Second Nature Geography and Regional Income Disparities in Colombia

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Abstract

In this paper, we derive and estimate a New Economic Geography model for the Colombian *departments*.[2] We first derive an econometric specification relating wages to a distance weighted sum of the volumes of economic activities of the surrounding locations. Them, we test our econometric specification with data for Colombian departments in the period 1975-2000. The empirical results confirm the theoretical predictions of our model, showing that *second nature geography* factors (access to consumer markets) are a key variable in explaining the spatial distribution of wages in Colombia

Key words: New Economic Geography, Spatial Structure of Wages, Market Access

JEL Classification: R11, R12, R13, R14, F12, F23

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[2] In Colombia, geographical regions are called "departments".

Potencial de Mercado y Estructura Espacial de Salarios: El Caso de Colombia

Market Potential and Spatial Wage Structure: The case of Colombia

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Resumen

En este trabajo se deriva y estima un modelo de Nueva Geografía Económica para los departamentos de Colombia. En primer lugar derivamos una especificación econométrica que relaciona los niveles de renta en cada localización con la suma ponderada por la distancia del volumen de actividad económica de las localizaciones colindantes. Posteriormente, estimamos la citada especificación con datos de los departamentos colombianos para el periodo 1975-2000. Los resultados empíricos apoyan las predicciones teóricas del modelo, corroborando la importancia del potencial de mercado en la configuración de la estructura espacial de salarios en Colombia.

Palabras Clave: Nueva Geografía Económica, Estructura Espacial de Salarios, Potencial de Mercado

Clasificación JEL: R11, R12, R13, R14, F12, F23

1. Introduction

A recent study on the 1975-2000 per capita income distribution among Colombian departments (Bonet and Meisel 2006)[3] shows that income disparities in Colombia are quite large; the per capita income in Bogota is well above the per capita income of any other department in Colombia.

Table 1 shows the evolution of per capita Gross Departmental Revenue (pc GDR) in Colombia computed as the mean of the periods 1975-1980, 1981-1985, 1986-1990, 1991-1995 and 1996-2000. Table 1 reveals that pc GDR in Bogota is more than twice as high as the national average, a ratio that has kept stable during the 1975-2000 period. If we focus on the income gap between Bogota and the poorest Colombian department, Choco, Table 1 figures show that pc GDR in Bogota is more than 8 times higher than in Choco, with a very slow tendency in narrowing this gap. Moreover, the spatial distribution of pc GDR in Colombia shows a strong core-periphery gradient (see Graph 1) where the poorest departments, Caquetá, Cauca, Cesar, Córdoba, Choco, Nariño, Norte de Santander, Magdalena and Sucre are predominantly located in the geographical periphery[4] whereas the richest departments are located close to the Colombian capital, Bogotá[5]. A detailed analysis carried out by Bonet and Meisel (2006) computing a Kernel for the Colombian pc GDR in the period 1975-2000 shows a clear polarization in the income distribution. Bonet and Meisel (2006) results conclude that on the one hand, Bogota is farther and farther away from the mean national income and, on the other hand, there is a tendency of the rest of Colombian departments to approach the national mean.

[3] Other papers dealing with regional income disparities in Colombia are Meisel (1993), Mora and Salazar (1994), Birchenall and Murcia (1996), Rocha and Vivas (1998), Bonet and Meisel (1999), Barón and Meisel (2003), Barón (2004) and Bonet and Meisel (2006).

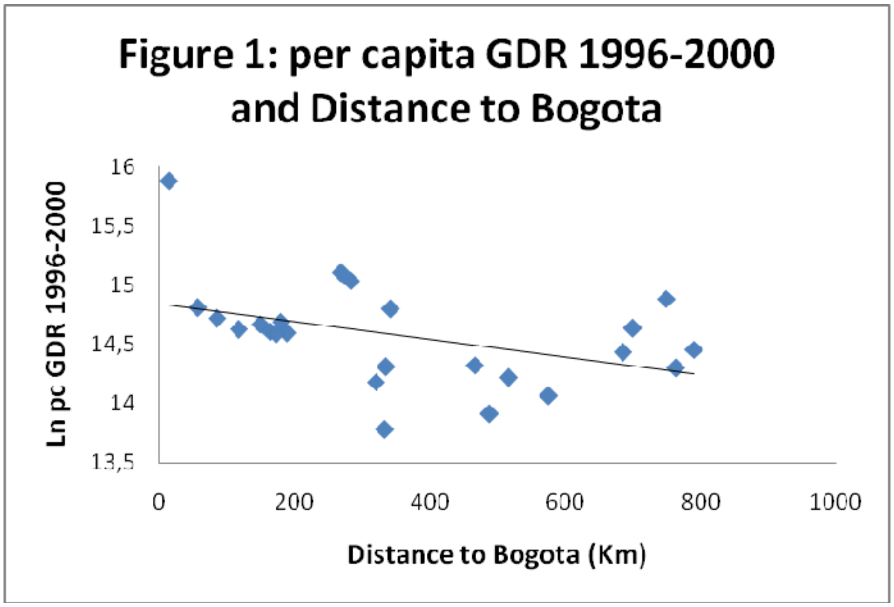
[4] According to Meisel (2007), 51% of the population with unsatisfied basic needs (necesidades básicas insatisfechas (NBI)) and 62% of illiterate persons live in the coastal periphery.

