82***	***389.11***	***-4.15***	***8.46***	***-7.10***	***93.41***
Finance and Management	-0.99	-3.22	-1.13	-7.57	-1.66	50.26	1.46	-2.98	-0.15	1.92
Natural sciences	-0.29	-0.95	-0.23	-1.55	-0.47	14.36	1.07	-2.17	-0.43	5.67
Health	-1.20	-3.89	-1.09	-7.30	-1.39	42.18	-1.22	2.48	-1.05	13.85
Social and other sciences	-0.65	-2.09	0.91	6.11	-0.31	9.50	-0.40	0.81	0.37	-4.89
Art, culture and sports	-3.94	-12.77	-2.06	-13.84	-3.19	96.68	-2.64	5.38	-1.67	21.97
Sales and services	0.01	0.05	-0.05	-0.34	-0.16	4.91	-0.47	0.96	-0.01	0.12
Mining or extraction activities	-0.95	-3.06	-0.92	-6.18	-1.18	35.71	-0.22	0.45	-0.69	9.12
Transport and equipment operation	-2.07	-6.70	-1.71	-11.47	-2.38	72.31	-1.68	3.42	-2.36	31.04
Manufactures	-1.75	-5.67	-0.93	-6.28	-2.08	63.21	-0.05	0.11	-1.11	14.62
Constant	-3.37	-10.91	10.83	72.82	20.15	-611.57	105.34	-214.56	64.03	-842.96
Total	**30.86**	**100.00**	**14.88**	**100.00**	**-3.29**	**100.00**	**-49.10**	**100.00**	**-7.60**	**100.00**

Source: based on EMB-2011.

As expected, the average impact of space is lower in the peripheries where returns to portable assets are lower. On average, households in the center would lose between $400,000 and $1,000,000 Colombian pesos (COP) if they moved to the periphery; this means a reduction of about 20%, and even almost 40%, in their income. On the other hand, people living at the peripheries could increase their income by $200,000 to $300,000 (15% to 20%) by moving to the center (Table 7).

Usually, location places a higher burden on the poor. For example, when the periphery is defined as group 2, poor households have an average impact of space of COP 56,000 and a median impact of –COP 13,000, while mean and median impact for non-poor households are of COP 409,000 and COP 234,000, respectively. Mean tests for these differences are highly significant. In pesos the differences are huge due to scale. However, the differences as percentage of each household's income show the same results. Mean changes in income due to space are always lower for poor households (Table 8).

Table 7. Impact of location over income by location

Periphery	Periphery			Rest			Total		
	Mean	Median	Standard deviation	Mean	Median	Standard deviation	Mean	Median	Standard deviation
				Thd COP					
Group 1	124	56	440	464	231	895	402	184	841
Group 2	56	-13	443	409	234	755	345	174	721
Group 3	30	-39	443	378	209	768	314	148	732
Group 4	-148	-168	363	1	-86	641	-27	-103	603
Group 5	-18	-108	492	385	160	859	312	71	819
				%					
Group 1	8.50	6.69	24.87	21.83	16.69	32.44	19.40	14.82	31.62
Group 2	1.25	-1.78	26.50	15.32	15.98	28.18	12.76	13.48	28.40
Group 3	-1.00	-4.97	25.12	12.79	15.47	27.20	10.28	12.70	27.36
Group 4	-15.45	-18.11	26.14	-3.53	-5.12	24.21	-5.70	-8.13	25.00
Group 5	-6.80	-13.51	28.34	12.19	13.45	32.63	8.73	7.18	32.72

Source: based on EMB-2011.
COP: Colombian Pesos.

But, what characteristics of location explain these differences? We identify three mechanisms by which space may affect income generation capacity of households:

i) *Access to urban services*: a lower access to these services reduces the ability of people to learn from different types of social interactions. Most importantly, access to the labor market increases the probability of finding a job and diversifies the range of income sources. Access is measured in terms of time-distance to urban services. We use time (in minutes) to the place of work, and dummy variables that identifies if households need to take a less than twenty minutes walk to reach different urban services.
ii) *Non-portable assets*: the characteristics of the house and the neighborhood that are exogenous to the sorting process can affect the efficiency at work by affecting, for example,

their health. We also include these aspects since governmental plans have focused in improving living conditions as a way to reduce poverty.

iii) *Characteristics of the community*: as the neighborhood effects theory asserts, individual behavior is affected by group behavior. We proxy the influence of the community's characteristics as the average expected income in the *localidad* of residence.

