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The role of market access and human capital in regional wage disparities: Empirical evidence for Ecuador

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Abstract

This article examines the effect of market access and human capital on regional wage disparities in Ecuador using the wage equation of the core-periphery model of the New Economic Geography and a multi-level model. Our results, based on cross-sectional data, suggest that market access has a positive and statistically significant effect on wages, although this effect is relatively small. Only a small degree of regional wage variation can be attributed to the effect of market size, while the composition of the labor force explains a significant part of the reduction of regional wage disparities. Consequently, efforts to reduce the unequal spatial distribution of human capital can contribute to the reduction of regional income disparity.

Keywords: Market access. Human capital. Wages. NEG. Multilevel regression. Ecuador.

JEL classification: J31. R12. J24.

1. Introduction

Like other Latin American countries, Ecuador is characterized by a persistent high level of income inequality (Arroyo, 2008). As well, economic activity and human capital follow a core-periphery spatial pattern. Some 66% of companies and 55% of skilled labor are concentrated in the regions of Guayas and Pichincha, where the cities of Guayaquil -the main port-, and Quito -the capital-are respectively located. It can be expected that wages, as the main source of individual income, are strongly conditioned by the geographic distribution of economic activity and human capital. In this respect, there is considerable concern among public policy makers about the regional disparities associated with economic concentration in Guayaquil and Quito given the problems arising from unequal regional development. This issue has also generated increasing debate among researchers oriented to designing mechanisms to reduce regional inequalities and accelerate the development of peripheral regions.

Analysis of regional income disparities in the last two decades has often been based on the core-periphery model of the New Economic Geography (NEG) first proposed by Krugman (1991). The wage equation of this model indicates that regional wage disparities are the result of a heterogeneous distribution of economic activities over space, characterized by greater market potential of regions in the core region. Greater market access reduces production costs, reinforces growing diversification and makes it possible to offer workers higher wages, which in turn contributes to increasing the urban agglomeration of the labor force (Redding and Venables, 2004). This positive relationship has been verified, in particular in developed countries (Hanson, 2005; Niebuhr, 2006; Breinlich, 2006; Brakman, Garretsen and Schramm, 2004; Fingleton, 2005). However, after two decades of theoretical and empirical debate about the NEG, Krugman (2011) himself noted that this model is not very relevant for developed countries where transport costs have significantly diminished (Glaeser and Kohlhase, 2004) and the participation of the agricultural sector in the economy is low (Lucas, 2004), and pointed out that the assumptions of his model are more coherent for developing countries. The productive structure of these countries is more like that formulated by the core-periphery model, where the primary sector employs a significant segment of the labor force and transport costs remain high owing to the limited development of infrastructure. Nevertheless, some developing countries have at least two structural characteristics that can attenuate the positive effect of market access on wages. Firstly, natural resource exploitation and agriculture oriented to the international market can generate high incomes in the exporting regions, which are not necessarily located near the main urban centers (Paredes and Iturra, 2012). Secondly, workers that migrate from peripheral rural areas to large cities can face high rates of informal labor and low salaries (Portes and Roberts, 2005).

Likewise, recent research indicates that the spatial distribution of human capital is associated with the distribution of economic activities and that the presence of universities and large companies increases human capital in the places where they are located (López-Rodríguez, Faíña and López Rodríguez, 2007; Abel and Deitz, 2012; Lehmer and Moller, 2010). This relationship is strengthened over time given that better incomes allow workers to access higher levels of education. Empirical works indicate that the way in which human capital is distributed over space can explain a significant part of regional wage disparities (Combes, Duranton and Gobillon, 2008; Mion and Naticchioni, 2009; Paredes, 2013; Chacón and Paredes, 2013). In this sense, it is relevant to consider that centralism, which is a characteristic feature of many countries in Latin America, has resulted in the best educational institutions being located in large urban centers, which reinforces spatial concentration of human capital. In the case of Ecuador, the best universities are predominantly located in Pichincha Region, which concentrates 31% of the qualified labor force while having only 17.8% of the population.

This article examines the effect of market access and human capital on regional wage disparities in Ecuador. We verified the hypothesis that the effect of market access on wages is low given that the primary sector oriented to the external market generates high incomes in some peripheral exporting regions and because of the high rate of informal labor in core regions. We first estimated the wage equation based on the NEG and then evaluated the effect of human capital in reducing regional wage disparities through a hierarchical model. The use of both techniques is justified because the regional attributes and the endowments of workers influence the average regional wage and individual (Fontes, et al., 2010; Paredes, 2013).We found robust empirical evidence that supports the argument that regional wage variations can be significantly attributed to the composition of the labor force and that only a small part of regional wage variation arises from market size. With this, our results contribute to the debate about the factors that affect regional income disparities in developing countries.

The article is divided into four sections. We present the theoretical framework in the first section and discuss the underlying mechanisms of the relationship between market access, human capital distribution and wages. Afterwards, we describe the case study, the data and the econometric strategy. Following this, we discuss the results and, finally, present our conclusions.

2. Theoretical framework and bibliographic discussion

The NEG core-periphery model has often been used in the last two decades to examine regional income disparities. The wage equation in this model presents a positive relationship between market access and wages (Krugman, 1991; Fujita, Krugman and Venables, 1999). The mechanism underlying this relationship is based on the idea that agglomeration reduces transport costs and gives access to more consumers allowing increasing returns to scale and the capacity to pay more for labor (Martin, 1999; Redding and Venables, 2004; Head and Mayer, 2011). Nevertheless, the benefits of economic concentration decline as increasing agglomeration results in congestion and higher land prices, and as consumers are located further from businesses, as first argued by Harris (1954) and reformulated by Krugman (1991) to formalize market access in the NEG.

Several authors have estimated wage elasticity in relation to market access, in particular in developed countries, among them are notably Hanson (2005) and Fallah, Partridge and Olfert (2011), for counties and metropolitan areas, respectively, in the USA; Niebuhr (2006), Head and Mayer (2006), Breinlich (2006) and Lopez-Rodríguez and Faíña (2006) for European countries; Brakman, Garretsen and Schramm (2004) for German districts; Fingleton (2005) for the regions of Great Britain; Mion (2004) for the Italian provinces; and Kiso (2005) for the Japanese prefectures. The results of these studies are not directly comparable because different methodologies were used, although it is possible to identify the average effect of market access on wages, namely that workers in regions with larger markets obtain higher wages (Breinlich, 2006; Lopez-Rodríguez and Faíña, 2006).

