Job Accessibility: An Empirical Approximation for Bogotá (Colombia)

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Abstract

The aim of this document is to estimate the impact of job accessibility on employment probability in Bogotá (Colombia). Having as theoretical reference the *Spatial Mismatch Framework* an employment probability equation is estimated which includes variables controlling for personal and household characteristics. Data used come from the *Household Surveys* (2008 and 2009) and the *Urban Planning Office* (2008). Moreover, the research focuses on the treatment of *Location-Endogeneity* problem using instrumental variables: (1) distance between actual residence location and the nearest official neighborhood in 1950; (2) distance between actual residence location and the nearest original settlements of the city. Results indicate that improving job accessibility have a positive impact on the employment probability, especially in the case of women.

R1 General Regional Economics

J64 Unemployment: Models, Duration, Incidence, and Job Search

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1. Introduction

Edward Glaeser (2011) argues that "*cities are the absence of physical space between people and companies. They are proximity, density, closeness. They enable us to work and play together, and their success depends on the demand for physical connection*". Nevertheless, people or groups of people face spatial frictions in accessing jobs, for this reason, unemployment is unevenly distributed within cities. This phenomenon is known as *Spatial Mismatch*. Indeed, Kain (1968) presented one of the first statements of the role that spatial separation might play in creating informational gaps between the poor and the rich in urban areas, since his paper classic papers written by Ihlanfeldt and Sjoquist (1989, 1990), Kasarda (1990) and Gobillon (2013) support this hypothesis both theoretically and empirically.

It's necessary to note that dynamics of urban development is different between countries and cities. For instance, Kylroy (2007) points out that in North America the poor tend to be clustered in the central cities, while higher-income residents are dispersed towards the periphery. On the other hand, in cities of developing countries, the poor are also concentrated in informal settlements at the urban periphery – it is possible to say that the last case is the case of Bogotá, the capital of Colombia.

Unfortunately, and probably due to lack of adequate data, very few studies exist on the effect of physical isolation from jobs on the state of labor markets in developing countries (Gobillon, 2013). On the subject, studies as Rospabé and Selod (2006) mention a positive relationship between distance to jobs and unemployment of citizens in the South African cities.

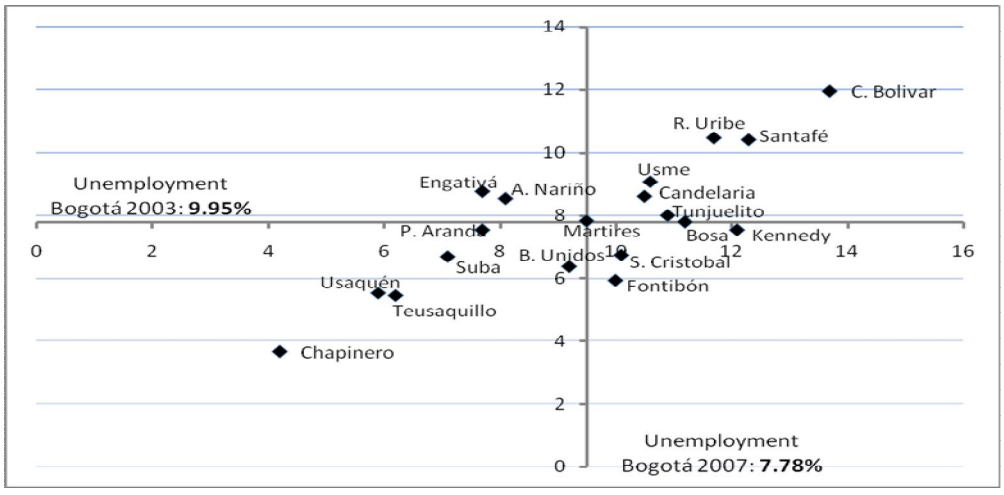
The aim of this document is to estimate the impact of job accessibility on employment probability in Bogotá (Colombia). Data used come from the *Household Surveys* (2008 and 2009) and the *Urban Planning Office* (2008). The theoretical structure used to estimate employment probability equations is the *Spatial Mismatch Framework*. Moreover, the research focuses on the treatment of *Location-Endogeneity* problem using instrumental variables: (1) distance between actual residence location and the nearest official

neighborhood in 1950; (2) distance between actual residence location and the nearest original settlements of the city.

Bogotá, in particular, poses a major challenge as a case study because it has experienced urban problems due to uncontrolled growth of peripheral neighborhoods and a socio-spatial segregation process which initiated about from 1950's. Regarding this issue, Table 3.4.1 shows the urban population and the urbanized area for Bogotá since 1539 until 2020. It is important to note that by the year 2008 Bogotá was a metropolis of approximately seven million inhabitants and, generally, workers who reside in impoverished and isolated areas there do not have enough job opportunities.

Bogotá is divided in 20 *Localidades*, its names are in the panel d) of the Maps 1.1 with the unemployment rate for the years 2003 and 2007 (the sources of the information are of Quality of Life Surveys). The Graph 1.1 shows the unemployment rates, in the horizontal axis are the unemployment rates for 2003 and in the vertical axis are the unemployment rates for 2007, it is important to show this information because there are some Localidades with an unemployment rates above the average of the city and it is a feature that is maintained over time.