Table 8. Impact of location over income by poverty level

Periphery	Poor			Non-poor			Total		
	Mean	Median	Standard deviation	Mean	Median	Standard deviation	Mean	Median	Standard deviation
Thd COP									
Group 1	-218	-126	384	538	273	853	402	184	841
Group 2	-260	-175	335	630	366	677	345	174	721
Group 3	-278	-179	354	654	391	674	314	148	732
Group 4	-242	-202	419	408	300	679	-27	-103	603
Group 5	-283	-193	387	861	683	724	312	71	819
%									
Group 1	-15.44	-12.89	17.71	27.03	19.92	28.74	19.40	14.82	31.62
Group 2	-18.18	-16.45	15.51	27.37	23.95	20.21	12.76	13.48	28.40
Group 3	-18.40	-16.79	14.79	26.72	24.57	17.63	10.28	12.70	27.36
Group 4	-17.35	-17.46	19.35	17.81	17.86	17.44	-5.70	-8.13	25.00
Group 5	-19.00	-17.98	17.02	34.35	33.01	20.62	8.73	7.18	32.72

Source: based on EMB-2011.

These characteristics are correlated with the impact of space in income generation capacity. Table 9 shows OLS results. Easy access to longer distance markets, as provided by the BRT, matters. Being near a station of the Bus Rapid Transit system (BRT) is correlated with a 2-5% increase in the impact of space in most of the cases, while time to work or access to other urban services is not significant or has a small effect. Access to banks is also significant. Characteristics of the building as if it is in a residential compound or if it is a house, the number of floors and having additional land (garage, balcony, courtyard) also have a saying. However, neighborhood characteristics as the quality of the building are not frequently significant. It is also worth noting that an additional person per room decreases the impact of space in 1% to 4%. The mean expected income by *localidad* is highly correlated with the impact of space.

The differentiated impact of space between poor and non-poor households is most certainly due to the fact that the characteristics of space vary systematically between them. We use the OB decomposition to see which are these characteristics. This time we do not differentiate between returns and endowments, we just use the total contribution of each variable to the difference. Table 10 presents the results.

Assets play a minor role explaining the differences, while access and other characteristics of space have a higher participation. For Groups 1 to 3 the share of access variables explaining the difference between poor and non-poor is between 39% and 47% while that of housing and neighborhood

assets is between 4% and 20% in absolute values. From this follows that, unlike what has been promoted by public policy in Bogotá, improving non-portable assets is not an ideal policy to reduce the concentration of poor households in space.

Table 9. Disaggregation of impact of space, Total

Dependent variable: ln(Impact)		Group 1	Group 2	Group 3	Group 4	Group 5
Access to urban services	Public transport	-0.018	-0.005	-0.008	0.048***	0.033
		(0.020)	(0.016)	(0.014)	(0.017)	(0.023)
	BRT Station	0.056***	0.029***	0.021***	-0.034***	0.004
		(0.009)	(0.006)	(0.006)	(0.006)	(0.009)
	Parks or green areas	0.003	0.004	0.010	-0.002	0.037***
		(0.009)	(0.007)	(0.007)	(0.010)	(0.011)
	Local market or supermarket	-0.021	-0.021	-0.018	-0.002	-0.058**
		(0.031)	(0.027)	(0.022)	(0.021)	(0.026)
	Drugstore	0.005	0.005	0.015	-0.020	-0.030
		(0.021)	(0.016)	(0.014)	(0.018)	(0.023)
	Banks	0.032***	0.024***	0.009	0.029***	0.091***
		(0.008)	(0.006)	(0.006)	(0.007)	(0.009)
	Police station	-0.000	-0.008	-0.013**	0.003	0.008
		(0.008)	(0.006)	(0.005)	(0.006)	(0.008)
	Time to work	-0.000	-0.000	0.000	0.001***	-0.000
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
House and neighborhood attributes	Near industry, commerce or service	-0.007	0.001	-0.009*	-0.010*	-0.003
		(0.007)	(0.005)	(0.005)	(0.006)	(0.008)
	Access to house has good quality	0.019**	0.011	0.001	0.003	0.062***
		(0.008)	(0.007)	(0.006)	(0.008)	(0.010)
	House have car entry	0.006	-0.002	-0.002	0.020***	0.037***
		(0.008)	(0.006)	(0.005)	(0.006)	(0.008)
	Residential compound	0.078***	0.059***	0.049***	-0.014*	0.128***
		(0.011)	(0.007)	(0.007)	(0.007)	(0.010)
	Building floors	0.005**	-0.003	-0.003**	-0.003*	0.010***
		(0.002)	(0.002)	(0.001)	(0.001)	(0.002)
	Walls and floor w/out cracks	0.012	0.006	0.006	-0.000	0.003
		(0.009)	(0.007)	(0.006)	(0.007)	(0.010)
	No humidity	-0.010	0.001	0.005	-0.004	-0.002
		(0.008)	(0.006)	(0.005)	(0.006)	(0.008)
	No cracks	0.004	0.003	0.003	0.018	0.031*
		(0.018)	(0.013)	(0.011)	(0.011)	(0.018)
	No failures in water system	-0.026**	-0.009	-0.011	-0.011	-0.028**
		(0.013)	(0.011)	(0.009)	(0.009)	(0.014)
	House	0.019**	0.011*	0.015***	0.004	0.002
		(0.008)	(0.006)	(0.005)	(0.006)	(0.008)
	Walls (quality)	-0.045	-0.002	0.005	0.031	-0.046
		(0.033)	(0.024)	(0.025)	(0.024)	(0.036)
	Floor (quality)	-0.023	-0.007	0.033***	0.003	-0.065***
		(0.018)	(0.013)	(0.011)	(0.013)	(0.015)
	Additional land	0.013	0.016***	0.015**	0.016**	0.029***
		(0.008)	(0.006)	(0.006)	(0.008)	(0.009)
	Overcrowding	-0.035***	-0.010***	-0.007**	0.009**	-0.053***
		(0.004)	(0.003)	(0.003)	(0.003)	(0.005)
Community	Mean expected income	0.378***	0.498***	0.517***	0.351***	0.305***
		(0.010)	(0.007)	(0.006)	(0.008)	(0.010)
Constant		-5.252***	-7.107***	-7.440***	-5.241***	-4.367***
		(0.148)	(0.107)	(0.094)	(0.119)	(0.157)
Observations		9,599	9,599	9,599	9,599	9,599
R-squared		0.304	0.524	0.578	0.271	0.377