[5] Barranquilla, the capital of the Atlántico department constitutes an exception because in our sample of 24 departments (without taking into account Nuevos Departamentos) it is among the richest cities and its distance from Bogotá (749 Km) places it as one of the cities farthest away from the capital.

Table 1:Per Capita Gross Departmental Revenue (pc GDR)

Department	**1975-1980**	**1981-1985**	**1986-1990**	**1991-1995**	**1996-2000**
Antioquia	39237	126148	454078	1545592	3626780
Atlántico	39158	134177	436388	1355559	2913580
Bogotá	77983	255225	896778	3177581	7847582
Bolívar	27387	87113	296440	967827	2267587
Boyacá	26125	82592	270908	953614	2212812
Caldas	28062	87437	292598	1000896	2346573
Caquetá	18998	58280	195515	597862	1439075
Cauca	18383	61883	201906	755283	1635055
Cesar	21744	64201	210785	781666	1848724
Córdoba	19055	52917	170530	591007	1494216
Cundinamarca	26972	90396	312591	1140496	2697816
Chocó	8516	25151	105204	387554	965927
Huila	26121	83150	247202	890494	2170807
La Guajira	12808	56582	242267	825042	1892829
Magdalena	17861	58532	191984	684531	1618720
Meta	28725	89932	310787	987355	2452051
Nariño	12969	46904	150252	440807	1098774
Norte de Santander	21028	67520	226716	789482	1662103
Quindío	31283	103007	337425	1048494	2148652
Risaralda	30297	98301	318364	1079318	2400146
Santander	32086	104426	338456	1114954	2665781
Sucre	16117	45844	159258	548684	1282288
Tolima	24652	74382	248581	874924	2239826
Valle	42526	138925	463175	1614317	3392979
Nuevos	26048	76506	335348	1058339	2662488
pc GDR mean	32806	107461	363651	1331275	3276619
Bogotá/mean pc GDR	2.38	2.38	2.47	2.39	2.40
Lowest pc GDR	8516	25151	105204	387554	965927
Bogotá/Lowest pc GDR	9.16	10.15	8.52	8.20	8.12

Source: Own elaboration based on CEGA



This preliminary analysis is in line with Bonet's and Meisel's (2006) results. However, they also conclude that neither the fiscal devolution policies nor the dismantling of industrialization and its replacement by import substitution carried out during the 1990s in Colombia were able to reduce interdepartmental disparities and, therefore, they failed to achieve a convergence process in the pc GDR[6].

At the theoretical level, there are many theories that explain the lack of convergence among countries or regions. From the point of view of growth theories, Barro and Sala-i-Martin, (1991, 1995) show that differences in saving rates, investment rates, human capital levels, sluggish technological diffusion, etc. may prevent income levels from narrowing. Traditional theories of economic development emphasize the role of *first nature geography* (i.e., access to waterways, ports, airports, hydrocarbons, climate conditions) in determining income levels (see Hall and Jones (1999)). In the early 1990s, a new branch of research within the Spatial Economics, the so-called New Economic Geography[7], began with the pioneering works of Krugman (1991a and 1991b). New Economic Geography added new insights and gave micro foundations to the explanation of why economic activities are clustered in space. In this new line of research which building blocks are increasing returns to scale at the firm level,

[6] For a critical analysis of the devolution policies as a mechanism for reducing regional disparities in Colombia see Baron and Meisel (2003), Meisel and Romero Prieto (2007) and Meisel (2007).

