



## Geographical Distribution of the Industry in Ecuador: Concentration and Urbanization Factors

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The research presented in this document aims to measure the geographical concentration for the period 1980–2010 of industrial activities in Ecuador and establish a possible relationship between the localization of industrial sectors and the urbanization levels of cities. The analysis of the geographical concentration of the 26 manufacturing sectors will be conducted by calculating the spatial concentration indices of industrial activity for each of the sectors. Four indicators are mainly used, the relative concentration, the Hirschman-Herfindahl index, the Gini locational coefficient and the Ellison and Glaeser concentration index. To analyse the relationship between urban agglomerations and industrial location, we use the methodology proposed by Holmes and Stevens. The results indicate the existence of geographical concentration as there is an average employment concentration above 70% in most sectors. The Tobacco Product Manufacturing industry is the most concentrated along with Other Chemical Manufacturing. On the other hand, a relationship is established between the industrial location and the degree of urbanization of the cities; there is no sector that operates in contexts of low concentration and urbanization. The results generated allow to conclude the coexistence of diversified and specialized areas within the same urban systems.

**Keywords:** Geographical concentration, Industrial activity, Localization, Spatial concentration indices, Urbanization levels

### Introduction

The New Economic Geography in the 90s rediscovers space as the core of the economy. Its objective is to explain the reason for the geographical concentration of economic activity, an area of research in which numerous theoretical and empirical studies are included.

Part of the empirical studies in this field have dealt with the calculation of territorial concentration indices of economic activity: United States<sup>1-8</sup>, France<sup>9,10</sup>, United Kingdom<sup>11-13</sup>, Spain<sup>14-17</sup>, China<sup>18-20</sup>, among others. These studies have focused almost exclusively on manufacturing sectors. Employment is the variable used in most studies as a measure of specialization due to the availability of data and its level of disaggregation, while the territorial unit of analysis corresponds to countries (when the study is carried out at international level), to regions, metropolitan areas and counties or municipalities. The different scales are noteworthy given that the results obtained differ in some cases depending on the choice of the scale.

The most commonly used geographical concentration indices are: relative spatial concentration, Hirschman - Herfindahl, Gini and the Ellison & Glaeser concentration index. The last one is more sophisticated than the others, since it allows us to discriminate to what degree external economies of agglomeration influence concentration patterns. For this purpose, the index controls the degree of economies of scale internal to the company in an industry, which are usually one of the reasons for spatial concentration to occur in an activity. Along the same lines, Maurel & Sédillot<sup>9</sup>, Devereux *et al.*<sup>11</sup> developed alternative localization indices with the same properties of the initial index. As for Duranton & Overman<sup>12,13</sup>, unlike the previous ones, they measure the magnitude of the localization by proposing to add to the characteristics of the Ellison & Glaeser localization test, those of statistical significance and impartiality regarding the aggregation of data.

The analyses that are derived incorporate a set of natural and social restrictions, past and present, tangible and intangible, and especially the particular importance of the effect exerted by economic conditions on the structure and dynamism of territories.

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In general terms, all the studies conclude that localization decisions are not taken randomly, localization often occurs at the level of metropolitan areas and follows broad sectoral patterns, within the framework of a correspondence relationship between economic activities and the geography.

In this context, this research aims to measure the geographical concentration of industrial activities in Ecuador and establish a possible relationship between the localization of industrial sectors and the urbanization levels in cities. The hypothesis to be tested is that depending on the manufacturing sector concerned, there will be more or less localization advantages in areas with different urbanization levels. In other words, it is about establishing the relationship between productive specialization and market size, which the literature on the new economic geography highlights. Following the methodology proposed by Holmes and Stevens<sup>6</sup>, it is expected to demonstrate that the degree of specialization varies substantially with the concentration of population, as a measure of the market size.

The most significant contribution of this work, in addition to the reduced geographical dimension of the unit of analysis: cantons (which from now on will be called cities); and from the extensive period of analysis considered (1980 – 2010), is to show the importance that colonial heritage continues to have in the geographical concentration of the manufacturing industry in this country. An additional motivation for this work, beyond contrasting the contributions of recent literature in Ecuador, is the fact that the period of analysis coincides with the commercial opening of Ecuador and its integration in the International Trade Organization, dating from 1993 and 1996, respectively. The results can be used for government actions in the context of productive transformation promoted in Ecuador today. This transformation involves moving from a primary export and extractive specialization pattern to one that favours diversified, eco-efficient production with greater added value, services based on the knowledge economy and biodiversity, on the basic pillars of productive diversification, value addition, selective import substitution and the promotion of exporting new products.<sup>21</sup>

### Database

One of the contributions of this work is the use of a single database built for this purpose and which has involved an enormous amount of work to collect and

digitize the source information. The databases used correspond to the Economic Censuses of the National Institute of Statistics and Censuses INEC<sup>22</sup> carried out in the years 1980 and 2010.