Source: based on EMB-2011.

Table 10. Difference of impact of location between poor and non-poor households explained by characteristics of space

	Group 1		Group 2		Group 3		Group 4		Group 5	
	Diff.	**Share**	**Diff.**	**Share**	**Diff.**	**Share**	**Diff.**	**Share**	**Diff.**	**Share**
Access to urban services	***7.14***	***56.41***	***5.12***	***37.24***	***4.86***	***36.53***	***-6.91***	***-63.27***	***2.53***	***13.41***
Public transport	-2.67	-21.04	-0.06	-0.47	-1.01	-7.63	0.60	5.46	-0.29	-1.52
BRT Station	1.24	9.77	1.26	9.19	0.43	3.21	-1.95	-17.82	0.95	5.03
Parks or green areas	2.12	16.78	1.22	8.88	1.27	9.51	0.21	1.90	4.63	24.56
Local market or supermarket	10.01	79.06	4.18	30.39	5.33	40.09	-5.28	-48.31	-12.84	-68.14
Drugstore	-7.02	-55.46	-3.21	-23.38	-2.83	-21.28	-0.71	-6.52	9.58	50.85
Banks	2.57	20.29	1.37	9.97	1.11	8.37	1.15	10.55	2.21	11.74
Police station	-0.20	-1.60	-0.01	-0.05	-0.07	-0.51	0.13	1.23	-0.89	-4.71
Time to work	1.09	8.61	0.37	2.72	0.63	4.75	-1.07	-9.77	-0.83	-4.39
Non-portable assets	***-1.67***	***-13.17***	***-0.37***	***-2.73***	***-0.74***	***-5.57***	***-9.26***	***-84.70***	***4.71***	***25.01***
Near industry, commerce or service	-0.47	-3.72	-0.52	-3.76	-0.38	-2.84	0.55	5.05	-0.69	-3.65
Access to house has good quality	2.43	19.17	2.27	16.53	2.30	17.26	1.24	11.38	5.87	31.19
House have car entry	0.21	1.70	0.13	0.97	-0.13	-0.97	0.44	4.07	-0.13	-0.67
Residential compound	1.99	15.74	1.65	12.03	1.25	9.36	-0.38	-3.49	1.89	10.05
Building floors	-1.17	-9.26	-2.45	-17.80	-2.76	-20.75	-2.14	-19.62	-2.80	-14.84
Walls and floor w/out cracks	2.57	20.28	1.28	9.32	0.53	3.96	-1.38	-12.61	2.64	14.00
No humidity	-0.10	-0.78	0.40	2.91	0.54	4.07	1.12	10.26	0.45	2.38
No cracks	-1.88	-14.86	-3.01	-21.91	-2.16	-16.27	-2.20	-20.12	-1.25	-6.62
No failures in water system	-2.73	-21.56	-1.99	-14.45	-2.28	-17.14	1.57	14.41	-4.31	-22.90
House	0.60	4.77	0.69	4.99	0.78	5.87	-0.04	-0.37	0.61	3.27
Walls (quality)	1.28	10.14	1.81	13.18	1.93	14.47	-0.03	-0.29	-1.05	-5.57
Floor (quality)	-1.37	-10.86	-1.10	-8.02	-0.25	-1.87	-3.22	-29.51	3.64	19.32
Additional land	-1.58	-12.47	0.80	5.81	0.74	5.55	-2.13	-19.53	1.06	5.62
Overcrowding	-1.45	-11.46	-0.35	-2.54	-0.84	-6.28	-2.66	-24.32	-1.23	-6.56
Community: Mean expected income	***43.27***	***341.65***	***27.37***	***199.15***	***79.16***	***595.15***	***77.71***	***711.13***	***177.18***	***940.69***
Constant	-36.08	-284.89	-18.37	-133.66	-69.98	-526.11	-50.61	-463.16	-165.59	-879.12
Total	**12.66**	**100.00**	**13.74**	**100.00**	**13.30**	**100.00**	**10.93**	**100.00**	**18.84**	**100.00**