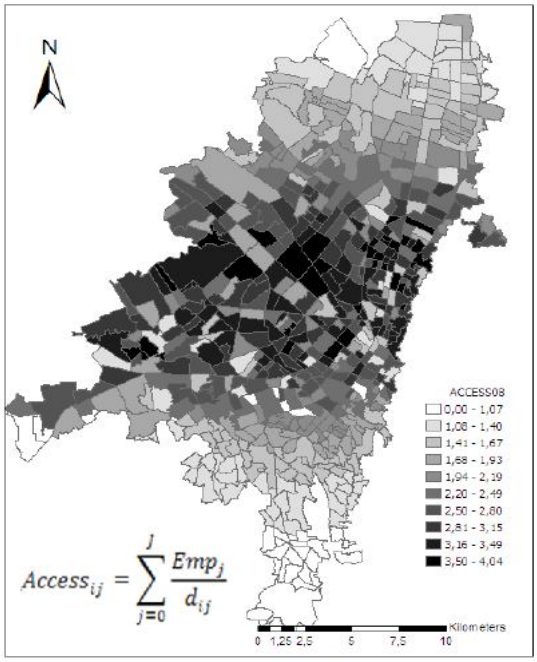
Graph 1.1 Unemployment Rate for Bogotá 2003 Vs 2007



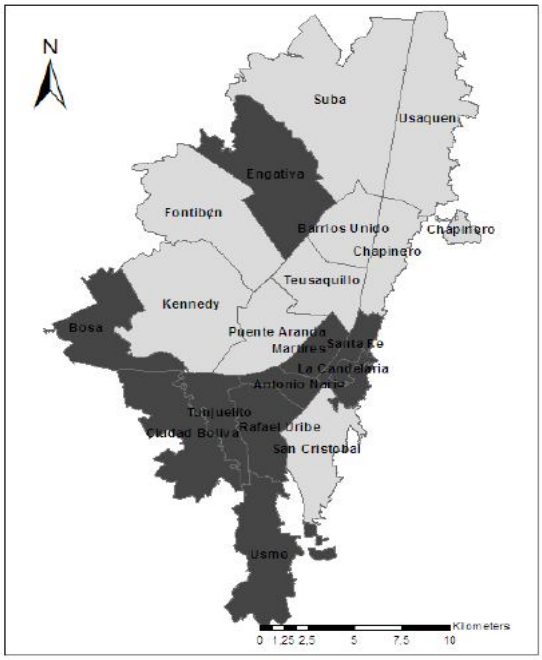
Source: DANE - DAPD Encuesta de Calidad de Vida Bogotá 2003 and SDP Encuesta de Calidad de Vida Bogotá 2007.

Maps 1.1 Job Accessibility Indices and Unemployment Rate for Bogotá

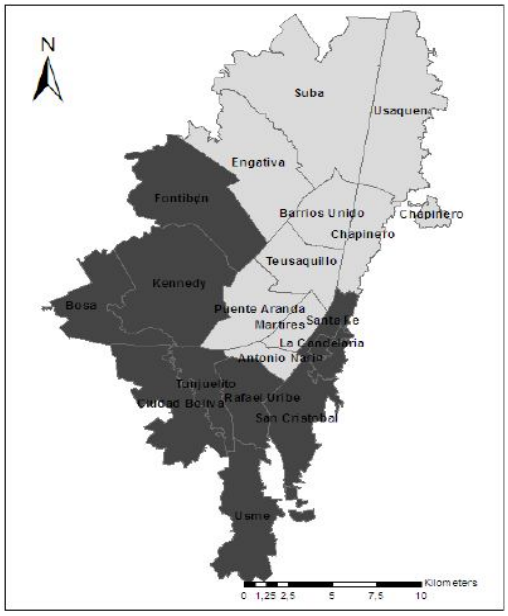
a) Job Accessibility Indices, Bogotá 2008



c) Unemployment Rate 2007



b) Unemployment Rate 2003



d) Unemployment Rate 2003 and 2007

LOCALIDAD	Unemployment Rate	
	ECV-2003	ECVB-2007
Ciudad Bolívar	13,7	11,94
Rafael Uribe Uribe	11,7	10,45
Santafé	12,3	10,39
Usme	10,6	9,05
Engativá	7,7	8,74
La Candelaria	10,5	8,59
Antonio Nariño	8,1	8,52
Tunjuelito	10,9	7,99
Los Martires	9,5	7,82
Bosa	11,2	7,79
Total Bogotá	9,5	7,78
Kennedy	12,1	7,54
Puente Aranda	7,7	7,54
San Cristóbal	10,1	6,73
Suba	7,1	6,68
Barrios Unidos	9,2	6,36
Fontibón	10,0	5,93
Usaquén	5,9	5,52
Teusaquillo	6,2	5,44
Chapinero	4,2	3,67

Source: *Secretaría Distrital de Planeación* (SDP) Bogotá 2008; DANE - DAPD Encuesta de Calidad de Vida Bogotá 2003; DANE - SDP Encuesta de Calidad de Vida Bogotá 2007.

The Maps 1.1 shows in the panel a) the Job Accessibility Index, which is calculated using the information of number of jobs *per census tract* and the direct distances between them, panel b) presents the *Localities* with the unemployment rate above the average of the city in black, and the *Localities* with the unemployment rate below the average in gray with the information of 2003; panel c) presents the *Localities* with the unemployment rate above the average of the city in black, and the *Localities* with the unemployment rate below the average in gray with the information of 2007. In general, it could be said that geographical distances have a significant economic impact on the labor market of Bogotá as the literature on urban economics suggests. The main conclusion in this document is that improving job accessibility has a positive impact on the employment probability, especially in the case of women.

This document, in addition to this introductory section include: Section 2 contains the literature review and a comment about the problem of *endogeneity* and possible solutions to address it. Section 3 contains the empirical exercise on Bogotá. Finally, there is a general conclusion from the estimated results.

2. Literature Review

The seminal work on the *Spatial Mismatch Hypothesis* was done by Kain (1968) who analyzed how housing segregation affects the distribution and level of Negro employment in two metropolitan areas where non-whites were highly segregated: Chicago and Detroit. The author found that housing market segregation may contribute to the high unemployment rates of metropolitan Negroes. Later, Kain (1993) reviewed the empirical literature concerning the effect of housing market discrimination on the employment and earnings of Afro-American workers. The hypothesis of Kain was that Black residents of the few, small black suburban concentrations that exist with housing market discrimination would have higher employment and earnings in comparison with those residents of central city neighborhoods.

After Kain's (1968) seminal work there were several studies that tried to contrast the *Spatial Mismatch Hypothesis*, such as, studies of the geography of social inequality and

income disparities that have been increasing since the 1980s (Townshend and Walker, 2002). For instance, Rospabe and Selod (2006) argue that the separation of residence's location from potential jobs is a consequence of long commuting journeys and high commuting costs, especially in places where private transport is expensive and public transport does not work well or, simply, due to the high costs of job search.

