Tariffs and industrial location in Ecuador

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ABSTRACT

The theoretical literature has reached no consensus on whether international trade liberalization increases concentration of economic activities within a given country or whether dispersion occurs as the country progressively opens to trade. This paper contributes to this literature by analyzing the experience of Ecuador in the first decade of the 21st century. This country is an interesting case study because it has two economic centres of similar size (Quito, the capital, and Guayaquil) which is different from other Latin American countries. At the same time, the trade liberalization policies followed a similar path as those in other Latin American countries that dismantled the import substitution regime. Our econometric results based on a sample of 20 provinces and 20 industrial sectors in two periods of time, 2000 and 2010, suggest that trade policy did not substantially modify the patterns of location of manufacturing in Ecuador during this period. If anything, it only reinforced, a little, the concentration of economic activities in Quito.

KEYWORDS

Trade liberalization, industrial location, tariffs, Ecuador.

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1. Introduction

Ecuador made substantial changes in trade policy in the 1990's aimed at reducing trade barriers and liberalizing its economy. As many other Latin American countries, Ecuador had followed import substitution policies in the 1960's and 1970's. With the discovery of oil in the Amazon region in 1972, a boom phase lasted until 1982, when external shocks and the decline of these policies lead to a debt crisis, followed by recession and impoverishment. The second half of the 1980's was a period of adjustment in an economy that had suffered from the Dutch disease. The adjustment, supervised closely by the IMF, implied a reduction in public investment from 5.9% of the GDP in 1981 to 2.6% in 1991. The main policy change occurred in the exchange rate with a series of devaluations of the national currency (the sucre). From 1980 to 1991, the sucre devaluated by 3857% and was subjected to instability and uncertainty, encouraging spontaneous dollarization, that eventually led to a full dollarization of the economy in 2000. Industrial planning and the industrialization policies of the ISI period were dismantled, and trade liberalization started with the elimination of import prohibitions in 1983.[1]

Full tariff reform only came about in the 1990's and it was inscribed in the context of the Andean Community (Bolivia, Colombia, Ecuador, and Peru), a regional block established in 1969 in the Cartagena agreement. By the Quito protocol approved in 1987, Ecuador committed to apply the Common External Tariff of the Andean group. But the free trade zone between members only entered in operation in 1993, and it was not transformed, though imperfectly, in a customs union until 1995.

Unilateral tariff reductions in Ecuador were approved in 1990, 1992, 1994 and 1995. The main effect of the reforms was a reduction in the average nominal tariff from 24% in 1990 to 11% in 1996. Another important change was the elimination of the "additional taxes", which were a discretional instrument that increased the average effective tariff. However, the reform did not change the traditional tariff structure that favored raw materials over final products.[2]

During the 1990's and first decade of the 2000's, Ecuador coordinated its negotiations

[1] For a complete analysis of the crisis, adjustment and change of regime in Ecuador see Beckerman and Solimano (2012) and Oleas (2017).
[2] For a full description of the tariff reforms in the period 1990-1996 see Tamayo (1997).

in the GATT and World Trade Organization with the rest of members of the Andean Community. However, the slow pace of progress after the Cancun and Hong Kong ministerial conferences led many countries in the area, including Ecuador, to negotiate bilateral free-trade agreements. Ecuador signed a preferential trade agreement with Mexico in 1993 and with Mercosur in 2004 and started negotiations to sign a free trade agreement with the U.S in 2003. The U.S is Ecuador's and the Andean Community's main commercial partner. In fact, intraregional trade in the Andean Community is low, while in 2005, 40% of its total exports were directed to the U.S. The Andean Trade Preference Agreement (ATPA) signed by the U.S in 1991 and followed in 2002 by the signature of the Andean Trade Preference Agreement and Drug Eradication (ATPDEA) boosted trade between these countries and the U.S.[3]

Despite its importance, the effects of trade liberalization in the Ecuadorian economy have not been widely studied. The literature has focused on the welfare and poverty effects of this policy by using CGE models and microsimulation (Vos & DeJong, 2003, Durán et al., 2007, and Wong & Kulmer, 2010). Other studies have analyzed the competitive and productivity effects of trade liberalization (Wong, 2007 and 2009). But, up to our knowledge, the economic geography effects of these trade reforms in Ecuador have not been studied.

Spatial effects are a well-known byproduct of trade policy reforms, and in particular the new economic geography literature has studied not only inter-country effects but also within-country spatial inequality following trade liberalization. However, as highlighted in Brülhart's (2011) survey on the spatial effects of trade openness, theoretical predictions are not robust. Depending on the model choices, trade openness can promote intra-national spatial convergence or divergence. Moreover, empirical evidence is also indeterminate and depends on each's countries specific geography, as the only robust prediction is that, other things equal, regions with better access to richer and larger foreign markets will benefit more from trade liberalization.