There is a growing empirical literature about emerging economies. Hanson (1997) estimated the effect of economic concentration on wages in Mexico; Hering and Poncet (2009, 2010) evaluated the role of the economic geography on wages in cities and provinces of China; Fally, Paillacar and Terra (2010) estimated the impact of market access on inter-state wage disparities in Brazil; and Amiti and Cameron (2007) estimated the effect of geography on wages in Indonesia. The results of these works confirm the key role of the geographic distribution of economic activity to explain spatial inequalities in wages, even after controlling for the characteristics of the workers (Head and Mayer, 2006; Fally, Paillacar and Terra, 2010; Hering and Poncet, 2010; Paredes, 2013). In this sense, empirical evidence confirms that workers in areas where there is greater economic concentration receive higher salaries than workers in regions with smaller markets (Lopez-Rodríguez, Faiña and Lopez-Rodríguez, 2007; Gabe and Abel, 2012). Furthermore, there are not significant differences in the effect of market access on wages between developed and emerging countries (See Fallah, Partridge and Olfert, 2011; Amiti and Cameron, 2007; Kiso, 2005; Fingleton; 2011).

Although there is a growing literature based on the NEG model, particularly in the context of developed economies, Krugman (2011) noted that the model is less relevant for developed countries than for the productive reality of underdeveloped economies. Likewise, several authors have identified elements that suggest the model is not applicable to developed countries. Glaeser and Kohlhase (2004) showed that transport costs have decreased significantly over time as a result of improvements in infrastructure and technology, while Lucas (2004) analyzed the decreasing participation of the agricultural sector in gross domestic product of developed countries. In contrast, agricultural activity still plays a significant role in developing countries (National Accounts Main Aggregate Database of the United Nations, 2013) and transport costs can be high due to the weak development of infrastructure (Arvis, Alina, Ojala, Shepherd and Saslavsky, 2012). Nevertheless, there are at least two characteristic of the productive structure of underdeveloped countries that can significantly attenuate the positive effect of market access in wages. Firstly, as it is well-known, natural resource exploitation and export-oriented agricultural activity in developing countries, and particularly in Latin America, generate high incomes in peripheral export regions that are not necessarily near major urban centers (Medina, 2010; Paredes and Iturra, 2012). Secondly, workers that migrate from peripheral rural areas to urban centers face a set of economic problems characteristic of large cities in developing countries, such as high rates of informal labor, limited or no access to public services, crime, lack of personal safety and poverty, among others (Portes and Roberts, 2005; Portes and Schauffler, 1993; Safa, 1989; Portes, 1989). The accelerated urbanization (Henderson, 2002) and disproportionate number of unskilled workers drawn to large urban centers in developing countries (Eeckhout, Pinheiro and Schmidheiny, 2010) can result in what some researchers have termed "concentration without growth" (Fay and Opal, 2000; Barrios, Bertinelli and Strobl, 2006;Collier, 2006).

There have been few empirical studies of underdeveloped countries using NEG models, duein particular to the lack of information. However, the structural characteristics of these countries can result in the relationship between market access and wages being weaker than in developed and emerging countries. The NEG indicates that productive activity associated with agriculture (competitive sector) generates low incomes and that urbanization produces economies of scale, which increases wages in core regions (Krugman, 1991; Fujita, Krugman and Venables, 1999; Redding and Venables, 2004). However, this proposition does not necessarily apply in some developing countries, particularly in economies where primary exports in some peripheral regions increase local wages. In this sense, the effect of the primary sector and the existence of peripheral regions with high wages (Paredes and Iturra, 2012; Paredes, 2013),and the potential "concentration without growth" and "urbanization without efficiency" (Fay and Opal, 2000; Collier, 2006), have not been fully formalized in the NEG literature. These structural characteristics, found in some underdeveloped countries, support our first hypothesis: the effect of market access on wages in Ecuador is low compared to its effect in developed and emerging countries.

In recent years, theoretical and empirical studies about the relationship between market access and wages to understand incomes have been extended to incorporate studies about the relationships between market access and human capital and the subsequent relationship between human capital and wages. López-Rodríguez, Faíña and López-Rodríguez (2007) indicated that workers in regions with more market access have higher educational levels. Likewise, there is an increasing empirical evidence suggesting that the way in which human capital is distributed over space contributes to understanding regional income disparities (Combes, Duranton and Gobillon, 2008; Mion and Naticchioni, 2009; Paredes, 2013; Chacón and Paredes, 2013). In this respect, the growing specialization of the labor force in core regions increases the capacity to innovate or adapt products and processes, generates knowledge external economies due to the interaction among specialized workers and increases average regional productivity (Rauch, 1993; Acemoglu, 1996; Ramos, Suriñach and Artís, 2010; Fisher, Bartkowska, Riel, Sardadvar, and Kunnert, 2009). From this perspective, average wages tend to be higher in regions where there is specialized human capital (Moretti, 2004; Matano and Naticchioni, 2012). High wage levels in terms of purchasing power allow the formation and attraction of qualified human capital (Hanson, 2001; López-Rodríguez, Faíña and López-Rodríguez, 2007). In this sense, the composition of the qualified labor force plays a central role in explaining regional wage levels given that qualified workers increase the productivity of the regions they are located in (Florida, Mellander, Stolarick and Ross, 2012). As well, the advantages of agglomeration economies in the local labor market, as manifested through mechanism of sharing, matching and learning (Duranton and Puga, 2004), and the availability of greater variety of consumer goods and amenities in large cities (Glaeser, Kolko and Saiz, 2001;Brueckner, Thisse and Zenou, 1999) can reinforce the concentration of human capital in urban centers.

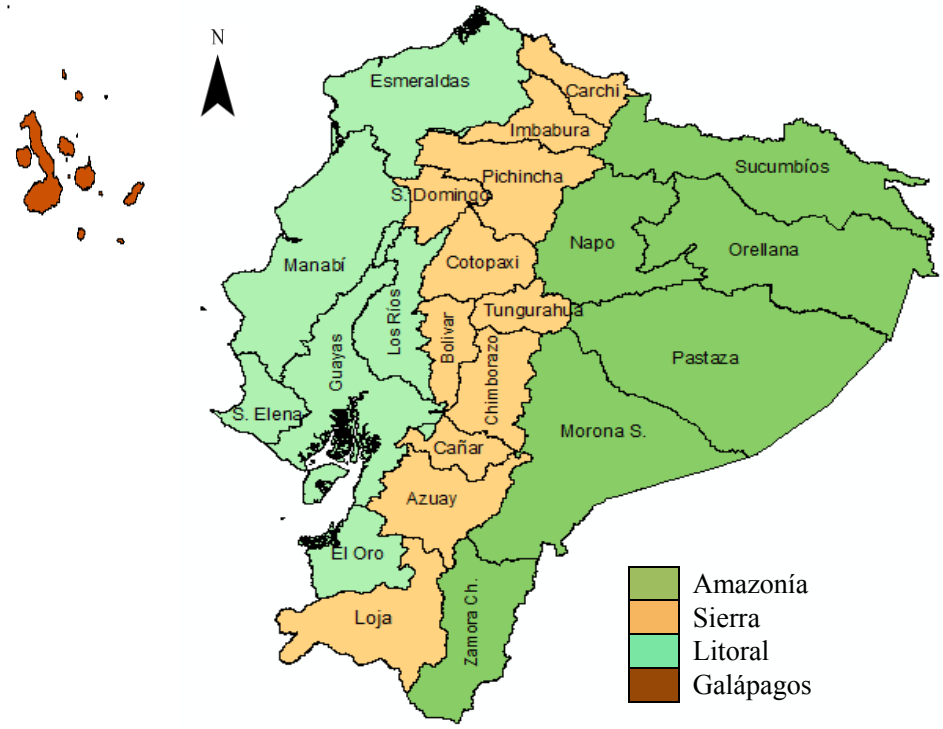
Likewise, recent research indicates that the presence of universities and large companies increases the presence of qualified human capital in the areas where they are located (Abel and Deitz, 2012; Lehmer and Moller, 2010), which can lead to increases in wage levels and can help us to understand regional income inequalities. The heterogeneous distribution of the labor force over space in Latin America is reinforced by the fact that educational institutions, in particular the best universities, are extremely concentrated in large urban centers. Currently, there is still scarce empirical evidence for Latin American countries. Two exceptions are Chacón and Paredes (2013) who estimated that 50% of spatial income inequality in Chile is explained by the concentration of human capital in the Metropolitan Region of Santiago and Paredes (2013) who found that human capital reduces spatial wage disparities by 84.65%.In this respect, our second hypothesis considers that the concentration of human capital predominantly explains regional wage disparities in Ecuador.