For the case of greater London, Fieldhouse (1999) finds that employment is correlated with job density for a few ethnic groups mainly: Pakistani and Bangladeshi. Meanwhile, Sanchez (1999) finds that transit accessibility increases labor participation in the cases of Portland and Atlanta (the author measures labor participation as the average annual weeks worked).

Raphael and Stoll (2001) show that spatial mismatch contributes to the unemployment of Hispanics and Asians, but to a lower extent than for Afro-Americans in the US Metropolitan Areas. Kawabata (2003) analyzes the metropolitan areas of Boston, Los Angeles and San Francisco, and shows that improved job accessibility drives up both the probability of being employed and the number of hours worked; the author finds that the effect is higher for workers without cars.

Recent developments in the spatial mismatch literature have led to investigations about the relevance of gender to the theory. This is the case of Blumenberg (2004), which for the case of Los Angeles, focuses on the residential and work place location choices of women in multi-person households (males and children); the author argues that, for women, this situation involves trips to various places such as schools and shops. Meanwhile, Huston (2005) develops a framework which conceptualizes and reconciles skills mismatch and spatial mismatch within metropolitan areas, incorporating the operation of local housing and labor markets, as well as the role of commuting. The author argues that skills and spatial mismatch are likely to reinforce each other.

Recently, Gobillon (2013) notes that in Europe, urban spatial structure is *somehow inverted* when compared with United States, and this is because in Europe jobs tend to be located in relatively central parts of the cities where as minorities are residentially concentrated in some relatively peripheral areas. Aslund et al. (2010) study the role of job proximity as a

determinant of the individual labor market outcomes for the case of Sweden. Authors estimate employment equations and find that the job proximity measure is significant for women, but small and insignificant for men. Furthermore, they estimate earnings equations in the overall population and find that the estimated coefficient related with the job proximity measure is larger for men. Authors conclude that local job proximity is positively correlated with individual outcomes.

Gobillon and Selod (2006) found only slight evidence of a negative effect of job accessibility on the probability of finding a job in Paris. When they examine accessibility and educational levels together, they find that only in the case of less-educated workers does accessibility improve job finding. Meanwhile, Matas et al. (2010) analyze the effect that the urban structure of Barcelona and Madrid has on the probability of female employment. The authors show that low job accessibility to public transport affects negatively the employment probability.

Other studies for Paris and Brussels show that the spatial mismatch hypothesis is not really an issue. Gobillon and Selod (2007) analyze the effects of residential segregation and disconnection from jobs on the labor-market transitions out of employment in the Paris region; they conclude that the locations where the unemployment rate is highest are also characterized by segregation but apparently not by bad job accessibility. The authors conclude that neighborhood segregation is a key factor that prevents unemployed workers from finding a job. Meanwhile, Dujardin et al. (2008) finds that the distance to jobs is not significant in explaining employment probability in Brussels; they argue that this result is coherent with the spatial structure of the city, where generally the unemployed individuals reside close to jobs.

There are few works about the Spatial Mismatch Hypothesis for cities in developing countries. Unfortunately, and probably due to lack of adequate data, very few studies exist on the effect of physical disconnection to jobs on the labor markets outcomes in developing countries (Gobillon, 2013). As an example Rospabé and Selod (2006) note that, in South African cities, research suggests that distance to jobs has a positive impact on the unemployment of citizens.

Urban development in Latin American cities is quite different in comparison to North American or European cities. Alinaga-Linares and Álvares-Rivadulla (2010) argue that socioeconomic segregation is a distinctive feature of the social and spatial structure of Latin American cities. Indeed, cities started to grow in the 1960s receiving rural migrants. As a matter of fact, in Bogotá most of the immigrants are attracted by the opportunities of the big city, but a percentage of them come having no other option since they are displaced by the violence in some parts of the countryside. Authors pointed out that in 2004 Bogotá received between 7 and 8 percent of the total displaced population in Colombia.

Alinaga-Linares and Álvares-Rivadulla (2010) argue that in Latin America the urbanization dynamic is not similar to US Metropolitan areas; indeed, there is little information about racial or ethnic segregation in the region, partly because of Regional Censuses have not asked for racial and ethnic information for many years. In cases where information exists, such as in some Brazilian cities, racial categories appeared to be less determinant of residential segregation than class categories, compared to the US cities.

Olarte (2012) analyzes the relationship between job accessibility, employment and income of inhabitants of Bogotá. The author takes into consideration the improvements of public transport using a Structural Equation Model (SEM). With the SEM empirical approach Olarte (2012) tries to capture the endogeneity and the causality among these variables. The author tries to explain whether accessibility, income and number of jobs have any influence on the decision to make some improvements in public transport or if the other way round, public transport improvements define the level of accessibility to each zone and the income level of residents.

In his analysis, Olarte (2012) noted that disparities of income in a city represent one of the principal causes of the gap between different zones of a city. Individuals with a high purchasing power (people with a high level of income) used to have more possibilities when choosing the area in the city where they wanted to dwell; these groups of people have more flexibility to move and change where they live. Nevertheless, people with a low level of income will not be able to live in certain zones because of house prices. The author concludes that the city center of Bogotá had declined from an urban and planning

perspective, and this is one of the reasons why the spatial mismatch has begun to settle down in the city.

2.1. The *location-endogeneity* problem

Ewing, et al. (2007) asks if does residential choice comes first and some other outcome follows (known as *environmental determinism*), or if people's physical activity determines their choice of residential environment (known as *self selection*): which one drives behavior?

Understanding that the *endogeneity-location* problem is inherent to the present field of study, Mansky (2003) argues that "*what econometricians can usefully do is to clarify what conclusion can and cannot logically be drawn given empirically relevant combinations of assumptions and data*".