[7] At the theoretical level, excellent textbooks in New Economic Geography are those of Fujita, Krugman and Venables (1999), Brakman et al. (2001), Fujita and Thisse (2002) and Baldwin et al. (2003).

transportation costs and imperfect competition emphasize the role of the so-called *second nature geography* (distance to consumer markets and distance to input suppliers) as opposed to *first nature geography*[8] as a way of explaining differences in income levels among regions or countries. Since the seminal contributions of Krugman (1991a and 1991b), New Economic Geography has triggered a plethora of theoretical contributions. However, empirical research is still lagging behind[9]. The first empirical attempt to validate the forces at work in the New Economy Geography models at the country level was Hanson (1998, 2005) for the United States. Since Hanson's contributions, many other scholars have tried to test New Economic Geography theoretical predictions for different scenarios. For a sample of world countries see Redding and Venables (2004), European Union regions (Breinlich (2006), Head and Mayer (2006) and Lopez-Rodriguez and Faiña (2007) among others and for single countries see Brackman et al. (2004), Combes and Lafourcale (2004), Roos (2001) and Pires (2006) among others.

The main goal of this paper is to contribute to the theoretical and empirical literature on New Economic Geography. In the first part of the paper, we derive a New Economic Geography model that relates the maximum wages a firm pays in a generic location "i" with a distance weighed sum of the volume of economic activity in the surrounding locations, the so-called *market access* of location "i" in a New Economic Geography fashion or *market potential* in a more traditional regional economics fashion. This relationship between wages and market access in the New Economic Geography literature is usually refer to as the *nominal wage equation*. In the second part of the paper, we estimate the *nominal wage equation* to check the extend to which the computed market access of the different Colombian departments is a key variable in the explanation of the observed differences in the per capita Gross Departmental Revenue in the period 1975-2000. For our estimation, we use data from a recent report made by

[8] A study about income level differences in Colombia analyzing the role of first nature geography, institutional variables and cultural variables can be seen in Bonet and Meisel (2006). Bonet's and Meisel's (2006) results conclude that neither the cultural variables nor the geographical variables were statistically significant in explaining income level differences among Colombian departments.

[9] For a comprehensive survey of the empirical literature about the estimation of the nominal wage equation in New Economic Geography models see López-Rodríguez and Faiña (2008). Other more general surveys on the topic can be found in Overman, Redding and Venables (2003), Combes and Overman (2004) and Head and Mayer (2004).

CEGA[10] for the 24 Colombian departments from the period 1975-2000. The results of our estimation prove to be robust with the theoretical predictions of core-periphery New Economic Geography models showing that *second nature geography* plays an important role in explaining per capita GDR disparities among Colombian departments.

Moreover, our analysis sheds new light on the observed polarization process between Bogota and the rest of the departments in Colombia by pointing out the crucial role played by market access[11] in avoiding departmental income disparities to be narrowed and, in so acting, as a penalty for the convergence process in income levels.

The remaining part of the paper is structured as follows: In section 2, we present the theoretical framework. Section 3 deals with the econometric specifications, data base and variables used in our analysis. Section 4 presents the results and discussions of our econometric estimations and finally section 5 offers conclusions.

2. New Economic Geography and Market Access: Theoretical Framework

The theoretical framework is a reduced version of a standard New Economic Geography model (multi-regional version of Krugman, 1991b) that incorporates the key elements to derive the so-called wage equation and market access. The wage equation will form the basis of our empirical estimations.

We consider a regional setting composed of R locations (j =1, 2……….R), and we focus on the analysis of the manufacturing sector. In this sector, firms produce a great number of varieties of a homogenous differentiated good (D) under increasing returns to scale and monopolistic competition. Firms face transport costs in an iceberg form in order to receive one unit of the differentiated good at location j from location i , $T_{i,j} > 1$ units must be shipped from i, so $T_{i,j} - 1$ measures the fraction of good that is melted in transit from i to j . The manufacturing sector can produce the differentiated good in different locations.

[10] CEGA (2006), Ingreso, Consumo y Ahorro in the Colombia Departments, 1975-2000, Vol. 2, Sistema Simplificado de Cuentas Departamentales, Bogotá.