3. Context, data and econometric strategy

3.1. Context of the research

Territorial organization and economic activity in Ecuador are determined by geography, with the Andean Mountain Range dividing the country into three natural regions[1] with distinct economic activities (Figure1). The Amazonian region is located in the interior of the country, where the economy is specialized in extracting petroleum and mining. The central region is composed of the Sierra or highlands, and is noted for agricultural and flower production. Finally, the coastal region is specialized in agricultural production and fisheries oriented to the export market. Furthermore, economic activities in the Sierra and coastal regions associated with trade and services are significant in relation to global output and employment. Table 6 in the Annex summarizes the regional distribution of economic activity in Ecuador.

Figure 1. Political division and natural regions in Ecuador



Source: Authors based on INEC, 2013

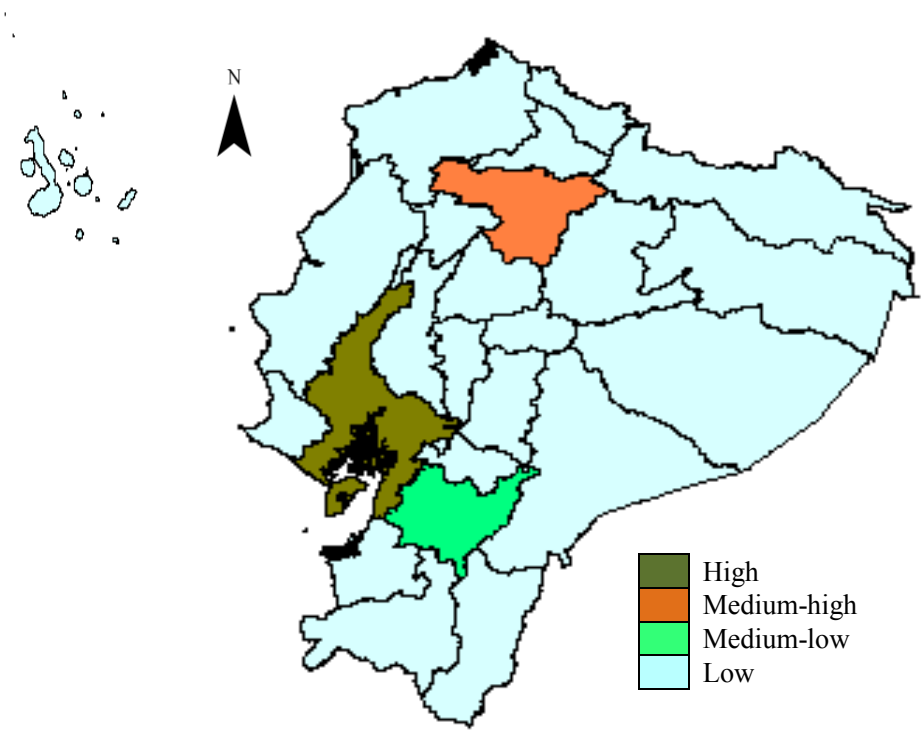
[1] The Galapagos Islands are excluded because of the lack of information and because the islands are disconnected from the rest of the country.

This country has experienced a rapid urbanization over the last six decades characterized by spatial concentration in the cities of Guayaquil and Quito. The urban population increased as a percentage of total population from 29%in 1950 to 63% in 2010. According to the economic census of 2010, 66% of enterprises, 72% of incomes and 83.8% of large companies are located in the regions of Guayas (Coast) and Pichincha (Sierra). The two largest cities in Ecuador (Guayaquil and Quito) are located in the regions of Guayas and Pichincha respectively. As a percentage of the total population, these cities went from 13.7% in 1950 to 26.7% in 2010 (WUP, 2011). Economic concentration in these two urban centers has been reinforced by increased urbanization and the transformation from an agricultural to a service-based economy. This situation can be observed in Figure 2, where we represent the market potential calculated according to Harris (1954) using the incomes of regions j weighted by the distances:

$$PM_j = \sum_{j=1}^{k}\left(\frac{Y_j}{D_{jk}}\right) = Y_{jj} + \frac{Y_{12}}{D_{12}} + \cdots + \frac{Y_{1k}}{D_{1k}} = Y_{jj} + \sum_{j=2}^{k}\frac{Y_j}{D_{jk}} (1).$$

Where, Y_j is the income of the j region and D_{jk} is the driving distance from j to the k regions.

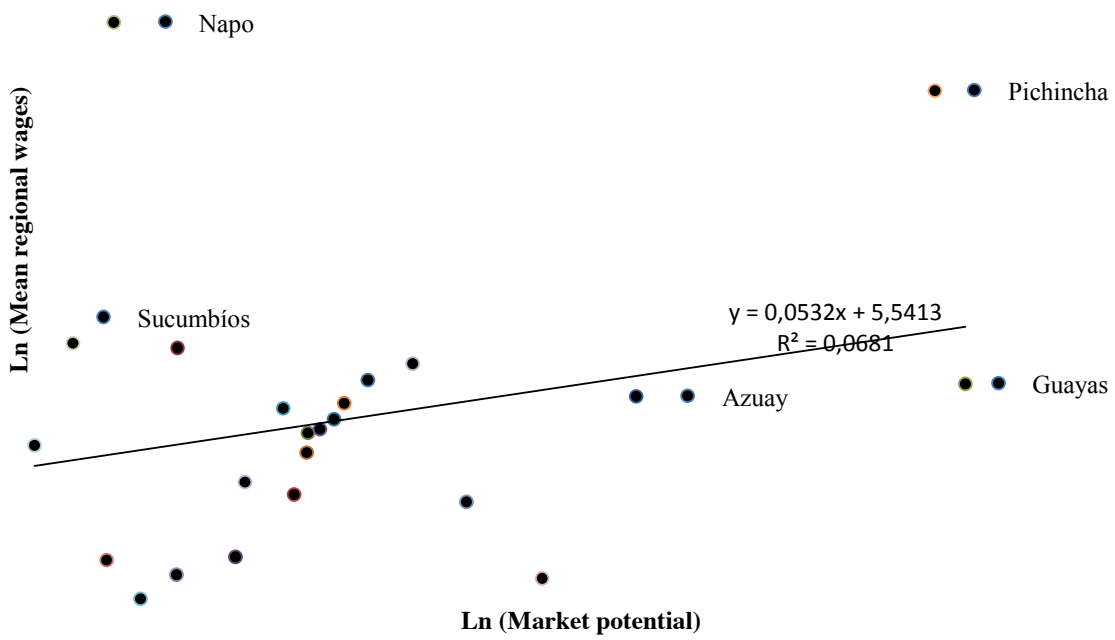
Figure 2: Regional market potential in Ecuador