As specialized literature points out, the main problem facing empirical exercises on job accessibility is *location-endogeneity* because there are individual unobserved factors that simultaneously have an effect on the labor-market results and the residence location choice.

Some works, such as Blumenberg (2004) or Matas et al. (2010), study the case of married women. Alternatively, O'Reagan and Quigley (1996a, 1996b, 1998) and Dujardin et al. (2008) handle the endogeneity problem by focusing the analysis on youths still living at parent's home. The subjacent assumption in this last procedure is that the residential location is exogenously determined by the parents. Ihlanfeldt (2006) remarks three general conclusions about using this procedure:

- Job access has a strong effect on the employment of youths;
- Black and Hispanic youths have worse access to jobs than White youths;
- The effects of racial differences in job access play an important part on racial differences in youth employment.

However, Ihlanfeldt and Sjquist (1998) and Ihlanfeldt (2006) point out some limitations that face these empirical results face:

- These results are not generalized to adults;
- The omitted productivity characteristics in equations estimated for youths may still be correlated with measures of neighborhood job opportunity. In this case children share behavioral characteristics with their parents (due to either nature or nurture)

To handle more successfully the bias problem, Ihlanfeldt (2006) recommends the use of simultaneous models of employment and residential location. This approximation requires some variables that affect the residential location but that do not affect employment. As a matter of fact, some studies have included variables that measure the preference for lifestyle in the residential location, but have excluded these variables from the employment equation.

Finally, some literature such as Oreopoulus (2003), Gobillon and Selod (2007) and, more recently, Aslund et al. (2010), uses information about re-localization programs (*government subsidized relocation programs*) in which localization residence choice is exogenous and depends on administrative decisions. Table 2.1.1 presents a summary of the main methods to handle the endogeneity problem.

Table 2.1.1: How to Handle the Endogeneity Problem?

Youths still residing with their parents	Married women	Government subsidized relocation programmes
O'Reagan and Quigley (1996, 1998).	Matas, Raymond, and Roig (2010).	Oreopoulus (2003), for a review.
Raphael, Steven (1998).	Blumenberg, Evelyn (2004).	Gobillon and Selod (2007).
Dujardin, Selod, and Thomas (2008).		Aslund et al. (2010).

As recommended by Ihlanfeldt (2006) to some extent, in the present work is handled the *location-endogeneity* problem using instrumental variables: (1) distance between actual residence location and the nearest official neighborhood in 1950; (2) distance between actual residence location and the nearest original settlements of the city. I propose these instruments because there is a relationship between the urban structure of the city in 1950 and the job accessibility variable, but the urban structure does not have a relation with the

residuals of the regression model which is estimated with information from 2008 and 2009 (the second instrumental variable also meets these characteristics).

3. Job Accessibility: An Empirical Approximation

In Spatial Mismatch studies is necessary to measure the residential accessibility to job opportunities. This variable has to take into account the spatial distribution of jobs and the distance or the cost of access to them (Rogers, 1997). Shen (1998) points out that those most existing operational measures of accessibility are based on Hansen's (1959) original formula. The job access measure can be generally expressed as:

$$S_i = \sum_j O_j \, f(C_{ij})$$

Where S_i is the accessibility for location i; O_j is the number of relevant opportunities in location j; C_{ij} is the travel time, distance, or cost for a trip from i to j; and $f(C_{ij})$ is the impedance function measuring the spatial separation between i and j for an urban or regional system with N locations, $i, j = 1, 2, \ldots, N$.

Ihlanfeldt (2006) notes that it is possible estimate the effect of job accessibility on the results of the labor market using ordinary least squares (OLS estimation):

$$E = \alpha (S_i) + \beta X + \varepsilon$$

Where E represents the individual labor-market result; S_i represents neighborhood job opportunity; X represents a standard set of human capital variables (e.g. education and experience). If α is positive and statistically significant and if blacks or low-skill workers have lower S_i than whites and high-skill workers, then part of the E difference between the groups can be attributed to the spatial mismatch. Ihlanfeldt (2006) points out that the same independent variables can be used to estimate the probability of unemployment or having a job using *Logit* or *Probit* estimations.

3.1. Data and Studied Area

Bogotá spans 33 km from north to south and 16 km from east to west. For the present empirical exercise the geo-statistics zones used are census tracts which are defined by the National Institute of Statistics (*Departamento Administrativo Nacional de Estadística*, DANE). The census track is the smallest spatial unit for which the number of jobs is available. Specifically speaking, the city is divided into 621 census tracts, in which 544 have employment and 14 do not (the number of jobs are not available in these census tracts because the urbanization process there has developed informally).

Table 3.1.1: Descriptive Statistics

Year	2008	48,84%		
	2009	51,16%		
Individual characteristics				
Sex	Men	52,41%		
	Women	47,59%		
Married	Yes	53,17%		
	No	46,83%		
Years of education	Mean	11,00	Std. Dev.	4,818
Potential experience	Mean	21,43	Std. Dev.	14,62
Family characteristics				
Children under 9	Mean	0,608	Std. Dev.	0,843
Children between 9 and 18	Mean	0,635	Std. Dev.	0,865
Household informality rate	Mean	0,23	Std. Dev.	0,69
No. Observations	36097			
Job Accessibility 2008	**Mean**	**2,01**	**Std. Dev.**	**0,636**
nearest distance to formal neighborhood	Mean	1476 (meters)	Std. Dev.	1144
nearest distance to foundational neighborhood	Mean	3356 (meters)	Std. Dev.	1797

Source: *Gran Encuesta Integrada de Hogares* (GEIH, 2008-2009)

Table 3.1.1 shows basic information about the variables used in the present empirical exercise. The information about workers and their residential location used comes from Household Surveys of 2008 and 2009; whereby around 49% of the information is 2008 and 51% is 2009. In the information 52% are men and 48% women; 52% are married and the remaining 48% are not married. The mean of years of education is 11, which is the finish of high school in Colombia. The potential experience is calculated as the worker's age minus

years of education minus 7, and this variable has a mean around 21 years. Variables of number of children are generated through the count of children with certain age in the home. There is a variable that is calculated by dividing the number of informal workers in the household by the number of employed, the rate is calculated without taking into account the specific worker. The household informality rate has a mean equal to 23%.