[11] Market Access in an intuitive way captures how far we are from consumer markets

On the demand side, the final demand in location j can be obtained via utility maximization of the corresponding CES utility function:

$$\max_{m_{i,j}(z)} D_j \qquad (1)$$

where D_j represents the consumption of the differentiated good in location j. D is an aggregate of industrial varieties defined by a CES function a la Dixit and Stiglitz (1977):

$$D_j = \left[\sum_{i=1}^{R} \int_0^{n_i} m_{i,j}(z)^{\sigma-1/\sigma} dz \right]^{\sigma/\sigma-1} \qquad (2)$$

where $m_{i,j}(z)$ means the consumption of the each available variety z in location j and produce in location i and n_i is the number of varieties produced in location i. σ represents the elasticity of substitution among the varieties of the differentiated good where $\sigma > 1$. Products are homogeneous if σ tends to infinity and varieties are very differentiated if σ is closet o one. Consumers maximize their utility (function #1) bearing in mind the following budget constraint:

$$\sum_{i=1}^{R} n_i x_{ij}^{D} p_{ij} = Y_j \qquad (3)$$

The consumer's problem solution gives the final demand in location j for each variety produce in location i.

$$x_{ij}^{D} = p_{ij}^{-\sigma} \left[\sum_{n=1}^{R} n_n p_{nj}^{1-\sigma} \right]^{-1} Y_j \qquad (4)$$

where p_{ij} ($p_{ij} = p_i T_{ij}$), is the price of varieties produced in location i and sold in j and Y_j represents the total income in location j.

If we define a price index for the differentiated goods[i] $P_j = \left[\sum_{n=1}^{R} n_n p_{nj}^{1-\sigma} \right]^{\frac{1}{1-\sigma}}$

and rewrite the consumption expenditure as $E_j = Y_j$, final demand in location j can be written as $x_{ij}^{consD} = p_{ij}^{-\sigma} P_j^{\sigma-1} E_j$. However, in order for x_{ij}^{consD} units of consumption to arrive at location j, $T_{i,j}x_{ij}^{consD}$ must be shipped. So the effective demand a firm in location i faces from a consumer in location j is given by:

$$x_{ij}^{D} = T_{ij}p_{ij}^{-\sigma}P_{j}^{\sigma-1}E_{j} = p_{i}^{-\sigma}T_{ij}^{1-\sigma}P_{j}^{\sigma-1}E_{j} \qquad (5)$$

On the supply side a typical firm in location i maximizes the following profit function:

$$\prod_{i} = \sum_{j=1}^{R}\frac{p_{ij}x_{ij}^{D}}{T_{i,j}} - w_{i}^{D}(F + cx_{i}^{D}) \qquad (6)$$

Technology in the increasing returns to scale manufacturing sector is given by the usual linear cost function: $l_{Dij} = F + cx_{ij}^{D}$, where l_{Dij}, represents the industrial workers used for the production of a variety in location i and sold in location j, F, represents a fixed cost of production, c, is the variable unit cost and x_{ij}^{D} is the amount of the differentiated good demanded in location j and produced in location i ($x_{i}^{D} \equiv \sum_{j} x_{ij}^{D}$ represents the total amount of output produced by the firm in location i and sold in the different j locations) and w_{i}^{D} is the nominal wage paid to the manufacturing workers in location i. The assumptions of increasing returns to scale, preference for variety by consumers, and the existence of an infinite number of varieties of the differentiated good means that each variety is going to be produced by a single specialized firm in only one location. In this way the number of the manufacturing firms is exactly the same as the number of available varieties. Each firm maximizes its profit behaving as a monopoly of its own variety of the differentiated good. First order conditions for profit maximization give the standard result that prices are set as a constant mark-up over marginal costs.

$$p_{i} = \frac{\sigma}{\sigma - 1}w_{i}^{D}c \qquad (7)$$

where $\frac{\sigma}{\sigma-1}$ represents the Marshall-Lerner price-cost mark-up. The higher this ratio, the higher the degree of monopoly power by a firm. As a result, Krugman (1991b) understands σ as an inverse measure of scale economies since it can be thought as a direct measure of price distortion and as an indirect measure of market distortion due to monopolistic power. Given that $\frac{\sigma}{\sigma-1}$ is higher than one, Krugman (1991b) interprets this result as a way of justifying the existence of an increasing return to scale. If we substitute this pricing rule into the profit function, the following expression for the equilibrium profit function can be obtained:

$$\Pi_i = \left(w_i^D\right)\left[\frac{c x_i^D}{\sigma-1} - F\right] \qquad (8)$$