Source: Authors based on INEC, 2013

Figure 3 shows a positive relationship between mean regional wages and market potential, which concurs with the underlying logic of the NEG wage equation. Nevertheless, there are several regions with low market potential and high wages, as well as regions with high market potential but with medium to low wages. The regions of Napo and Guayas, respectively, represent clear examples of these exceptions. Table6 (see annex) shows the regional rates of poverty and informal labor. We can observe that most of the regions have high rates of informal labor, and that Guayas not has the lowest poverty rate in the country, even though the region also has the highest concentration of economic activity, which suggests that urbanization has not necessarily resulted in efficiency. Specialization in primary economic activities and self-employment among a significant part of the rural labor force, as well as rapid urbanization, can explain the high level of informal labor, which can attenuate the effect of market access on wages.

Figure 3. Relationship between average regional wages and market potential

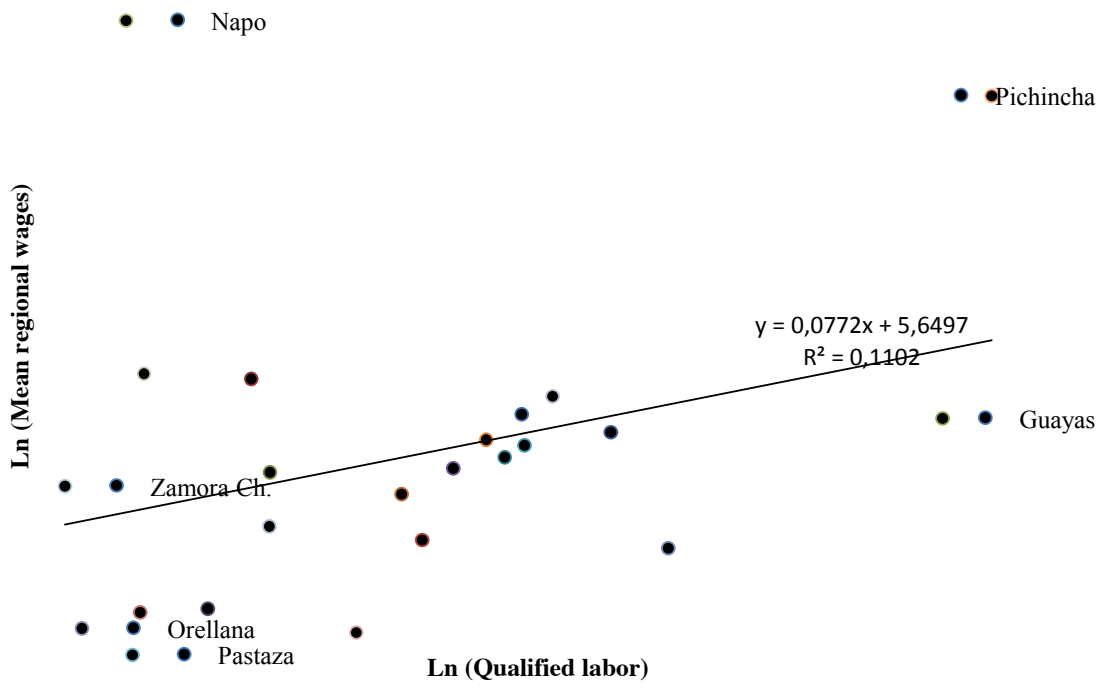


Source: Authors based on INEC, 2013

The distribution of human capital is similar to the regional distribution of economic activity. Figure4 shows the positive relationship between skilled labor, measured as the percentage of workers with college-educated and graduate, and average regional wages. Workers in the regions of Pichincha and Guayas have significantly higher average levels of education than their counterparts in other regions (National Institute of Statistics and

Censuses, 2010). For example, 11.7% of workers in Pichincha have some level of college and graduate education compared to only 3.2% in Orellana. The strong concentration of the best universities in Quito and the scarcity of universities in peripheral regions can explain the heterogeneous regional distribution of qualified human capital[2]. The spatial distribution of economic activity, wage levels, wider variety of consumer goods, more amenities and the interactions among specialized workers are some of the factors that could explain the spatial distribution of qualified labor in the country. Empirical works that have studied the effect of human capital on wages in Ecuador (MacIsaac and Rama, 1997; García-Aracil and Winter, 2006) have not incorporated the effect of economic geography, even though, as suggested by the theoretical and empirical literature discussed in the previous section, considering this effect can contribute to our understanding of regional wage disparities.

Figure 4. Relationship between average regional wages and qualified labour



Source: Authors based on INEC, 2013

[2] There are 54 universities in Ecuador. The Council for Evaluation, Accreditation and Assurance of the Quality of Higher Education classifies universities in function of four categories:from category A (best) to D (deficient). Considering the head offices of universities, there are five universities in category A, 23 in B, 18 in C, and 8 in D. One in four universities and four of the five universities in category A are located in Pichincha. Table 5 in the annex present a broad regional distribution of the universities in this country.

3.2. Data

We used statistical information in this article from two databases, the National Economic Census and the Employment and Unemployment Survey, both from 2010. Both databases were prepared and published by the National Institute of Statistics and Censuses.

In the first set of regressions, based on the NEG wage equation, the variables are obtained as follows. Market access is measured a la Harris using two variables, the sum of the incomes of firms and the size of the population. The use of these variables is consistent with other empirical works that used regional population and sum of regional salaries of incomes (Fingleton, 2006; Paredes and Iturra, 2012; Hering and Poncet, 2009). As well, the use of these variables reduces potential endogeneity when the sum of wages is incorporated as an independent variable and the mean regional wage as a dependent variable in the NEG wage equation. The average regional wage is obtained based on the ratio between monthly expenditures on wages and the number of workers in each region. Finally, we included a set of controls associated with economic concentration as an explanatory variable: population density, the rate of urbanization and the participation of regional companies and workers in the national total.