At the bottom of the table are the mean and standard deviation of the rate of access to employment and the distances are used as instrumental variables: : (1) distance between actual residence location and the nearest official neighborhood in 1950; (2) distance between actual residence location and the nearest original settlements of the city.

3.2. The Job Accessibility Index

Olarte (2012) founded that the central part of the city contains more than 50 percent of jobs, and most of the people commuting to this zone come from the north, the north-west, the west, and the south-west. The more relevant characteristic of the "*outer zones*" of the city is lower incomes. Additionally, the author mentions that the availability of jobs in the city is directly related to the improvements in the public transport system and the income of the citizens.

As it was pointed out by Dujardin, et al. (2008), the relevant job density for residents of neighborhood j is the ratio of the number of jobs located in that neighborhood and in the adjacent neighborhoods to the overall labor force residing in the same areas. This definition has the advantage of smoothing job density over an area and attenuating extreme values.

Following Rogers (1997), this variable has to take into account the spatial distribution of jobs and the distance or the cost of access to them. As in Matas et al. (2010), the variable used here is the employment potential of each residential zone in the metropolitan area. Indeed, the relevant variable should be the number of vacancies but, as data do not supply such a variable at this level of spatial disaggregation, the total number of jobs located in each zone serves as a proxy for vacancies (Matas et al., 2010). It is expected that zones with a higher number of jobs also generate a larger number of vacancies (Rogers, 1997).

Map 3.2.1 shows the distribution of a job accessibility index for Bogotá in 2008. The urban census tracts of the city cover an area of 380 square kilometers (or 147 square miles); maximum length of the city is 30 kilometers and maximum its width is 17 kilometers. The measure of job accessibility is calculated similar to Matas, et al. (2010):

$$Access_j = \sum_j \frac{Emp_j}{d_{ij}}$$

Where Emp_j is the number of jobs in census tract j; d_{ij} is the distance between the census tract of residence of individual i and the census tract of jobs j. The data used to calculate the job accessibility index is given by the *Urban Planning Office* of the city; information about employment per census tract for 2008.

As it is presented in the panel a) in Maps 1.1 (Introduction), the highest job accessibility indices are located on the Eastern border of the city. The city could not expand in this direction because of the presence of a chain of mountains. Historically the expansion of Bogotá was to the south and north and, more recently, to the west (Olarte, 2012).

3.3. Probability of Being Employed

Similar to Matas, et al. (2010) the estimated model has the following form:

$$\Pr[E = 1] = \Pr[\beta X + \varepsilon > 0]$$

$$= \Lambda(\beta X)$$

Where Λ is the distribution function. The dummy dependent variable (E) is equal to 1 when the individual is employed, and is equal to 0 in any other case. Variables in X are personal characteristics of the individual such as: sex, marital status, years of education, potential experience, and the squared of the potential experience; in addition are included some family characteristics such as: household informality rate and the number of children at home both under nine years and between nine and eighteen; it is expected that the estimated coefficient's sign will be negative. Also a dummy variable is included which takes the

value of 1 for the information of 2009 and 0 for 2008. Finally, the variable $access08_{ij}$ represents the job accessibility index for individual i at the census tract j which was defined as in the previous subsection. It is expected that better access will be associated with higher probability of being employed (Rogers, 1997).

Table 3.3.1 present the results of the estimated *marginal effects* of the *Probit* estimation. In general being married, the variable of years of education and experience are positively related to the probability of being employed. The number of children at home is not statistically significant. On the other hand, the coefficient associated with the household informality rate is negative and statistically significant. With respect to the coefficient associated to the job accessibility variable, the result is positive and statistically significant for the entire sample and for men and women separately. This result gives evidence that the job accessibility measure could be positively related to the probability of being employed, especially for women.

Table 3.3.1: Dependent Variable: 1 = Employed, 0 = otherwise. Entire Survey, *Gran Encuesta Integrada de Hogares* (GEIH, 2008-2009)

	1 = Employed; 0 = otherwise					
	Total		Male		Female	
	M-Effects	z-Statistic	M-Effects	z-Statistic	M-Effects	z-Statistic
Individual characteristics						
Sex (male=1)	0,00090	0,31				
Married	0,05816	16,06***	0,07341	12,29***	0,05275	11,01***
Years of education	0,00102	2,47**	0,00035	0,64	0,00209	3,40***
Potential experience	0,00282	8,92***	0,00244	5,73***	0,00240	5,10***
Potential experience*2	-0,00003	-5,77***	-0,00004	-5,79***	0,00001	-0,63
Family characteristics						
Children under 9	0,00330	1,92*	0,00350	1,41	0,00308	1,27
Children between 9 and 18	-0,00003	-0,02	0,00142	0,64	-0,00207	-0,84
Household informality	-0,03607	-13,85***	-0,03442	-9,86***	-0,03610	-9,45***
Year (1=2009; 0=2008)	-0,02109	-7,25***	-0,02504	-6,39***	-0,01632	-3,83***
Job Accessibility	**0,01063**	**4,27*** **	**0,00943**	**2,81*** **	**0,01157**	**3,19*** **
Number of obs.	26198		13405		12793	

Marginal-effects: calculates the marginal effects or elasticities at the means of the independent variables by using the default prediction option associated with the previous estimation command. Significant level: * 10%, ** 5%, *** 1%.

The literature notes that these preliminary estimations of the coefficient associated with the job accessibility index could be inconsistent because of the presence of the *endogeneity-location* problem. In short, if workers with higher probability of being employed choose neighborhoods with higher values of the job accessibility measure, then the estimate of its coefficient may be upwardly biased. In this sense, bias would be avoided only in the unlikely event that X fully captures differences in productivity among workers (Ihlanfeldt, 2006).