Regarding the geographical units of analysis, it should be noted that it is information at a cantonal level, made up of urban and rural parishes, and which also constitute the second-level administrative division in Ecuador, after provinces. There are a total of 114, except for the 3 corresponding to the Insular Region or the Galapagos Islands, which will not be taken into account for this work. For drafting purposes, cantons are considered cities in the rest of the work. An important issue that is worth considering is that given the geographical characteristics of Ecuador, cities are of very different sizes, for example the area in km<sup>2</sup> of the largest city is 19,930 km<sup>2</sup> (Pastaza-Amazon), whereas the smallest one is only 19 km<sup>2</sup> (Cevallos-Sierra). Consequently, the geography is a determining factor to be taken into account in this study.

The comparative analysis between both years requires for the two bases to be homogeneous. In general terms, the data for sectors and cities were made compatible without much difficulty. Consequently, the study will be conducted with data at the level of 26 manufacturing sectors. For the period of analysis, the “petroleum products” sector is excluded, since it is found in a single province. The variables to be used correspond to the employment or number of employees and the number of establishments in each manufacturing sector, and for each geographical unit.

In summary, we will work with a database disaggregated at geographical level in 114 cities, and at the level of 26 manufacturing sectors, a scale that has not been used at country level for dynamic analysis of this nature, which is an important contribution that should be taken into account.

### Results

#### Manufacturing Concentration: An Aggregate Analysis

The industrial sector is the second most important in terms of GDP in the Ecuadorian economy, but it is the most dynamic given that, unlike the other sectors, it experienced a growth of 9% between 1980 and 2010 according to World Bank data.<sup>23</sup> In this period of analysis, the locational pattern of the industries has been almost the same in both years Quito (22.7% total employment), Guayaquil (25.8%), Cuenca (9.6%) and Ambato (4.6%) have the highest employment levels in

the sector, added to these in 2010: Durán, Manta, Santo Domingo, Rumiñahui, Latacunga and Montecristi. The locational patterns can be analysed through a classification of the five most important cities in terms of the industrial employment found in them in 1980 and 2010, and in each case, of the five main manufacturing activities. In 2010, the five largest industries are: Quito (Manufacture of food products (19.1%), Manufacture of clothing (except footwear) (14.2%), Manufacture of textiles (7.9%), Manufacture of furniture (7.7 %), Manufacture of metal products (except machinery and equipment) (7.6%)) and Guayaquil (Manufacture of food products (39.4%), Manufacture of plastic products (9.2%), Manufacture of metal products (except machinery and equipment) (7.9%), Manufacture of other chemical products (5.4%), Printing, publishing and related industries (5.4%)) (INEC).<sup>22</sup>

It is surprising that in the last three decades, there has not been a major change in the composition of the Ecuadorian industrial sector. Furthermore, with hindsight, according to data from Quintero and Silva<sup>24</sup>, only in 1961 the Manufacture of textiles, clothing and the leather industry was the most relevant textile sector in terms of employees (34.3%); from then on until today the Food products sector occupies this position.

Regarding the size of the companies (number of employees), both in 2010 and in 1980 there is a high predominance of micro, small and medium-sized enterprises MIPYMES in Ecuador (99% in both cases), only the remaining 1% corresponds to the typology of large manufacturing companies. In both cases, micro-enterprises are the most relevant with 95% and 85%, respectively. In 2010, the most representative sectors in microenterprises correspond to the Manufacture of food products (20.6%), Manufacture of clothing (17.5%), Manufacture of fabricated metal products, except machinery and equipment (17.4%) and Manufacture of furniture (12%). Regarding small enterprises, the Manufacture of rubber and plastic products is included; while medium-sized enterprises are made up of the Manufacture of food products (29.6%), Manufacture of clothing (8.9%) and Manufacture of rubber and plastic products (9.3%). Lastly, in large companies, the most representative sector is the Manufacture of food products with 12.8%.

#### **Geographical Concentration: Sector Analysis**

The analysis of the geographical concentration of the 26 manufacturing sectors for the period 1980–

2010 will be conducted by calculating the spatial concentration indices of industrial activity for each of the sectors. Four main indicators are used: the relative concentration index, the Hirschman-Herfindahl index, the locational Gini coefficient and the Ellison & Glaeser<sup>2</sup> concentration index, hereinafter EG.