Free of entry assures that in the long run firms break even. So, the incentives for a firm to relocate in a different location have vanished. This implies that the equilibrium output is the following:

$$x_i^D = \bar{x} = \frac{F(\sigma-1)}{c} \qquad (9)$$

The price that is needed to sell this amount of output is $P_i^{\sigma} = \frac{1}{\bar{x}}\sum_{j=1}^{R} E_j P_j^{\sigma-1} T_{i,j}^{1-\sigma}$. If we combine this expression with the fact that in equilibrium prices are a constant mark-up over marginal costs , the following zero-profit condition can be obtained:

$$w_i^D = \left(\frac{\sigma-1}{\sigma c}\right)\left[\frac{1}{\bar{x}}\sum_{j=1}^{R} E_j P_j^{\sigma-1} T_{i,j}^{1-\sigma}\right]^{1/\sigma} \qquad (10)$$

This equation is the so-called *nominal wage equation* in the literature of New Economic Geography and constitutes the key relationship we want to test empirically. Equation (10) shows that the nominal wage level at location i depends on a weighted sum of the purchasing power of the surrounding locations where the weighted scheme is a distance function that decreases as the distance between i and j increases. In the New Economic Geography Literature, the right hand side of the expression (10) has different names; the most common are *market access* (see Redding and Venables (2001, 2004)) and *real market potential* (see Head y Mayer (2004)). We are going to refer to this expression as market access and it will be denoted by MA. The meaning of this equation is that those firms in locations that have a good access to big markets (high market access) will tend to remunerate their local factors of production (workers) with better salaries due to their savings in transportation costs.

If we normalize output production choosing our units in such a way that $c = \frac{(\sigma - 1)}{\sigma}$,

and we set the fixed input requirement as $F = \frac{1}{\sigma}$, and define market access in location i

as $MA_i = \sum_{j=1}^{R} E_j G_j^{\sigma-1} T_{i,j}^{1-\sigma}$, we can rewrite the *nominal wage equation* as:

$$w_i^D = \left[MA_i\right]^{1/\sigma} \qquad (11)$$

This simplification in the *nominal wage equation* is very similar to the Harris (1954) market potential function in the sense that the economic activity is higher in those regions that are closer to big markets. So, New Economic Geography gives the micro-foundations for the ad-hoc formulation of the Harris (1954) market potential formulation.

3. Econometric specification

If we take logs in the expression (11), the estimation of the nominal wage equation is based on the following expression:

$$\log(w_i) = \theta + \sigma^{-1} \log\left[MA_i\right] + \eta_i \qquad (12)$$

where η_i represents the error term and the other variables as defined in the previous section. This equation relates nominal wages in location i with GDP in the surrounding locations weighted by distance and prices. In accordance with the theoretical predictions of the model, the higher the prices and GDP in the surrounding locations and the shorter the distance between the different locations, the higher will be the local wage. This specification captures the notion of a spatial wage structure and allows us to check for a direct relationship between nominal wages in a particular location and its market access. This also constitutes an important condition in understanding agglomeration dynamics.

However, equation (12) is a restricted specification to analyze the effects of market access on nominal wages. The reason is that when running this bivariate regression we cannot be assured that the relationship is a causality relationship or simply captures correlations with omitted variables, such as infrastructure, human capital, innovation, etc. In order to deal with these issues and control for the existence of other shocks that might be affecting the dependent variable and are correlated with market Access, we also estimated an alternative specification that explicitly takes into account the aforementioned considerations. The estimation of the extended nominal wage equation takes the following form:

$$Lnw_i = \theta + \sigma^{-1} \ln MA_i + \sum_{n=1}^{N} \gamma_n X_{i,n} + \eta_i \qquad (13)$$

where X_{in} is a vector of control variables and γ_{in} the correspondent coefficient.

3. 1 Data source and variables

Most of the data for our study come from the computations carried out by a private Colombian organization, CEGA. In 2006, CEGA released a report in which they built for the first time for Colombia, a series of income, consumption and savings for the 25 territorial divisions: 24 departments (Departamentos) plus Bogotá. Until 1991 Colombia had what was known as *intendencias* and *comisarías* that were transformed into departments in the new approved Constitution. Using the label *new departments* (*nuevos departamentos)* CEGA gathers economic information on Amazonas, Arauca, Guainia, Guaviare, Vaupes, Vichada, Casanare, Putumayo and San Andres regions. Per capita Gross Departmental Product in these regions is very much influenced by mining, especially in the cases of Arauca and Cananare.