3.4. *Location-Endogeneity*: Correction Using Instrumental Variables

Marsh (1983) remarks that since 1950 rapid urbanization has caused important changes throughout Latin America. Additionally, the continent had had economical circumstances characterized by a grossly inequitable distribution of land wealth. In this sense, the high population growth rates and the concentration of the best agricultural land in each country have driven the rural poor to the towns and cities in search of work and basic services. This phenomenon has resulted in overcrowded cities with high unemployment rates, serious service deficiencies and enormous wealth side by side with dire poverty.

In Colombia, by 1940, 71 percent of the population lived in the country side or in villages with less than fifteen hundred people. This percentage diminished to 39.6 percent by 1974, which indicates that Colombia is a part of the Latin American trend of rapid urbanization (Marsh, 1983). Indeed, by 1993 around 60 percent of the Colombian population lived in cities (50 years ago the figure was less than 30 percent).

Table 3.4.1 shows some information about Bogotá. In the second column of the Table shows the urban population, in the third the urbanized area and in the forth the population density since 1539 until 2005 (information is not available for all years).

According to the information shown in the Table 3.4.1, the population of Bogotá was approximately 100,000 inhabitants by the beginning of the twentieth century. The urbanization process started to be important in the 1930's with the migration of rural families. The migratory phenomenon basically was the consequence of the crisis in the

agro-mineral exportation model and the politics of industrialization by importations substitution (Dureau, et al. 2007, Chapter 2).

On the other hand, one of the most important aspects of Colombian history is the phenomenon of rural violence which dates back to 1950. On 9 April 1948 the liberal leader *Jorge Eliecer Gaitan* was assassinated in Bogotá. After this tragic political episode which triggered massive riots in the city they then began in the rest of the country. As a result, violence settled in rural areas of the country where government forces had no presence.

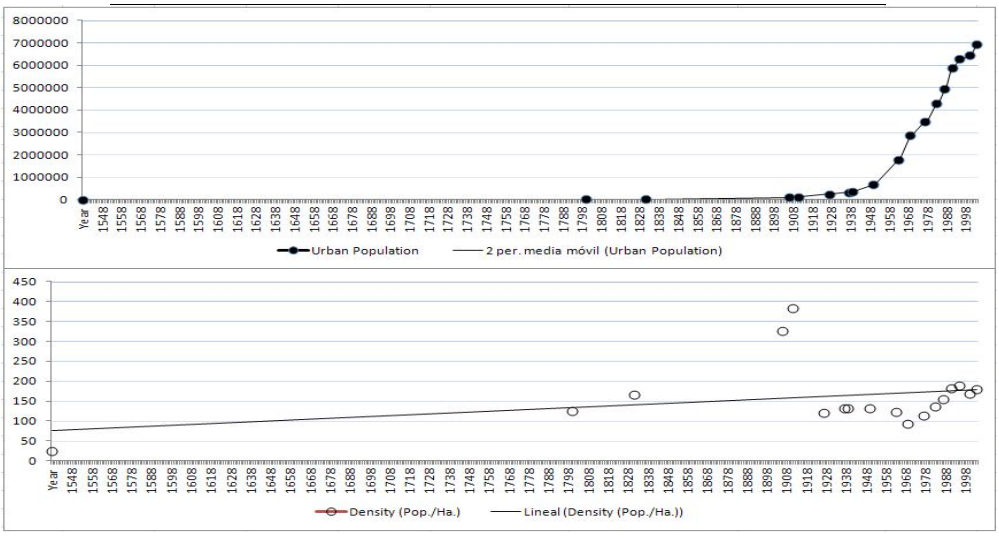
Francoise Dureau, et al. (2007, Chapter 2) points out that between 1940 and 1970 the population of Bogotá grew at 6 percent annually. The main reason for the population growth was the arrival of rural families fleeing war. The dramatic situation was that poor families have basically had two options when they arrive at the city:

- Rent a place in the historical city center (in *overcrowded tenements*)
- *Auto-construction* in peripheral territories, generally occupied illegally.

After the rapid population growth, since 1970 the population growth rate per year has been 3 percent (Francoise Dureau, et al., 2007, Pp. 51). However, competition for land access remains harder for new immigrants in some zones in the city. To take one particular example, in a zone called *Soacha* in Bogotá, the population growth rate was 11 percent per year between 1985 and 1993. Particularly, in *Soacha* land control was especially deficient and illegal auto-construction has been the main way of construction for residential purposes.

Table 3.4.1: Urban Population and Urbanized Area, Bogotá 1539-2020.

Year	Urban Population	Urbanized Area (Ha.)	Density (Pop./Ha.)
1539	500	20	25
1801	21394	170	126
1832	28341	170	167
1907	100000	306	327
1912	116951	306	382
1928	235000	1958	120
1938	330312	2514	131
1940	372000	2833	131
1951	**660000**	**5026**	**131**
1964	**1794852**	**14615**	**123**
1970	2861913	30423	94
1978	3500000	30886	113
1984	4302943	31419	137
1988	4925075	31952	154
1992	5898000	32458	182
1996	6276428	33018	190
2001	6437842	38305	168
2005	6944398	38430	181
2010*	7363782		
2015*	7878783		
2020*	8380801		

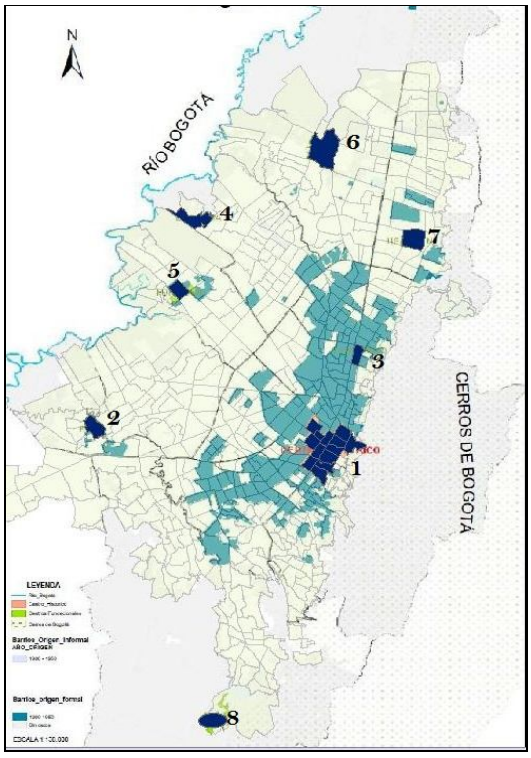


Source: Martinez, Sergio (2010). Information is not available for all years.
http://www.slideshare.net/smmtocan/evolucion-urbana-informal-en-bogota
* DANE, forecast group.