In the multi-analysis, we first include the composition of the labor force using microdata, while in the second level we incorporate regional data on qualified human capital, market access, economic sectors and the regional export capacity. Fujita and Thisse (2000) suggested that cities could be adequate geographic units to capture the effect of agglomeration economies. Nevertheless, the regional scale was chosen as the geographic unit to capture the effect of economic geography on wages due to data limitations. The regional scale is the smallest unit with statistical representation in the database of the National Institute of Statistics and Censuses.

3.3. Econometric strategy

The econometric strategy is divided into two parts. First, we estimate the effect of market access on the average regional wage. For this purpose, we estimate the wage equation of the NGE. At this stage, the econometric model focuses on verifying the aggregate average effect on a regional scale. Second, we estimate a hierarchical linear model of two levels. At the first level, we include a set of variables associated with human capital endowments of the labor force, and at the second level, we include the regional features. We use two strategies because the individual salary is affected by the characteristics of the environment where the employee is located and by their own endowments.

3.3.1. *The New Economic Geography Model*

To examine the effect of market access on wages in Ecuadoran regions, we began with the model proposed by Krugman (1991) and Fujita, Krugman and Venables (1999) and continued the model proposed by Niebuhr (2006). The model considers that there are j regions with two sectors; one competitive that produces homogeneous goods C and the other a monopoly that produces differentiated goods M. Workers from sector $C$are not mobile, which ensures demand in peripheral regions, while workers from sector M respond to variations in real wages. However, the incentive to move disappears when the real wage (w_i) is the same among regions ($w_j/I_j = w_k/I_k$).

The functional forms of iceberg-type transport costs differ among studies. In this work, we adopted an exponential function with the driving distance($T_{jk} = exp - \tau(\delta - 1)d_{jk}$; where T_{jk} is the costs for region j to transport goods to regions k and τ measures the variation in transportation costs when the distance varies[3]. Following Redding and Venables (2004), when$j = k$ we use the function$D_{jj} = (2/3)\sqrt{A_j/\pi}$, where$A_j$is the area of the region j. Adopting an exponential function for transportation costs is justified by the deficient level of infrastructure and the difficult geography of Ecuador, and because the most commonly used form of transportation for goods and passengers is by road. Furthermore, exponential functions are commonly used in the empirical NEG literature (García, 2006; Niebuhr, 2006).

We assume a Cobb-Douglas consumers´ utility function; that businesses choose the region in which they produce and prefer to be located where there is more demand; that each business has only one plant; and that the production function has increasing returns. Considering an income (Y) for region$j$, transportation costsT_{jk}, the constant termγ_0 and the residual errorε_j (prices do not vary over space), we obtain a wage equation based on the NEG core-periphery model:

$$w_j = \left[\sum_{j=1}^{k} Y_j e^{\tau(\sigma-1)d_{jk}}\right]^{1/\sigma} \quad (2)$$

$$\ln w_j = \gamma_0 + \gamma_1 \ln \sum_{j=1}^{J} Y_j e^{\tau(\sigma-1)d_{jk}} + \gamma_2 lnX_j + \varepsilon_j = \gamma_0 + \gamma_1 \ln MA_j + \gamma_2 lnX_j + \varepsilon_j \quad (3).$$

Where $\gamma_1 = 1/\sigma$, w_i is the average wage in region j, $\sum_{j=1}^{J} Y_j e^{\tau(\sigma-1)d_{jk}}$ represents market access, $X_j$is a set of covariants that capture the effect of economic concentration on wages and $\gamma_i$is the respective coefficient. Based on equation (2), we estimated the parameters of

[3] With the aim of ensuring the robustness of the estimators, a potential function of transportation costs was also included. Table 1 showsthat there were no significant changes in the results.

the NEG wage model for Ecuador using simulations. After obtaining the parameters we include market access in equation (3). Ifγ_1 is positive and significant, we can conclude that market access explains regional wage disparities (Paredes, 2013).

3.3.2. *The hierarchical model*

The hierarchical model used to examine the effect of human capital in reducing regional wage disparities has two levels. Level one has the individuals i and level two has the regions j. This methodology captures the effect of variables that operate at different levels, that is level one considers the composition of the labor force (educational level, age, experience, gender, marital status, informal labor, ethnicity and economic sector) and regional characteristics at level two (market access, economic sector and regional export capacity). Several works using different research methodologies indicate that ignoring the effect of one of these levels can lead to biased and inconsistent conclusions when the observations are grouped, in particular about the coefficients, variance and standard error (Van Landeghem; 2005; Moerbeek, 2004; Opdenakker and Van Damme, 2010).

A growing number of researchers have used this econometric strategy to analyze regional wage disparities (Fontes, Simoes and De Oliveira, 2010; Paredes, 2013; Chacón and Paredes, 2013). In our model, the dependent variable is in level one and the independent variables are in levels one and two. Based on the interaction between the workers and the place where they are located, it can be expected that regional characteristics influence workers' decisions about where they locate, while at the same time, the characteristics of the workers themselves influence average regional wages. The hierarchical linear modelused as a starting point was a random intercept type that was formulated as follows:

$$lnw_{ij} = \beta_{0j} + r_{ij} \qquad (4)$$

$$\beta_{0j} = \gamma_{00} + u_{0j} \qquad (5)$$

Wherelnw_{ij} represents the wage-per-hour logarithm for worker $i$for the main activity conducted in region j, $\beta_{0j}$is the mean of the dependent variable for region$j$ and r_{ij} is the residual error term for level one and u_{0j} is the residual error at the regional scale. Re-ordering Equations (4) and (5) yields a hierarchical model in which the salary lnw_{ij} has two components: one fixed (γ_{00}) that represents the mean total and the other random ($u_{0j} + r_{ij}$) that represents the sum of error at the individual level plus error at the regional level, respectively.

$$lnw_{ij} = \gamma_{00} + u_{0j} + r_{ij} \qquad (6)$$

We assume that error at the individual level r_{ij}follows a normal distribution, with a mean of zero and a common variance for all groups $[r_{ij} \sim N(0, \sigma^2)]$ and that error at the regional level u_{0j} follows a normal multivariate distribution with mean of zero $[u_{0j} \sim N(0, \tau_{00})]$, which is independent from the error of level one $[cov\ (u_{0j} + r_{ij}\ ) = 0]$. This model breaks down the variance oflnw_{ij} into two components, the first(σ^2) being variance at the level of individual error and the second (τ_{00})being variance of the level of regional error. Formally, σ^2measures wage variability among individuals andτ_{00}measures wage variability among regions. Total wage variability is expressed as the sum of the two variances:

$$var(lnw_{ij}) = var(u_{0j} + r_{ij}) = \sigma^2 + \tau_{00} \quad (7)$$

Both variances can be estimated by maximum likelihood (Hox, 1998; Snijders and Bosker, 1999). For the purposes of the present research, ifτ_{00} is statistically equal to zero, there are no regional wage disparities, which in turn results in the intraclass correlation coefficient ρ tending toward zero. In this case, wage variance is determined by the composition of the labor force, while ifτ_{00} and ρ are statistically different from zero, wage variance can be attributed to regional characteristics. A standard interpretation ofρin the multi-level literature is that it measures the proportion of total variance explained by the observations in each region (Raudenbush and Bryk, 2002; Hox, 1995; Fontes, Simoes and De Oliveira, 2010). The intraclass correlation coefficient is calculated with the following formula:

$$\rho = \tau_{00}/(\tau_{00} + \sigma^2) \quad (8).$$

The following step estimates a hierarchical model that incorporates a set of covariants associated with the observable characteristics or composition of human capital of the labor force to evaluate the reduction of regional wage disparities, with the following multi-level linear equation:

$$lnw_{ij} = \gamma_{00} + \beta_i HC_{ij} + \mu_{0j} + r_{ij} \quad (9).$$

Where HC_{ij} represents a set of covariants associated with the standard Mincer human capital equation (1974). We incorporated two additional covariants, ethnicity (Etn) and informal labor (Inf) with the aim of capturing the high levels of ethnic heterogeneity and informal labor in the country. Including the variables in level one decrease σ^2 and in turn, the reduction of τ_{00}implies that regional wage disparities are explained by the composition of human capital. The intercept inequation (9) can vary among regions and can capture the characteristics of the local labor market. Incorporating the variables of age and experience in quadratic form captures the fact that the wages of individual$i$increases with age and experience at a decreasing rate. With the incorporation of these variables, the multi-level model is expressed as follows:

$$lnw_{ij} = \gamma_{00} + \beta_i CH_{ij} + \delta_1 Inf_{ij} + \delta_2 Etn_{ij} + \mu_{0j} + r_{ij} \qquad (10)$$

$$lnw_{ij} = \gamma_{00} + \gamma_{m0} X_{mij} + \gamma_{0n} Z_{nj} + \mu_{0j} + r_{ij} \qquad (11)$$

With the aim of evaluating the effects of regional characteristics associated with market size, the economic sector and the regional export capacity, equation (11) includes a vector (Z_{nj}) with these variables controlled by a vector (X_{nij}) of n variables associated with the composition of the human capital of the labor force described in equation (10).

4. Discussion of results

4.1. New Economic Geography

Table 1 shows the results of estimating equation (3) based on the NEG. Columns [1] and [2] feature the regression estimators that evaluate the effect of market access on average regional wages when we use the output of enterprises and the population together with the driving distances to compute market access. Likewise, it reports the estimators of a set of covariants associated with economic concentration: the participation of private companies and employed individuals of the region j in the country as a whole, population density and expenditures in regional research and development. In no case does market access-wage elasticity exceed 0.03%. These results suggest that market size has a positive and significant effect on the average regional wage, as the NEG wage equation indicates. Nevertheless, this effect is small compared to that found in research in developing and emerging countries.[4]

Figure2 offers a possible explanation of the results obtained. Two regions in this figure, Napo and Sucumbíos, are highly specialized in oil drilling and have limited market access. Nevertheless, the average wages in these regions are among the highest in the country. This coincides with the high per capita income of these regions compared to other regions. The incomes generated by activities oriented to the international market, together with the possibility of obtaining foreign direct investment in strategic economic sectors can explain these wage levels. In contrast, Guayas, the region with the highest concentration of economic activity and population has an average wage comparable to that of workers in regions in the center of distribution. Average wages in seven regions exceed those of workers in Guayas. In this sense, wage levels of a significant part of the labor force of the region with the largest market are lower than those of workers in regions with smaller market potential. The high level of informal labor and the existence of peripheral regions specialized in primary production oriented mainly to foreign markets could explain the low effect of market potential on wages. According to the 2010Employment and Unemployment Survey, a high percentage of the labor force of the three most urbanized regions, Guayas (61%), Pichincha (54%) and Azuay (63%), do not have access to social security, which implies that they are informal workers. In this respect, urbanization has not increased productive efficiency, as indicated by Henderson (2003). The following section provides empirical evidence that confirms that the informal labor force receives lower wages than their counterparts in the formal sector and that the difference is statistically significant at 1%.

[4]Fallah, Partridge and Olfert (2011): 0,30-0,42; Amiti and Cameron (2007): 0,10-0,22; Kiso (2005): 0,16-0,70; Fingleton (2011): 0,03-0,26; among others.

Table 1: Results of the wage regression equation based on the NEG

	[1]	[2]	[3]	[4]	[5]
MA1	0.00292***				
	(12.71)				
Participation of private firms	-0.0186	-0.0216	-0.00959	0.315*	
	(-1.25)	(-1.21)	(-0.50)	(2.38)	
MA2		0.0024***			
		(11.70)			
Population density		0.00605	0.0122	0.0822	
		(0.39)	(0.79)	(1.76)	
MA3			0.0025***		
			(11.79)		
R&D			-0.0162	0.0236	
			(-1.44)	(0.84)	
MA4				0.00045*	
				(2.31)	
Employed individuals				-0.364*	
				(-2.21)	
Export firms					0,647**
					(2.46)
Constant	5.609***	5.650***	5.705***	6.714***	568.6***
	(60.55)	(55.16)	(53.52)	(12.07)	(11.76)
σ	108.4	105.6	105.6	93.59	
	(0.31)	(0.02)	(0.02)	(0.21)	
μ	1.109***	1.080*	1.080*	0.956***	
	(25.53)	(2.15)	(2.15)	(12.38)	
τ	0.00030	0.00032	0.00032	0.166*	
	(0.85)	(0.73)	(0.73)	(2.19)	
Observations	23	23	23	23	

**Notes:* *t* statistics in parentheses and denote the significance $^{*}p< 0.05$, $^{**}p< 0.01$, $^{***}p< 0.001$
Source: Authors

Recent empirical works on NEG suggest the low explanatory capacity of the NEG on spatial wage disparities in countries with natural resources plays a central role in the productive structure. Specifically market access-wage elasticity is heterogeneous among spatial units. In Chile, wages in the mining and salmon farming clusters in the north and south of the country, respectively are comparable to or higher than the wages of workers in the Metropolitan Region of Santiago where industrial and service activities are concentrated (Paredes and Iturra, 2012; Paredes, 2013). Columns [3] and [4] show the estimators and parameters of the regression of equation (3) when market access is computed with incomes and the population using a potential function with driving distances. Adopting this functional form of transportation costs does not alter the results shown in columns [1] and [2]. Column 4 shows a decrease in elasticity in practice, low market access-wage elasticity persists compared to the levels found in developed and emerging countries. Finally, with the aim of evaluating the effect on wages of primary production oriented to the international market, Column [5] shows the results of a simple linear regression, where the dependent variable is the average regional wage and the

independent variable is the number of companies that export as a proxy for the regional export capacity. The coefficient of this regression is statistically significant at 10%, which implies that the export capacity of the regions positively affects regional wages levels.