As a proxy for wages, we use data from per capita Gross Departmental Revenue for the years 1985, 1990, 1995 and 2000 computed by CEGA. The advantages of using this variable to proxy our dependent variable instead of per capita Gross Departmental Product are several: In first place, per capita Gross Departmental Revenue allows us a better approximation of the wages paid within a department than per capita Gross Departmental Product and we do not incur the typical overestimation issue that arises when people have to commute to their work places or there are foreign factors in the production. Although Gross Domestic Product better captures the added value generated by the factors of production in a region, Gross Domestic Revenue better captures what is left to remunerate domestic factors of production in a region by also taking into account fiscal transfers to the different regions. In the second place, Gross Domestic Revenue has a high correlation with quality of life indicators. The correlation between per capita Real Gross Domestic Revenue in 2000 and the Life Quality Indicator (ICV) of 1993 was 0.7 whereas its correlation with per capita Real Gross Domestic Product was 0.18. In the third place, due to the fact that we are running regressions for different periods of time, a good property in the methodology of computation of the different variables is the constancy for the whole series. Data on Gross Departmental Revenue computed by CEGA[12] fulfill this property.

With respect to market access, we have built two different measures of market access for the years of our estimations. Market access of a location "i" according to the expression of the model is a distance weighed sum of the volume of economic activity of the surrounding locations. In order to proxy the volume of economic activity, we use both the Gross Department Product and Gross Department Revenue expressed in current units ($). With respect to the distance discount factor in the computation of market access, it must be borne in mind that when we talk about the "*new departments*" in Colombia, these are isolated regions in its vast majority and are only reach by air or maritime transportation. So, in order to avoid biases in our market access computations, *new departments* were eliminated from our sample. Computations are carried out for the 24 remaining departments where the distance discount factor is measured in kilometers between the capital cities of each department. The internal distance in each department is computed as proportional to the square root of the department's area. The expression we use to compute it is $0.66\sqrt{\frac{Area}{\pi}}$ where "Area" represents the size of the department in Km2. This expression gives the average distance between two points in a circular location (see Head and Mayer, 2000, Nitsch 2000 and Crozet 2004 for a discussion of this internal distance). Computations were carried out using a Geographical Information System and the cartographic information was provided by the Instituto Geográfico Agustin Codazzi.

As control variables, we decided to add those variables that might be affecting nominal wages through our market access measure. We use as controls the stock of human capital measured as the percentage of population in each department with secondary education. The theoretical foundations for the relationship between market access and educational levels have been described by Redding and Schott (2003). They proved that high market access provides log-run incentives for human capital accumulation by increasing the premium of skilled labor. Empirical works carried out at international and

[12]The Colombian National Statistical Department (DANE) publishes Gross Department Product series but it changed the computation method which makes it difficult to compare different Gross Department Product series over the years.

European level have confirmed this relationship (see Lopez-Rodriguez et. al. (2007) and Redding and Schott, (2003)). We also use as a control variable the stock of physical capital measured as road kilometers in each department weighted by the department area in a similar vein to Breinlich (2006)

3. Empirical Results

A. Cross section regressions

Table 2 presents results for the nominal wage equation (equation 12), for four time periods: 1985, 1990, 1995 and 2000. We calculated the market potential based on the Gross Department Product. Column (1) from Table 2 shows that, on average, if market potential increases by 1%, nominal wages expressed in terms of Gross Department Product rise by 0.63%, for the year 1985. Estimates in columns (2), (3) and (4) in Table 2 are similar and statistically significant at all standard levels.

Results from Table 2 allowed us to conclude that, at least for the Colombian case in these four time periods, higher levels of income and prices and lower distances among locations, are associated with higher local wages. These results are in line with the model described before.

Table 2: Gross Department Revenue per Capita as a function of Market Access based on the Gross Department Product per Capita, Cross-section regressions

	Gross Department Revenue (in logs)			
	1985 (1)	**1990 (2)**	**1995 (3)**	**2000 (4)**
Constant	5.33 (2.21)**	5.79 (2.38)**	6.22 (2.67)**	6.20 (2.67)**
Market Access based on the Gross Department Product (log)	0.63 (0.22)***	0.62 (0.20)***	0.62 (0.21)***	0.63 (0.20)***
N	24	24	24	24
R^2	0.27	0.28	0.27	0.29

Note: Standard error robust to heteroskedasticity in parentheses
*: Statistically significant at the 10% level
**: Statistically significant at the 5% level
***: Statistically significant at the 1% level

Table 3 presents results from estimating equation (12), but this time we calculated the Market Access based on the Gross Department Revenue. According to column (1) from Table 3, an increase of 1% in market access is associated with an average increase of

0.60% in nominal wages. The estimated coefficient seems to slowly decrease with time: column (2) shows a coefficient of 0.56% for 1990; in column (3) , the coefficient for 1995 is 0.55% and lastly, the estimated coefficient for the year 2000, presented in column (4), is 0.54%.