Each of these indices has its own specificities that must be taken into account to analyse the results obtained. In this way, although the relative concentration coefficients (which measure the concentration of a sector in the first geographical areas with the greatest presence in terms of employment in this sector), and the Gini index allow to observe the differences in the territorial distribution between sectors, they have a limitation to be considered: none of these indicators takes into account the differences in the size of the territorial units analysed, a situation that can be solved by calculating other indicators. Regarding the Hirschman-Herfindahl indicator, it does not distinguish between randomness and non-randomness in the distribution of establishments; and furthermore, it is sensitive to the number of establishments in an industry if it is less than the number of regions.<sup>3</sup> Regarding the EG index, unlike the previous ones, it allows to discriminate to what degree the external economies of agglomeration influence concentration patterns.

#### *Relative Concentration Indices*

Relative concentration indices are used to measure industrial concentration and assess the importance of the first business units, arranged from the highest to the lowest according to the volume of employment found in them, in relation to the total number of companies considered. The main disadvantage of this indicator is that it considers data partially, as it does not take into account the smallest establishments.

Given that this study focuses on geographical concentration, business units are replaced by cities to analyse the concentration levels of the first  $m$  cities that have more employment in the sector considered. For this, the following expression is applied:

$$RCmi = \frac{\sum_{j=1}^m L_{ij}}{\sum_j L_{ij}} \quad \dots (1)$$

where,  $L_{ij}$  is the employment of sector  $i$  in the city of analysis  $j$ ;  $m$  is the number of units chosen from the geographical areas arranged from the highest to the lowest; the numerator considers the employment of the  $m$  cities considered and the denominator the total employment in the sector for all the cities.

The results obtained from the calculation of the RC3 and RC10 indices for the years 1980 and 2010 are shown in Table 1. These suggest a high concentration of the manufacturing sectors in the cities of Ecuador because in both years, the concentration of employment on average is above 70%. In addition, there are a few sectors whose values are below the average.

When the ranking of cities RC3 and RC10 is considered, there is a difference in the results between the two years, with the exception of the first two positions.

When comparing the two years, the trend towards a greater dispersion of manufacturing activity is observed at a general level, due to the fact that the employment share is lower in 2010 compared to 1980 in the RC3 and RC10 indices, as well as because the concentration indicators decreased in 12 of the 26 sectors analysed, and among these, they decreased very significantly in the Manufacture of metal products sector. On the other

hand, these indicators increased in the rest of the sectors, highlighting the Basic iron and steel industry, Wood Industry and Manufacture of footwear sectors, whose increase exceeded 10 points.

Finally, it should be noted that the RC3 cities are the same between 1980 and 2010 (Quito, Guayaquil and Cuenca), while the RC10 are not, with the exception of Ambato, Manta and Riobamba, which are the similar cities within this group, which suggests that in this study period, a group of new territories, mainly on the Coast and Sierra, have been incorporated into the current industrial dynamics of the country.

#### *Hirschman - Herfindahl Index*

The Hirschman-Herfindahl index (hereinafter HH), consists of characterizing employment in industry *i* in region *j*, as a proportion of employment in industry *i* over all *j* regions. Applied to studies of industrial organization, it is an index of non-diversity, because the higher its value, the less competitive the market

Table 1 — RC3 and RC10 Concentration Ratios of the industrial sector, 1980 and 2010

SECTORS	1980			2010		
	RC3	RC10	Ranking	RC3	RC10	Ranking
Manufacture of food products	47.50	80.03	20	57.04	75.26	21
Preparation of beverages	80.77	86.40	14	87.17	90.17	11
Manufacture of tobacco products	99.80	99.80	1	100.00	100.00	1
Textile manufacturing	82.09	85.88	15	71.76	83.90	18
Manufacture of clothing	54.34	67.39	24	55.46	70.04	24
Leather industry	49.60	85.10	17	35.01	81.79	19
Footwear manufacturing	44.44	73.92	22	33.47	84.11	17
Wood Industry	39.62	51.98	26	41.69	63.97	26
Furniture manufacturing	62.33	73.02	23	59.03	70.41	23
Manufacture of paper and paper products	78.84	85.06	18	67.38	86.06	16
Printers, publishers and related industries	83.15	91.08	10	80.34	88.12	13
Manufacture of industrial chemicals	98.47	99.04	4	93.47	98.02	4
Manufacture of other chemicals	96.47	99.39	2	95.40	98.79	2
Manufacture of rubber products	90.08	92.72	9	91.46	97.15	5
Manufacture of plastic products	90.02	99.16	3	92.27	96.84	7
Manufacture of glass and glass products	91.67	95.35	7	64.68	86.13	15
Manufacture of other non-metallic mineral products n.e.c.	57.14	76.05	21	51.66	76.93	20
Basic iron and steel industry	79.80	80.98	19	72.91	95.64	9
Basic non-ferrous metal industries	89.32	96.35	6	66.38	97.14	6
Manufacture of metal products	75.91	85.63	16	55.67	69.52	25
Manufacture of machinery	91.01	92.89	8	77.79	88.50	12
Manufacture of electrical equipment	96.40	97.23	5	93.79	98.25	3
Manufacture of transport equipment	62.26	86.49	13	73.21	92.76	10
Manufacture of professional and scientific equipment	85.38	88.56	12	92.68	96.41	8
Other manufacturing industries	81.22	90.28	11	58.58	72.36	22
Other manufacturing industries n.e.c.	60.14	63.51	25	66.39	86.26	14
Total employment	66%	81%		63%	79%	
Mean	75.68	85.51		70.56	86.33	