In addition to the factors already discussed, the limited effect of market access on wages could be explained by the composition of the labor force and the regional productive structure discussed above. It can be expected that in an economy with limited qualified human capital, the location of qualified workers significantly affects regional productivity and, consequently, positively affects regional disparities in wages and incomes. The regional productive structure produces a similar effect. Wages are higher in regions with more dynamic economic activities. The following section evaluates the effect of human capital on regional wage disparities.

4.2. Multi-level analysis

The result of estimating the hierarchical linear model with a random intercept, formalized in equation (6), provides a coefficient of an intraclass correlation of $\rho = 0{,}0327, 0{,}1094$ and $0{,}0286$when level two includes market access, the economic sector and the regional export capacity, respectively. Table (2) summarizes the results of this regression without controlling for the composition of the labor force. The level of statistical significance of the coefficients suggests there are regional wage disparities due to market access and differences in the economic sector and export capacity of regions.

Table 2. Structure of data grouping

	[1]	[2]	[4]
Constant	0.414***	0.299*	0.389***
	(13.51)	(2.13)	(12.31)
Var.(Spatial)			
Constant	-2.010***	-1.417***	-2.078***
	(-11.33)	(-3.47)	(-11.01)
Var. (Residual)			
Constant	-0.316***	-0.368***	-0.315***
	(-56.38)	(-65.88)	(-56.37)
Observations	15988	15988	15988

**Notes:* *t* statistics in parentheses and denote the significance $^{*}p< 0.05$, $^{**}p< 0.01$, $^{***}p< 0.001$
Source: Authors

According to Paredes (2013), including a set of covariants in level one in a second stage to capture the effect of the characteristics associated to human capital (educational level, experience, age, marital status, gender, ethnicity, areas of activity and degree of labor

informality) on individual wages shows expected results. The effect of these variables is reflected in the reduction of the regional variable. Table 3 shows the results of this estimation in column [1]. Columns [2] and [3] show estimators as a result of incorporating the composition of the labor force at levels one, while in level two market access, the economic sector and the regional export capacity, respectively. Including the standard variables of human capital, ethnicity and informal labor reduce regional wage disparities(τ_{00}) by 79.31%, 99.99% and 80.93%, respectively.

Table 3. Results of the multi-level model and spatial concentration of human capital

	[1]	[2]	[3]
Fixed Effect			
Educational level	0.0550***	0.0552***	0.0550***
	(47.46)	(47.78)	(47.43)
Experience	0.0132***	0.0129***	0.0131***
	(9.65)	(9.38)	(9.53)
Experience2	-0.00029***	-0.00029***	-0.00029***
	(-7.65)	(-7.68)	(-7.71)
Age	0.0349***	0.0347***	0.0351***
	(14.58)	(14.45)	(14.63)
Age2	-0.00032***	-0.00031***	-0.00032***
	(-10.46)	(-10.30)	(-10.47)
Married	0.0849***	0.0827***	0.0818***
	(7.96)	(7.87)	(7.66)
Man	0.195***	0.195***	0.198***
	(18.65)	(18.61)	(18.87)
Ethnicity	0.0650**	0.0649**	0.0679***
	(3.20)	(3.19)	(3.34)
Manufacturing	0.200***	0.199***	0.197***
	(14.12)	(14.35)	(13.90)
Services	0.232***	0.228***	0.226***
	(17.67)	(17.59)	(17.27)
Formal	0.311***	0.312***	0.310***
	(28.86)	(28.96)	(28.70)
Constant	-1.508***	-1.503***	-1.508***
	(-32.12)	(-33.49)	(-32.17)
Random effects			
Var (Spatial)			
Constant	-2.797***	-14.71	-2.906***
	(-14.96)	(-1.17)	(-14.48)
Var (Residual)			
Constant	-0.552***	-0.546***	-0.551***
	(-98.67)	(-97.72)	(-98.48)
Intraclass correlation coefficient	0.01178	4.95e-13	0.0089
Reduction of wage inequalities	79.31%	99.99%	80.93%
Reduction of residual variance	37.7%	29.95%	37.57%
Log likelihood	-13878.65	-13878.1%	-13893.9
Observations	15988	15988	15988

**Notes:* *t* statistics in parentheses and denote the significance $^{*}p< 0.05$, $^{**}p< 0.01$, $^{***}p< 0.001$

Source: Authors

The explanatory capacity of traditional variables of human capital and categorical variables justifies their inclusion in the model. The coefficients presented the expected signs and are statistically significant at 0.1%. Individual wages increase with educational level, age and experience at a decreasing rate. Likewise, the results suggest there is wage discrimination based on gender and ethnicity. An interesting result in relation to the aims of this research is that workers from the formal sector receive higher hourly wages than their counterparts in the informal sector, which supports the hypothesis that the high rate of informal labor attenuates the effect of market size on wages. These results suggest that the composition of the labor force significantly reduces regional wage disparities in Ecuador. The results concur with the heterogeneous geographic distribution of human capital described in this work and is consistent with recent theoretical and empirical literature that indicates that the way in which human capital is distributed over space explains a significant part of regional wage disparities (Combes, Duranton and Gobillon, 2008; Matano and Naticchioni, 2009 and 2012; Paredes, 2013; Chacón and Paredes, 20013).

5. Conclusions

This work examined the nexus among market access, human capital and regional wage disparities in Ecuador, a country characterized by a high percentage of national output and employment located in primary export, as well as by a high level of economic concentration in Quito and Guayaquil. This analysis was based on the NEG wage equation and a multi-level model to evaluate the effect of human capital in reducing regional wage disparities. We verified the hypothesis that given the productive structure of Ecuador, the effect of market access on wages is low for two reasons, firstly because the primary sector oriented to the international market generates high incomes in some export regions and, secondly, because of the high rate of informal labor.

Our results provide robust empirical evidence suggesting a low explanatory capacity of the NEG core-periphery of wage disparities, despite Krugman (2011) noted that this model can be adjusted more effectively to the productive reality of developing countries and that the structural characteristics of these countries are very similar to the assumptions of the NEG. Likewise, we found evidence indicating that regional variation in wages can be attributed predominantly to the composition of human capital of the labor force. As well, our results confirm the importance of a heterogeneous distribution of human capital over space as a policy instrument that contributes to the reduction of income disparities between core and periphery regions. A policy implication of our results is that one way to reduce regional disparities is by promoting a heterogeneous distribution of human capital over space through mechanisms that increase human capital in less developed regions and by accelerating the development of these regions.