One possible explanation for this phenomenon is that those Departments with the lowest market access increased their nominal wages systematically during the time period 1985-2000. However, this comparison may not take into account that market potential may have also changed during these years. Therefore, a richer analysis would add all observations from 1975 to 2000, to avoid the confounding effect of the association between market access and nominal wages with an unilateral movement in market access. These results are presented in Table 4.

Table 3: Gross Department Revenue per Capita as a function of Market Access based on Gross Department Revenue per Capita, Cross-section regressions

	Gross Department Revenue per capita (in logs)			
	1985 (1)	**1990 (2)**	**1995 (3)**	**2000 (4)**
Constant	5.61 (1.45)***	6.48 (1.70)***	6.48 (1.70)***	7.51 (1.87)***
Market Access based on the Gross Department Product (log)	0.60 (0.15)***	0.56 (0.15)***	0.55 (0.16)***	0.54 (0.14)***
N	24	24	24	24
R^2	0.27	0.28	0.26	0.29

Note: Standard error robust to heteroskedasticity in parentheses
*: Statistically significant at the 10% level
**: Statistically significant at the 5% level
***: Statistically significant at the 1% level

B. Pooled OLS

Column (1) from Table 4 shows that if market access, calculated using the Gross Department Product increases 1%, the Gross Department Revenue rises by 0.90% on average, per person. The point estimate obtained with both variables, Gross Department Product and Gross Department Revenue, are very similar, as it is shown in columns (1) and (2) of Table 4.

Columns (3) and (4) from Table 4 present estimates obtained from the estimation of equation 13. In other words, control variables that could be influencing both, market access and nominal wages, are added. Control variables used here to estimate equation 13 include proxies of human and physical capital. In particular, we include percentage of the population with secondary education in the Department as a proxy of human capital and the kilometers of paved roads of the Department divided by the Department area. These control variables are important to identify the effect of market potential on nominal wages, avoiding confounding factors that could influence both, market access and nominal wages, such as education and infrastructure. Whereas infrastructure was measured in 1995, the secondary education measure varies every year. However, it is possible that the stock of physical infrastructure varies very little from one year to the next.

Table 4: Gross Department Revenue per Capita as a function of Market Access based on Gross Department Revenue per Capita and Gross Department Product per Capita, Pooled OLS regressions

	Gross Department Revenue per capita (in logs)			
	(1)	**(2)**	**(3)**	**(4)**
Constant	2.65 (0.084)***	2.84 (0.085)***	3.52 (0.30)***	3.82 (0.30)***
Market Access based on the Gross Department Product (log)	0.90 (0.007)***		0.84 (0.022)***	
Market Access based on the Gross Department Revenue (log)		0.89 (0.008)***		0.82 (0.021)***
Roads (log)			0.11 (0.021)***	0.11 (0.021)***
Secondary education (log)			0.19 (0.075)**	0.20 (0.077)***
N	624	624	384	384
R^2	0.95	0.95	0.90	0.90

Note: Standard error robust to heteroskedasticity in parentheses
*: Statistically significant at the 10% level
**: Statistically significant at the 5% level
***: Statistically significant at the 1% level

Even if control variables are added, the relationship between market access and nominal wages is robust and the point estimates remain very close to previous estimated coefficients. For example, column (3) of Table 4 indicates that if market potential based on Gross Department Revenue increases by 1%, nominal wages rise by 0.845 on average, holding constant human and physical capital. In other words, the inclusion of these two control variables, made the market access coefficient decrease by only 6 percentage points.

Lastly, column (4) of Table 4 shows that if the market potential variable, measured using the Gross Department Revenue, changes by 1%, nominal wages change 0.82% on average, holding human and physical capital constant. The market access coefficient, besides, is statistically significant at all standard levels.