Source: based on EMB-2011.

5. Conclusions

In this paper we have decomposed the income differential of a group living at the urban periphery of Bogotá compared against its peer group that lives at the inner city. The decomposition allows us to account whether the sociodemographic characteristics of households or returns to these characteristics in either location explain such income differential. Sociodemographic characteristics

are assumed to make up a mincerian income profile, where the structure of income generation depends on location. The method, the Oaxaca-Blinder mean decomposition, was applied splitting the sample by location and, subsequently comparing returns between the two groups; thus, it allows us to assimilate return differentials as the share of location explaining income differentials. In parallel, differences in average sociodemographic characteristics account for non-spatial determinants.

We argue that a city may be segregating its low income population if individuals with comparable sociodemographic profiles are drag to poor places in comparison with a process where they freely choose their locations, and therefore are better off there than elsewhere within the city. If the share of location in explaining income differentials between inner and peripheral city dwellers is relatively higher than the share explained by socioeconomic characteristics, then low-income earners are dragged and locked within poor places. A process we call segregation as to give theoretical content to a concept that has been used extensively in urban policies in Latin America.

The first stage of this article highlights the relevance of place-based interventions to reduce poverty, while the second part goes deeper into the type of policies that should be addressed from a territorial point of view. We found that the participation of location in explaining the lower income of peripheral urban dwellers in Bogotá is almost a third, while sociodemographic characteristics explain two thirds, of the income differential. Thus, segregation plays a significant role, but not the main role, in explaining income differentials. From a policy perspective, actions aiming to ameliorate the households' portable assets should be prioritized over placed-based policies at least two thirds of the times. Then, the fight against segregation can be better served investing alternatively in the elements that non-spatial research has found to be effective for reducing income poverty.

Further, we rank a set of interventions associated to space in order to understand better which place-based policies can actually help to close the income differential if the poor continue to cluster in the peripheries. Among a list of problems to be addressed including better accessibility to economic center of the city, local public facilities and local private services we found local public facilities to rank last. Thus, to alleviate poverty policies that facilitate access to the city markets should be put at the top of the list.

These results show the kind of problems that should be tackled and the priority that should be given to attend each of them, but they do not address the specific type of policies to be used. In the case of Bogotá's POT the results help to prioritize place-based policies but they do not give further information over which policy is more appropriate to achieve the desired goal. For example, to increase the access of poor households the actual POT proposes to expand transport services into poorer neighborhoods, while the reform proposal intend to increase low-income housing supply in locations closer to economic activity, to urban services and to a more balanced mix of income groups. However, which has the best benefit-cost ratio? Which fits better the long-term vision, for example, for a densified or expanded city? Are questions left unanswered. Deciding over policies requires further decision criteria. Notice that other policy guidelines as strengthening controls on

land prices speculation and promoting new centers of economic activity closer to clusters of poverty are options that can drag households to places with better access and facilities.

On the other hand, still a sizeable component of the public budget in Bogotá is regularly invested in public facilities aiming, according to official plans, to reduce what they define as segregation; a definition that includes the lack of local public facilities, poor access to the city's main markets and concentration of poor households. Further, the debate on segregation is still lacking a stronger conceptual framework and empirical work in order to enlighten the also important, but different, ethics debate about the acceptability for the society of current living conditions of the poor dwelling at the urban periphery. We have made some progress but further research should be done. It is especially important to exploit further the spatial variance in the data beyond the dichotomous approach of the Oaxaca-Blinder methodology used here. At the same time, a closer zoom to the local phenomena can be achieved by applying new geo-referencing techniques and spatial econometrics. Lastly, an important avenue to help disentangling the role of local public policies can be transited by expanding this research to other cities in Latin America where, for instance, urban regulation is different.

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