Source: Own elaboration based on data from INEC<sup>22</sup>

environment. This index uses the market shares of all companies in the industry. It is calculated by taking the sum of the squares of the market shares of each company in the industry. Its mathematical expression is the following:

$$HH_i = \sum_{j=1}^j (S_{ij}^c)^2 \quad \dots (2)$$

where,  $i$  =industry;  $S_{ij}^c$  = employment share of industry  $i$  in city  $j$ , in the total (national) of industry  $i$ . The  $HH_i$  has a value of 0 if the distribution of industrial employment in the city is equal to the distribution of total employment. An index value above 0 is interpreted as a spatial concentration of industrial activity.<sup>3</sup>

The values obtained for the Ecuadorian industry allow to deduce a different concentration level in the years analysed, but in both cases well above 0. Thus, the Manufacture of tobacco products industry is the most concentrated in both years; while the Manufacture of machinery (except electrical) also appears among the five sectors with the highest concentration, both in 1980 and 2010.

In addition to these sectors, in 1980 there were the Basic industry of non-ferrous metals, Manufacture of glass and glass products and Manufacture of electrical equipment, all with values above 0.5. On the other hand, in 2010 the values of the HH indicator are generally lower than those of 1980, which suggests a lower concentration level. The branches that stand out in this case due to their high concentration level are the Manufacture of plastic products, the Manufacture of industrial chemical substances and the Manufacture of other chemical products.

Regarding the least concentrated sectors between these years, there is a coincidence in the Wood industry and the Manufacture of furniture. The rest of the sectors differ between the two years analysed. In addition to these, in 1980 the least concentrated sectors were the Manufacture of clothing and the Manufacture of footwear. In 2010 they include: Manufacture of non-metallic mineral products n.e.c., Manufacture of metal products and other manufacturing industries.

On the other hand, the reduction in the mean value of HH, which goes from 0.33 to 0.28 between 1980 and 2010, suggests a lower geographical concentration in the most recent year.

#### Gini index

The Gini index is a measure of inequality, which in this case allows to observe differences in the

territorial distribution of industrial sectors, although it must be taken into account that it does not consider the different dimensions of the territorial units analysed. The index varies between 0 and 1, approaching zero as a certain activity is located in multiple municipalities. The Gini coefficient (hereinafter GI) for an industry  $j$  is calculated as:

$$GI = \sum_{j=1}^{N-1} (p_j - q_{ij}) / \sum_{j=1}^{N-1} p_j \quad \dots (3)$$

where,  $i$  is the city;  $j$  the sector;  $q_{ij}$  denotes the weight of employment in city  $i$  in sector  $j$  in relation to the total number of employees in sector  $j$ ;  $p_j$  the weight of employment in city  $i$  in relation to total employment in the country. The  $q_{ij}$  ratio is normalized by the share of each city in total manufacturing ( $p_j$ ). The cities are then arranged in ascending order, to then calculate the index according to the formula.

Based on the results obtained, the sectors whose activity is located in numerous cities in Ecuador correspond to those with the lowest spatial concentration, of which the Manufacture of footwear is the only industry that coincides in both years. In contrast, the sector with the highest spatial concentration is the Manufacture of tobacco products in 2010; and the Basic non-ferrous metals industry in 1980. The rest of the sectors that make up this group differ widely in the period of analysis.

In terms of the percentage of industrial employment, the Manufacture of food products is relevant in both years, representing 21.48% and 28.89% in 1980 and 2010, respectively. Next, there is the Manufacture of clothing with 12% of employment in 1980 and 10.99% in 2010, which allows to infer that there is a low diversification of activities in the industrial sector in a period of thirty years. Regarding the average GI, its value is almost the same between both years (0.94), which suggests the permanence of a high concentration pattern in this period.

Finally, it should be mentioned that the GI has the same limitations as the HH in terms of the impossibility of distinguishing between random and non-random distributions, and not considering the number of establishments in the industry.

#### Ellison and Glaeser Index

The index proposed by Ellison & Glaeser<sup>2</sup> (hereinafter EG), allows to differentiate those industrial sectors that are highly concentrated due to the fact that they are made up of a few companies, from those that

are made up of a multitude of small companies located in a few geographical units. Thus, the above-mentioned limitations of the HH and EG index are overcome. However, although this indicator measures the economies of agglomeration present in the decisions to locate companies in a sector in the territory more reliably, it is not capable of discriminating whether such agglomeration forces come from certain characteristics of the territory or the existence of external economies of localization or inter-company spillovers, within the industry.