Storper (2010) argued that by updating it, the NEG could offer a convincing focus for agglomeration and the specialization encouraged by innovation in developed countries. Perhaps the NEG should also be updated for peripheral regions specializing in exploiting and exporting natural resources that can generate higher incomes. These results could also be extended by correcting the spatial auto-correlation, which can emerge from the use of the regional scale in level two of the hierarchical model. Future research could focus on the use of functional regions given that administrative regions often do not reflect the productive structure, and in particular do not capture the interaction among economic agents in space. Broadening the temporal coverage should be considered. A serious limitation to this work is the lack of statistical data with a broader temporal horizon and smaller spatial scale.

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Annex:

Table 4. Descriptive statistics of the variables of the first level

Variable	Obs.	Mean	St. Dev.	Min.	Max.
Hourly wage	15988	0,36	0,73	-5,29	4,67
Schooling	15988	10,07	4,93	0	21
Age	15988	36,00	12,78	15	65
Age squared	15988	1459,98	990,76	225	4225
Experience	15988	9,00	10,39	0	60
Experience squared	15988	189,26	336,26	0	3600
Sex (1 Man, 0 Women)	15988	0,66	0,47	0	1
Labor informality (1 Yes, 0 Other case)	15988	0,46	0,49	0	1
marital status (1 Married, 0 Other case)	15988	0,36	0,47	0	1
Ethnicity (1 White, 0 Other case)	15988	0,05	0,22	0	1
Economic sectors (1 Primary, 2 manufacturing, 3 Services)	15988	2,23	0,86	1	3
Market potential	22	17,38	1,66	14,62	19,81
Qualified human capital	22	10,82	1,25	8,29	12,61
Export companies	22	4,79	1,21	0,69	6,54

Source: Authors based on information from INEC, 2013

Table 5. Regional distribution of colleges in Ecuador

Region	Category A	Category B	Category C	Category D	Total region
Azuay	0	3	0	1	4
Bolívar	0	0	1	0	1
Cañar	0	0	0	0	0
Carchi	0	1	0	0	1
Chimborazo	0	1	1	0	2
Cotopaxi	0	0	1	0	1
El Oro	0	0	0	1	1
Esmeraldas	0	0	0	1	1
Galápagos	0	0	0	0	0
Guayas	1	3	5	2	11
Imbabura	0	1	0	1	2
Loja	0	2	0	0	2
Los Ríos	0	2	0	0	2
Manabí	0	0	4	2	6
Morona Santiago	0	0	0	0	0
Napo	0	0	0	0	0
Orellana	0	0	0	0	0
Pastaza	0	1	0	0	1
Pichincha	4	6	4	0	14
Santa Elena	0	0	1	0	1
Santo Domingo	0	1	0	0	1
Sucumbíos	0	0	0	0	0
Tungurahua	0	2	1	0	3
Zamora Chinchipe	0	0	0	0	0
Total category	5	23	18	8	54

Source: Authors based on CEAACES, 2013

Table 6. Regional distribution of economic activity in Ecuador and other variables

Region	AW	MP	CO	Y	EW	PD	YS	QL	UA	R&D	UR	LC	RP	RA	LI	RP
Azuay	637,4	64023718,6	12902	60638058	133974	82,4	9,3	7,16	642	9989658	0,64	52	712127	8639	0,63	0,24
Bolívar	701,7	4946424,2	1575	271427	11629	56,4	7,7	5,21	33	206264	0,37	0	183641	3254	0,74	0,63
Cañar	592,8	10246501,7	2314	5618438	26268	57,6	7,6	4,64	270	1076570	0,5	0	225184	3908	0,67	0,39
Carchi	463,3	6834092,9	1997	4419233	16523	44,5	8,3	4,75	86	47082	0,58	0	164524	3699	0,57	0,45
Chimborazo	609,2	11853170,4	5031	7279314	51359	86,7	8,2	6,79	452	1368312	0,52	2	458581	5287	0,75	0,53
Cotopaxi	570	10176109,5	3620	3102236	35160	62,3	7,7	4,71	75	891094	0,39	4	409205	6569	0,68	0,48
El Oro	658,4	14316233,6	10581	10708370	72631	100,3	9,7	5,61	356	214360	0,82	11	600659	5988	0,56	0,25
Esmeraldas	524,5	9482070,5	5156	6960936	43436	32	8,6	3,97	204	190498	0,45	7	534092	14983	0,64	0,51
Guayas	653,5	402565983,4	107074	400808219	548644	212,7	10,2	6,55	4945	37620578	0,85	395	3645483	17139	0,61	0,27
Imbabura	597,1	10953434,9	5068	6702673	46627	86,6	8,6	6,15	408	676421	0,59	8	398244	4599	0,63	0,37
Loja	622,4	8924384,1	6286	6852060	60957	40,7	9,5	7,60	408	649752	0,54	4	448966	11027	0,68	0,41
Los Ríos	628,8	12537747,9	5817	4375336	59233	124,4	8,3	3,67	266	2170513	0,6	8	778115	6254	0,61	0,37
Manabí	516,8	24824664,9	13627	20994504	135449	74,4	8,5	4,86	415	1847315	0,63	30	1369780	18400	0,72	0,44
Morona S.	460,3	3326870,6	1699	631682	14804	5,8	8,7	3,86	101	219557	0,45	0	147940	25690	0,72	0,47
Napo	1341,2	3465733,2	1282	207287	7214	7,8	9,3	5,15	101	43728	0,43	0	103697	13271	0,60	0,68
Orellana	447,1	4913343	1519	2755993	10846	6,6	8,5	3,19	39	272687	0,36	0	136396	20773	0,71	0,55
Pastaza	426,2	4022406,6	1446	640165	11049	2,8	9,6	6,56	167	12745	0,51	0	83933	29520	0,45	0,40
Pichincha	1170,6	339369363,3	82743	337452661	589466	271,4	11,4	11,65	3071	165839771	0,71	451	2576287	9612	0,54	0,19
S. Elena	537,6	7205339,7	1625	3424093	28828	82	8,8	3,37	459	468734	0,56	3	308693	3763	-	-
S. Domingo	443,8	37881005,3	3600	32860777	47108	98	8,8	4,24	198	2592494	0,69	4	368013	4180	-	-
Sucumbíos	708,5	2758606,2	2473	482357	14206	9,5	9,3	3,29	48	87931	0,48	1	176472	18612	0,59	0,37
Tungurahua	680,2	18392256,5	7450	13111487	77203	151,3	9	7,71	691	2802406	0,52	13	504583	3334	0,63	0,29
Zamora Ch.	578,3	2224912	1477	299091	10840	8,7	8,8	4,40	71	2152770	0,48	1	91376	10556	0,64	0,44

AW = Average Wages | **EW** = Employed Workers | **UA** = Urban Amenities | **RP** = Regional Population
MP = Market Potential | **PD** = Population Density | **R&D** = Research and development | **RA** = Regional Area (km2)
CO = Companies | **YS** = Years of Schooling | **UR** = Urbanization Rate | **PI** = Informal Population
Y = Income | **QL** = Qualified Labor | **LC** = Large Companies | **RP** = Regional Poverty

Source: Authors based on INEC, 2013