Map 3.4.1 shows in ***light blue*** the official neighborhoods that existed in Bogotá by 1950 when urban population was around 660000 inhabitants; and in ***dark blue*** are the original settlements of the city - Table 3.4.2 shows year of the original settlements -.

As the literature recommends, what is needed is a method to generate only exogenous variation in the job accessibility index variable. Therefore, to obtain the instrumental variables I have calculated: the distance between actual residence location (2008 or 2009) and the nearest official neighborhood in 1950 (*near_dist_barr*); and the distance between actual residence location (2008 or 2009) and the nearest original settlements of the city (*near_dist_loc*). These variables are instruments (*z*) that the property has that are related to the job accessibility index (*x*) variable but not lead to a change in the employment probability (*y*) - aside from the indirect route via *x* -. These variables *z* are causally associated with *x* but not *u* (Cameron and Trivedi, 2005).

Map 3.4.1: Official neighborhoods in 1950 and Original settlements of Bogotá.



Source: Maestría en Gestión Urbana – Línea HAT. Universidad Piloto de Colombia.

Table 3.4.2: Year of the founding of the localities in dark blue, Map 3.3.1

Id.	Original settlement	year	Description
1	Historical city center	1538	Gonzalo Jiménez de Quesada founded what would become the City of Bogotá
2	Bosa	1538	Meeting place of three conquerors: Jiménez de Quesada, Nicolás de Federmán y Sebastián de Belalcázar
3	Chapinero	1812	The place began to be populated by artisans and potters after independence
4	Engativa	Before 1492	It dates back to pre-Columbian times
5	Fontibon	Aprox. 1525	During the colonial period was somewhere between Bogota and the Magdalena River.
6	Suba	1550	The Spanish settlement was founded by Antonio Cardoso days.
7	Usaquen	1539	Was a "*Muisca*" town in pre-Hispanic times and was founded in 1539 as an Indian village.
8	Usme	1650	The center of a rural area dedicated to agriculture, provides important part of the food for the capital.

These instrumental variables are calculated with information from the city when the number of settlers was small. And I assume that historical characteristics of the city are not correlated with the error term (*u)* in the regression. Table 3.3.3 shows the Instrumental Variable Estimation using as instrument the distance to the nearest official neighborhood of 1950 as an instrument (results using the second instrument are in the Table of the Appendix - results are similar).

The estimation is executed using the maximum likelihood method, and the estimator assumes that the endogenous regressor is continuous. The first-stage regression in the bottom of the Table 3.4.3 shows the relationship between the endogenous variable (job accessibility index: *access08*) and the instrument (distance between residential census tract and the nearest official neighborhood in 1950). It is a negative and statistically significant, and is the expected result, since at greater distances a lower accessibility index is expected.

At the bottom of the Output Table is a Wald test of the exogeneity of the instrumented variable. The result shows that there is not sufficient information in the sample to reject the null hypothesis of exogeneity. Therefore, a regular "*probit*" regression may be appropriate: the point estimates from "*probit model with instrumental variables*" are consistent, though those from "*probit*" are likely to have smaller standard errors.

Table 3.4.3: Instrumental Variable: Distance to nearest Official neighborhood of 1950.

1 = Employed; 0 = otherwise						
	Total		Male		Female	
	Coeff.	z-Statistic	Coeff.	z-Statistic	Coeff.	z-Statistic
Individual characteristics						
Constant	0,83262	9,77***	1,02400	9,06***	0,61647	4,99***
Sex (male=1)	0,00779	0,31				
Married	0,47146	16,80***	0,58698	13,65***	0,43450	11,08***
Years of education	0,00905	2,39***	0,00496	0,94	0,01633	2,95***
Potential experience	0,02459	8,96***	0,02223	5,80***	0,02022	5,02***
Potential experience*2	-0,00028	-5,79***	-0,00037	-5,82***	-0,00005	-0,62
Family characteristics						
Children under 9	0,02859	1,89*	0,02994	1,33	0,02812	1,35
Children between 9 and 18	-0,00044	-0,03	0,01063	0,53	-0,01605	-0,76
Household informality	-0,31416	-13,27***	-0,31008	-9,41***	-0,31104	-9,13***
Year (1=2009; 0=2008)	-0,18344	-7,12***	-0,23011	-6,49***	-0,13422	-3,58***
Job Accessibility	**0,08838**	**2,49****	**0,04597**	**0,91**	**0,13480**	**2,70*****
Dependent variable: Job Accessibility index (access08)						
Individual characteristics						
Constant	2,16090	127,70***	2,16014	98,58***	2,14897	84,50***
Sex (male=1)	-0,00898	-1,44				
Married	-0,01939	-2,73***	-0,01332	-1,21	-0,01713	-1,78*
Years of education	0,02961	35,66***	0,03015	27,33***	0,02931	22,86***
Potential experience	0,00408	5,59***	0,00233	2,25**	0,00541	5,06***
Potential experience*2	-0,00001	-0,57	0,00001	0,76	-0,00002	-0,98
Family characteristics						
Children under 9	-0,03563	-10,10***	-0,03412	-6,87***	-0,03631	-7,12***
Children between 9 and 18	-0,03151	-9,15***	-0,03333	-7,19***	-0,03013	-5,80***
Household informality	0,01526	3,21***	0,02123	3,25***	0,00908	1,30
Year (1=2009; 0=2008)	-0,09196	-14,85***	-0,08776	-10,26***	-0,09639	-10,70***
near_dist_barr	**-0,00031**	**-109,57*****	**-0,00031**	**-79,46*****	**-0,00031**	**-75,51*****
Wald Test of Exogeneity (/athrho=0)						
chi2(1)	0,02		0,98		0,80	
Prob>chi2	**0,8803**		**0,3216**		**0,3701**	

Table 3.4.4 shows the estimated coefficient associated with the variable of interest - job accessibility index - obtained from both regressions: instrumental variables method and the probit estimation. The results show that the coefficient is positive, but it is not possible to

say if it is different between the methods of estimation because in the instrumental variables method, the standard error is bigger.