C. Fixed Effects Regressions

In this last section, we estimated a panel data model where we take into account that there could be unobserved and time-invariant variables, inherent to each Department, and that could be associated with nominal wages and market access. There exists a vast literature linking institutions with economic development, for example, (Buchanan and Tullock, 1962; North and Tomas, 1973; North, 1991, 1990), and in particular, about the association between institutions and city growth (DeLong and Shleifer, 1993).

Besides institutions, which are difficult to measure and could be a source of endogeneity, there could be other unobserved variables at the Department level, which could be correlated to nominal wages and market access. Another important source of variation that is relevant to subtract to identify the causal effect of market Access on nominal wages is the temporal variation, i.e. temporal shocks or the economic cycle. All these reasons motivated us to consider that the true model of the nominal wage equation could be the following:

$$Lnw_{idt} = \theta + \sigma^{-1} \ln MA_{idt} + \sum_{t=1975}^{2000} \beta_t + \eta_i + \varepsilon_{idt} \qquad (14)$$

Where w and MA are defined as before. β is the time parameter and η_i is the “nuisance” parameter, or the unobserved term, which includes institutional factors and other error components that are exclusive to each Department. η_i is known in the literature as the “fixed effect” When estimating equation 14, we also allowed the errors to be correlated at the Department level.

Table 5: Gross Department Revenue per Capita as a function of Market Access based on Gross Department Revenue per Capita and Gross Department Product per Capita, Panel Data (Fixed Effect) Regressions

	Gross Department Revenue per Capita (logs)			
	(1)	**(2)**	**(3)**	**(4)**
Market Access based on the Gross Department Product (log)	0.91 (0.006)***	1.49 (0.60)**		
Market Access based on the Gross Department Revenue (log)			0.90 (0.006)***	1.63 (0.53)***
Time fixed effects	no	yes	no	yes
Department fixed effects	yes	yes	yes	yes
F calc under H_0 that time fixed effects are all equal to zero (p-value)		0.000		0.000
N	624	624	624	624
R^2	0.95	0.92	0.95	0.91

Note: Standard error robust to heteroskedasticity in parentheses
*: Statistically significant at the 10% level
**: Statistically significant at the 5% level
***: Statistically significant at the 1% level

Table 5 presents estimates from equation (14). Column (1), which excludes time fixed effects, shows that the coefficient of market access is 0.91. This means that taking into account variations within each Department, if market access is increased b 1%, nominal wages rise by 0.91% on average. This coefficient is significant at all standard levels.

If temporal variations common to all Departments are allowed, the coefficient increases to 1.49 (column (2)). This means that when variations within each Department are exploited, if market potential increases 1%, nominal wages increase on average by 1.49%. This coefficient is significant at the 5% level and the R^2 indicates that more than 90% of the variation of nominal wages is explained by the variation of the variables included in the model. Further, the p-value of the F-test under the null hypothesis that all year coefficients are equal to zero, is very close to zero. As a consequence, we can reject the hypothesis that time effects are not important to explain nominal wages.

In columns (3) and (4) we repeated the same exercise but calculating the market Access using department revenues. We obtained very similar results, which indicates the robustness of the relationship between market access and nominal wages. For example, the point estimate presented in column (3) denotes that if market access increases by 1%, nominal wages rise by 0.90%. This number is very close to the coefficient presented in the first column (0.91). Coefficients in Column (4) denote that including variations within each Department and temporal variations, a 1% change in market access is associated with a change of 1.63% in nominal wages. Coefficients in columns (3) and (4) are statistically significant at all standard levels and again, it is possible to reject the null hypothesis that all time effects are equal to zero.

4. Conclusions

Results from this work demonstrate that market potential is positively associated with nominal wages in the Colombian Departments during the 1975-2000 time period. Therefore, economic geography plays a fundamental role at explaining gross revenue per capita growth. From our estimations, it is possible to conclude that an increase in market access by 1%, is associated with an improvement of between 0.90% and 1.60% in nominal wages, depending on the assumptions. On the other hand, it is possible to say that this relationship is robust to different kinds of econometric specifications. Therefore, Departments with better access to bigger markets can better remunerate their factors and consequently, pay higher salaries.

It is true, however, that economic geography may not be the only cause that explains why Departments located in the periphery have not converged to the central Departments in terms of economic outcomes. History, political decisions, and the lack of a true State policy should also explain the poor economic performance of these regions (Meisel, 2007).

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[i] This Industrial Price Index in location j measures the minimum costs of purchasing a unit of the composed index of manufacturing goods D so it can be interpreted as an expenditure function.