Since the level of economic concentration of employment in a given sector is compared with that which would occur if all the plants in this sector were randomly located in different places, the evaluation of such randomness requires knowing data about the industrial organization of each sector and its geographical concentration. To approximate the industrial organization of different industries, Ellison & Glaeser resort to the Hirshman-Herfindhal Index. The index of EG ( $\gamma$ ) has the following form:

$$\gamma_i = \frac{G - (1 - \sum_i x_i^2) HH_i}{(1 - \sum_i x_i^2) (1 - HH_i)} \quad \dots (4)$$

where,  $G$  is the spatial Gini index;  $x_i$  includes the share of total industrial employment in city  $j$  with respect to industrial employment in the whole territory;  $HH_i$  is the Hirshman - Herfindhal index, which measures the concentration of the size of the establishments that make up each sector.

To calculate the  $HH_i$  index properly, it is necessary to know the employment for each of the  $k$  establishments for each  $i$  sector and  $j$  city, which are not available in the database used. Therefore, it is convenient to carry out an approximation according to the work of Schmalensee.<sup>24</sup> For this, the 2010 Economic Census database is used, which contains updated data on the required variables. However, it is not possible to locate such data for the year 1980. Therefore, the value of the  $HH_i$  index for 2010 is the one used to calculate the EG index for 1980.

The data provided by the INEC<sup>22</sup> for 2010 correspond to the number of economic establishments and employment for each branch of the Ecuadorian industry and for each one of the so-called "employment brackets", in which the database breaks down the total (1–9 workers; 10–49; 50–99; 100–199; 200–499; 500 and more workers). An approximation to HH is obtained by the following expression:

$$HH_i = \sum_{k^*} \left[ \frac{L_{ik^*}}{N_{ik^*}} \right]^2 N_{ik^*} = \sum_{k^*} \left[ \frac{L_{ik^*}}{\sum_{k^*} L_{ik^*}} \right]^2 \frac{1}{N_{ik^*}} \dots (5)$$

where,  $N$  is the number of establishments;  $k^*$  is each of the six employment brackets.

Positive EG values indicate a concentration level above and higher than what would be expected by chance. In other words, they indicate a concentration higher than that of the whole economic activity, suggesting the existence of agglomeration forces that lead companies in a sector to be concentrated in the territory. One question that remains open is how to interpret a negative EG<sup>6</sup>, although Rosenthal and Strange<sup>4</sup> attribute this situation to an excess of spread of employment. For the purposes of this study, negative EG values are considered as sectors where there seem to be no factors that lead companies to focus on space, such as the *Basic iron and steel industry*, *Manufacture of rubber products*, *Manufacture of professional and technical equipment*; and *the Production of tobacco goods* in the two years analysed. As opposed to 1980, the following are added: *the Manufacture of paper and paper articles*, *Manufacture of glass and glass products*, *Manufacture of machinery and Manufacture of tobacco products*.

As before, the *Manufacture of tobacco products* shows an atypical result of a very high geographical concentration. Although Ellison and Glaeser<sup>2</sup> indicate that the decision of the index levels that constitute significant deviations from a random location is not evident, in their analysis at state level in the USA, for the computer and automobile sector, they define<sup>7</sup>  $>0.05$  as being of high concentration and  $<0.02$  as not being very concentrated. Such a definition applied to the results obtained for Ecuador would indicate a moderate industrial concentration, if it is taken into account that in each year less than half of the sectors exceed the threshold of 0.05 and that also between both years, the number of sectors with these values decreases. Regarding the established ranking, within the five highest values of the<sup>7</sup> index for 2010, none coincides with 1980, which indicates a certain variation in the degree of geographical concentration of the industrial sectors in the country in this period.

Finally, and based on data available for 2010, it is possible to conduct an analysis at different levels of disaggregation (two digits, three digits and four digits) and at the geographical scale of city and province. As expected, the average level of

agglomeration increases as the level of sectoral disaggregation of the data from 2 to 3 and 3 to 4 digits does. In general, as industries are aggregated into broader and fewer categories, the spatial pattern of localization of establishments eventually approaches that of the economy as a whole, causing G and EG to shrink to zero.

#### Urban Agglomerations and Industrial Localization

This section aims to determine whether companies in the same sector have locational preferences for large urban agglomerations or alternatively prefer to be located in less urban environments. The initial idea is that large and dense urban environments are more productive for companies and workers, and it is also here where the vast majority of important innovations emerge.<sup>25</sup> In summary, the advantages of a larger urban scale for industrial localization are found in innovation, local industrial expansion, and the attraction effect on other companies, which together generate three types of external economies: localization, urbanization and transportation.