Table 3.4.4 estimated coefficient associated with the variable of job accessibility index

1 = Employed; 0 = otherwise						
	Total		Male		Female	
	Coeff.	z-Statistic	Coeff.	z-Statistic	Coeff.	z-Statistic
Job Accessibility variable						
Probit coefficient	0,09261	4,26***	0,08544	2,82***	0,09919	3,17***
IVProbit Coefficient	0,08838	2,49**	0,04597	0,91	0,13480	2,70***

3.5. Changes in the probability of being employed

Having ruled out the problem of *endogeneity* in the *probit* estimation, at least statistically speaking, it is possible to perform an additional exercise which consists of evaluating the change in the probability of being employed when the level of job accessibility for all the individuals in the sample is set at least equal to the average value of this variable for the census tracts in the highest quintile of its distribution. On average, this simulation implies increasing job accessibility by 52 per cent in Bogotá.

Table 3.5.1: Impact of Accessibility Increases on the Employment Probability

	Baseline Prediction	**Simulated Value**	**Difference**	**Elasticity**
Entire Survey	92,58	93,71	1,22	0,0191
Survey: Men	92,53	93,58	1,13	0,0177
Survey: Women	92,51	93,70	1,29	0,0201

*Elasticity = difference/52

In Table 3.5.1, the second column corresponds to the predicted value of the employment rate at the observed values for accessibility. The third column is the predicted probability in the employment rate derived from the accessibility increase, and the fourth column is the difference between them. The last column shows the elasticity.

The results point out that job accessibility is important in the sense that it represents a measure of job opportunities for people in the city. In this sense, improving job accessibility has a positive effect of employment. As can be observed, this effect is greater for women than for men.

Conclusion

Generally, workers who reside in impoverished and isolated areas do not have enough job opportunities and the literature notes that geographic distance has a significant economic impact on labor market results. Bogotá has experienced this phenomenon due to an uncontrolled growth of peripheral neighborhoods and a socio-spatial segregation process.

For the present empirical exercise it is used information on job location for 2008 and characteristics of the workers for 2008 and 2009. After controlling individual characteristics, the main result of this work is that the job accessibility is a significant determinant of the probability of being employed, especially for women.

To control potential simultaneity problems the regressions were estimated using instrumental variables: (1) distance between actual residence location and the nearest official neighborhood in 1950; (2) distance between actual residence location and the nearest original settlements of the city.

The underlying idea is understand the relationship between location and the labor market in order to explore the possible role for government to bring about a more desirable allocation of resources.

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Appendix

Instrumental Variable: Distance to foundational neighborhood

1 = Employed; 0 = otherwise						
	Total		Male		Female	
	M-Effects	z-Statistic	M-Effects	z-Statistic	M-Effects	z-Statistic
Individual characteristics						
Constant	0,68972	4,74***	0,68449	3,39***	0,66252	3,20***
Sex (male=1)	0,00923	0,37				
Married	0,47335	16,86***	0,58868	13,72***	0,43370	11,02***
Years of education	0,00501	1,00	-0,00474	-0,67	0,01768	2,48**
Potential experience	0,02401	8,58***	0,02127	5,48***	0,02049	4,97***
Potential experience*2	-0,00028	-5,78***	-0,00037	-5,89***	-0,00005	-0,63
Family characteristics						
Children under 9	0,03289	2,12**	0,03957	1,72*	0,02665	1,24
Children between 9 and 18	0,00388	0,26	0,02194	1,07	-0,1753	-0,82
Household informality	-0,31743	-13,39***	-0,31778	-9,67***	-0,30979	-9,08***
Year (1=2009; 0=2008)	-0,16980	-6,03***	-0,19871	-5,14***	-0,13894	-3,36***
Job Accessibility	**0,17994**	**2,17****	**0,26259**	**2,26****	**0,10452**	**0,88**
Dependent variable: Job Accessibility index (access08)						
Individual characteristics						
Constant	1,89769	89,76***	1,89512	68,43***	1,88105	59,72***
Sex (male=1)	-0,01339	-1,80*				
Married	-0,02836	-3,34***	-0,02229	-1,69*	-0,02559	-2,24**
Years of education	0,03771	38,03***	0,03802	28,62***	0,03774	24,87***
Potential experience	0,00564	6,58***	0,00402	3,30***	0,00678	5,39***
Potential experience*2	-0,00001	-0,76	0,00001	0,32	-0,00002	-0,82
Family characteristics						
Children under 9	-0,03980	-9,35***	-0,03965	-6,63***	-0,03891	-6,32***
Children between 9 and 18	-0,03521	-8,53***	-0,03906	-7,07***	-0,03131	-5,00***
Household informality	0,03847	6,79***	0,04340	5,59***	0,03339	4,03***
Year (1=2009; 0=2008)	-0,15686	-21,15***	-0,15197	-14,84***	-0,16202	-15,07***
near_dist_loc	**-0,00008**	**-40,98*****	**-0,00008**	**-29,24*****	**-0,00008**	**-28,67*****
Instrumented: access08						
Instruments: bsexo unido ed2 exper exper2 niños9hogar niños918hogar tinformalhog_1 cano near_dist_loc						
Wald Test of Exogeneity (/athrho=0)						
chi2(1)	1,18		2,44		0,00	
Prob>chi2	**0,2768**		**0,1185**		**0,9628**	