In this regard, there is extensive economic literature that studies the importance of specialization and diversification in industrial localization<sup>26-29</sup>, respectively. In the first case, it is suggested that the concentration of the industry in a city helps to reduce production costs by providing specialized inputs and knowledge spillovers, which together promotes the growth of the industry. In the second case, it is the environment of industrial diversity that facilitates the transfer of technology and knowledge of the different industries, thereby stimulating innovation and local industrial growth. With these theories as a foundation, various empirical studies have been carried out that generally analyze the MAR - Jacobs dichotomy, among which the following stand out: Glaeser *et al.*<sup>1</sup>, Rosenthal and Strange<sup>4</sup>, Viladecans-Marsal<sup>15</sup>, Fu and Hong<sup>37</sup>, Rensky<sup>31</sup>, Billings and Johnson<sup>32</sup>, Combes *et al.*<sup>33,34</sup>, Lu *et al.*<sup>20</sup> and Jofre-Monseny.<sup>35</sup>

The driving force of this part of the work is the methodology proposed by Holmes & Stevens<sup>6</sup>, who establish the specialization patterns according to the urbanization level in the US and Canada, recognising that the composition of economic activity varies substantially across large, small, and rural areas. This implies arranging cities from the highest to the lowest in terms of employment in order to obtain four quartiles, so that each one contains 25% of total employment, although none of them contains exactly such a percentage of employment. The variables obtained by each quartile in absolute and percentage terms are listed in Table 2.

With the exception of employment, none of the other variables is 25% in each quartile, the differences between them are quite broad. The most relevant case is the number of cities corresponding to each one. Only one city makes up quartile 4, while 3 make up the second quartile, 16 the third quartile, and the remaining 200 make up the fourth quartile. Since colonial times, Quito and Guayaquil have maintained their hegemony over the rest of the cities in Ecuador, which is why it is argued that the country has always had a very high economic bi-centralism. In fact, of the total industries considered, 26% and 21% are found in Quito and Guayaquil, respectively.

According to the methodology of Holmes & Stevens<sup>6</sup>, the urbanization measure that is proposed for each  $i$  and  $j$  city is defined as:  $N_i = \{j \mid \text{such that } d_{ij} < 30\}$ . The vicinity includes all the cities within 30 miles from county  $i$ , and includes county  $i$ . Therefore, the vicinity population of  $i$  is defined to be the total population of all the counties in  $N_i$ . Holmes and Stevens<sup>6</sup> use the longitude and latitude coordinates of each county, which in most cases is the geographical centre of gravity, in other cases it is just a point located within the county.

The consideration that underlies this approach is that the population of the municipality and its

Table 2 — Description of the Quartiles to 2010

Variable	Quartile 1		Quartile 2		Quartile 3		Quartile 4		Total
	Value	%	Value	%	Value	%	Value	%	
Number of cities	200	91.3	16	7.3	2	0.9	1	0.5	219
Population	6,007, 399	41.6	3, 343, 659	23.1	2, 856, 500	19.8	2, 239, 191	15.5	14, 446, 749
Employment	437, 942	21.3	510, 763	24.9	558, 481	27.2	547, 067	26.6	2, 054, 253
Manufacturing employment	42,633	16.2	66, 917	25.4	81, 993	31.1	72, 045	27.3	263, 588
Area (km <sup>2</sup> )	221, 437.14	89.3	15, 024.00	6.1	7, 386.91	3.0	4, 217.95	1.7	248, 066

Source: Own elaboration based on data from INEC<sup>22</sup>

surroundings characterize the urbanization level of a municipality better. In the case of Ecuador, given its physical characteristics, the administrative limits of cities are well defined, so it is assumed that they reflect the real economic area of their territories. In this regard, unlike Holmes & Stevens<sup>6</sup>, a distance threshold is not established between one city and another, but rather works directly with the populations found in each of the previously defined quartiles or urbanization quartiles at city level.

Since the initial interest is in how specialization varies with the size of the city, the localization ratios are calculated for the quartiles described from the expression:

$$CL_i = \frac{S_i}{X_i} = \frac{S_i}{N_i} \quad \dots (6)$$

where,  $S_i$  is industrial employment in city  $i$ ; relativized by aggregate employment in  $N_i$ , that is, by the urbanization measure, in this case the population of each city or municipality.

Given that each quartile represents about 25% of total employment, by definition, the sum of the localization quotients of the four quartiles should be four. The tendency of a sector to locate its employment in the most urban areas is calculated by the difference between the localization quotients of the fourth and first quartile. The data on the urbanization of the industry have been arranged from the lowest to the highest according to this difference, and since there are negative values, sectors with lower urbanization levels are made more evident, and consequently are more inclined to be located in less urban environments. The sectors of Manufacture of food products, Production of wood, Manufacture of leather and related products, Manufacture of other non-ferrous metallic mineral products, Manufacture of fabricated metal products except machinery and equipment, Manufacture of metal products, Manufacture of furniture, Other manufacturing industries and Manufacture of clothing.

In contrast, higher values of industrial urbanization indicate the tendency of certain sectors to be located in more urban areas, such as the following in order of importance: the Manufacture of motor vehicles, trailers and semi-trailers; the Manufacture of pharmaceutical products; Manufacture of beverages; Manufacture of computer, electronic and optical products; Manufacture of textile products; as well as Printing and reproduction of recordings, among the most important. In the previous paragraphs, a relationship has just been established between

industrial localization and the urbanization level of cities. In this part of the work the aim is to study further the two ideas mentioned so far, that is, if the most concentrated sectors in the territory are located in the most urban areas, or if the trend is the opposite, preferring less urban environments. According to Duranton & Puga<sup>36</sup>, the presence of diversity in the various industrial sectors is common in urban areas, and therefore, of higher economic dimensions.

Regarding less urban territories, these tend to have industrial structures in which specialization takes place, due to the fact that certain sectors are more important. Consequently, activities with higher levels of geographical concentration will preferably be located in less urban settings, with the tendency to increase the productive specialization of these territories in this activity, while more urban locations are preferred for activities with lower concentration levels, and thus the trend is towards the diversification of these environments.

The relationship between the concentration of the different industrial sectors (measured by the EG index with the level of urbanization IU) is shown in Fig. 1. The figure shows the position of each sector of the industry at a level of disaggregation of two digits within four quadrants that result from the combination of the chosen variables.

In summary, four different groups stand out: the first one is made up of the sectors Manufacture of motor vehicles, trailers and semi-trailers; Manufacture of chemical substances and products; Manufacture of pharmaceutical products; Manufacture of textile products; Manufacture of rubber and plastic products; and Manufacture of electrical equipment, those that perform in a high concentration and urbanization context. The second group: Manufacture of tobacco products; Manufacture of beverages; Manufacture of computer, electronic and optical products; and Manufacture of other types of transport equipment, which do so in a high concentration, but low urbanization level environment. The third group: Manufacture of leather and related products; and Manufacture of other non-ferrous metallic mineral products, located in less urban but more concentrated environments. Regarding the fourth group, it is located in the central part of the graph in which no distinctive behaviour is observed regarding its spatial concentration, nor its locational preferences in more or less urbanized areas such as those related to the Manufacture of fabricated metal products except



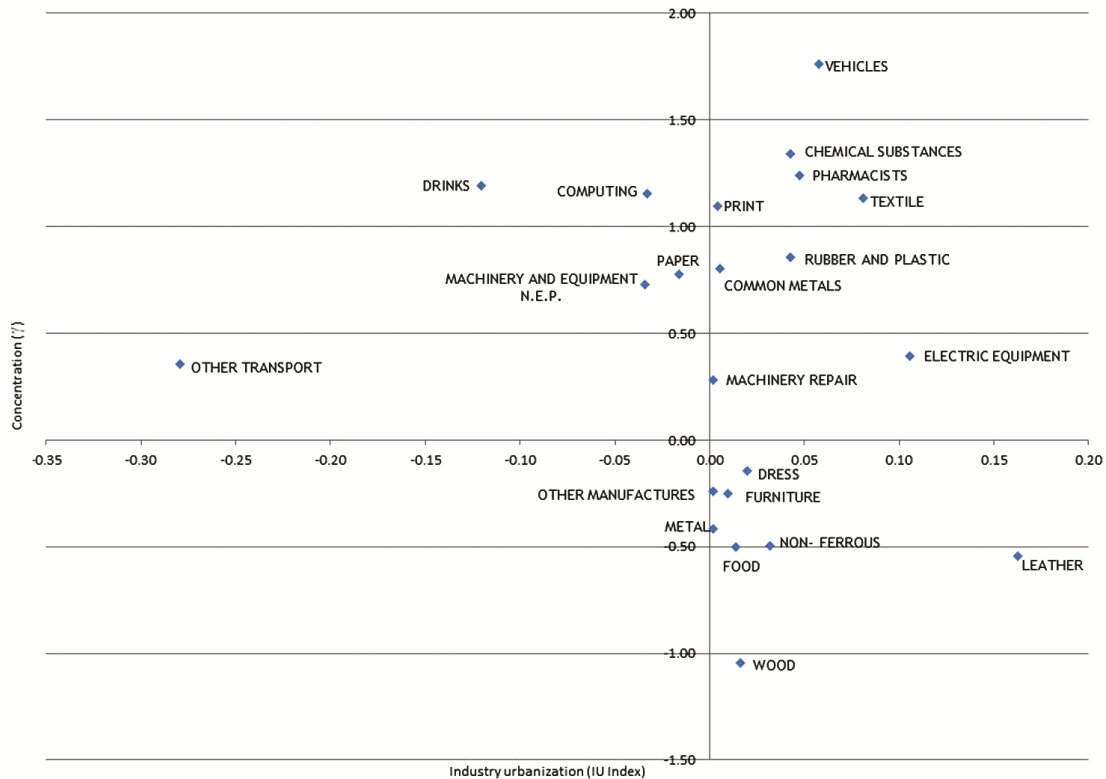


Fig. 1 — Geographic concentration and level of urbanization, 2010 - 2D (The graph does not include the tobacco industry  $(-2.46, 3.36)$  only because it does not facilitate observing the behavior of the rest of the sectors; *Source*: Own elaboration based on the EG and IU index)

machinery and equipment; Repair and installation of machinery; Other manufacturing industries; Printing and reproduction of recordings; Manufacture of common metals; Manufacture of furniture; Manufacture of food products; Wood production; Manufacture of clothing; Manufacture of paper and paper articles and Manufacture of machinery and equipment n.e.c. It should be mentioned that there is no sector that operates in low concentration and urbanization contexts.

In general, the results obtained are consistent with other empirical studies that use other methodologies, in which it is shown that diversity and not specialization explains the localization of manufacturing<sup>1,15,37,38</sup> better. Similarly, studies such as those by Henderson<sup>38</sup>, Nakamura<sup>39</sup> and Jofre-Monseny & Viladecans<sup>40</sup> highlight the idea that the most technologically advanced activities obtain greater advantages when located in environments with high economies of urbanization.

## Discussion

During the 1990s, the economic literature showed a high interest in locational patterns of economic

activity. Although the studies produced since then were more theoretical than empirical, mainly due to the quality of the data available, more and more diverse methodologies have been developed and whose aim is to analyse the relationship of economies of agglomeration in such patterns. Traditionally, the measurement of geographical concentration in space uses industrial employment data and various indicators, among which the one developed by Ellison and Glaeser<sup>2</sup> stands out as the best one methodologically. This indicator controls the degree of economies of scale internal to the company in a given industry, which, if not considered, may lead to inaccurate conclusions about the territorial concentration of the activities of relevance.

The results for Ecuador's industry based on this index show a higher concentration than that of economic activity as a whole, suggesting the existence of agglomeration forces in most industrial sectors, in the two years analysed. There are only exceptions in the case of the *Manufacture of electrical equipment* and *Manufacture of transport equipment* sector, which in this period went from being excessively wide-spread in terms of the employment found in them in 1980, to

being highly concentrated in 2010. In the rest of the sectors, between the two years, the main difference lies in the importance they represent in terms of concentration in one year and another. Finally, it is verified as expected, that the agglomeration levels increase depending on the level of sectoral disaggregation, which is verified for 2010, given the availability of information required for this effect.

The objectives set out in this work have been carried out by using the only census databases of industrial economic activity available (1980 and 2010) provided by the INEC.<sup>22</sup> The novelty that is methodologically provided is the territorial scope analysed (cities), as well as the relationship between the spatial concentration of manufacturing activities in the territory and the urbanization level of this territory. This consideration is relevant given that there are no similar studies for Latin American countries, with the exception of Brazil.<sup>34</sup>

The measurement of the geographical concentration of industrial activities in Ecuador allows us to infer that there are great disparities between manufacturing sectors and between the years of the study. The analysis that relates the localization of industrial sectors and the locational preference for more or less urban environments (in population terms), carried out following the work of Holmes and Stevens<sup>6</sup>, also shows different behaviours that depend on the sector concerned. The results generated allow to infer the coexistence of diversified and specialized areas within the same urban systems.

### Conclusions

A significant result of this work is to demonstrate that the productive and locational pattern of the Ecuadorian industry in the period of analysis has not changed substantially, which leads to the recognition of local productive possibilities and public policies focused on promoting the emergence of new activities and on the reinforcement of the most dynamic already existing ones.

Furthermore, it should be noted that between 1980 and 2010, the country's concentration patterns have not changed, being evident the importance that colonial heritage continues to have in the geographical concentration of manufacturing in this country. The cities of Quito and Guayaquil have continued to maintain their supremacy over the others since their colony, and therefore, they perform important economic, regional and international functions. They have the five largest industries in the

years analysed, which is why they show a significant concentration of economic and population activity.

The noticeable difference between these years lies in the economic, political and social conditions of each era. Without a doubt, the dollarization of the Ecuadorian economy, together with other factors such as the expansion of the domestic market due to the reduction of poverty, mainly improved the country's industrial environment; However, Ecuador reaches a decade of excellent opportunities for Latin America with a weak industry, in which production continues to be essential.

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