The empirical analysis of industrial location in Ecuador in a context of trade liberalization could contribute to the efforts to assess this important dimension of trade

[3] We only mention the trade agreements signed until 2010 as this is the period we will study in our empirical analysis. However, since 2010, Ecuador has signed a preferential trade agreement with Guatemala in 2011, and free trade agreements with the EU in 2014, the EFTA in 2018, the UK in 2019, Chile in 2020, and China in 2023. The negotiations to sign a free trade agreement with the US were abandoned in 2006 and were retaken in 2020.

policies. Moreover, the regional issue has been extremely important in this country due to historical, geographical, and political reasons. Competition between the "Sierra" (mountain highlands), centered on the capital, Quito, and the "Costa" (coastal lowlands), centered on the port city of Guayaquil, has been a main feature of Ecuador's history. These two regions were completely separated before the creation of the Republic of Ecuador in 1830 and since then the two regions have been culturally and economically distinct. As a former center for intracolonial sea trade, and a producer of the main agricultural commodity exports (cacao, banana, and shrimps), Guayaquil's elites favored liberal policies while conservative landowners were based in Quito. The rivalry between the two regions has impeded both the central government's political and administrative capacities and regional autonomy, for fear of breaking the country apart (Beckerman & Solimano, 2012).

Did trade liberalization policies had an impact on the internal geography of Ecuador? Was the concentration of economic activities in Quito (Pichincha) and Guayaquil (Guayas) reinforced or on the contrary did the country experience a redispersion of activity? Which one of the two traditional economic centers of Ecuador was more favored by these policies? Our main hypothesis is that trade liberalization would have favored a dispersion of economic activity away from Quito as import substitution policies which favoured the concentration of activity in the main capital cities of Latin America were abandoned (Krugman & Livas, 1996).

The rest of the work is organized as follows. The second section reviews the literature on trade liberalization and internal geography. The third section describes the data used and shows descriptive evidence on industrial location patterns and tariffs. The fourth section explains the empirical methodology. The fifth section presents the estimation results. And the sixth section concludes.

2. Trade liberalization and internal geography in the literature

The New Economic Geography models developed in the 1990's, offered a new approach to analyze the geographical distribution of economic activities, using a monopolistic competition framework and internalizing scale economies. In these models, the spatial economy is a result of the interaction between agglomeration and dispersion forces, and these forces can be modified with transport costs. Hence, the effects of trade liberalization on the spatial distribution of industrial activity were a

primary object of research of this literature. Inter-country or inter-regions models were the first to be developed but soon followed models that analyzed the intra-national effects of inter-country trade liberalization, as empirical evidence pointed towards a higher effect of trade openness on regional inequalities inside countries than between countries.

To analyze the impact of integration on the intra-country geography of economic activities, the first theoretical papers extended the Krugman (1991) 2-country (or 2-region) setting to frameworks in which both inter- and intra-national inequalities were assessed. Krugman & Livas (1996) were the first to extend the 2-regions model to analyze the impact of trade liberalization within countries. In a model with three regions, two belonging to the same domestic country and one to the foreign country, the authors show that, when both countries open to trade, the domestic country experiences a geographical dispersal of its economic activity between its two hosted regions.

However, this dispersion result is not general as it strongly depends upon the use of an urban congestion cost in the model. When a population of immobile workers as in Krugman (1991) is used instead (Monfort & Nicolini, 2000, Paluzie, 2001), international integration is shown to foster agglomeration in the domestic economy. As in most new economic geography models, this result comes from the interaction of two counteracting endogenous forces: the agglomeration forces and the dispersion forces. The opening up to trade with a foreign economy increases exports (foreign demand) and imports (foreign supply). On the one hand, foreign demand lowers the incentive for domestic firms to locate close to domestic consumers and thus weakens one of the agglomeration forces (the home market effect). As foreign supply decreases the incentive for domestic costumers to locate near the domestic supply, the cost effect is also weakened. But on the other hand, trade liberalization also weakens the dispersion force (the local competition effect), as the presence of foreign supply lowers the need for domestic firms to locate far from domestic competitors. Overall, this last effect outpaces the former and the domestic economy finally concentrates in a single location.

In the same setting, Crozet & Koenig-Soubeyran (2004) introduce an asymmetry between the two domestic regions, assuming that one region is farther away from the international market than the other. Trade liberalization moves then domestic firms to

the region closer to the external market unless competition pressure from the foreign market is too fierce. The relationship between the performance of border regions and economic integration would not be monotonic but the result of two counteracting forces: increased market access (favorable to export production) and increased import competition (negative for domestic producers that compete with foreign supply).

The core-periphery models of the Krugman's type are known for their extreme results yet, with the reduction in trade costs leading to catastrophic agglomeration, but also for their analytical intractability. Hence, recent studies try to both attenuate centripetal forces and provide analytical solutions to the models. For instance, Brülhart et al. (2004) use a 3-region framework setting in which the manufacturing sector uses mobile human capital as the fixed cost and labor as the variable cost of production. They find that, for most parameter configurations, external liberalization favors the concentration of human capital in the border region. However, this mechanism is not deterministic: A sufficiently strong pre-liberalization concentration of economic activity in the interior region can make this concentration globally stable and predict even more agglomeration in this region.

This question has also been analyzed in a setting alternative to the Dixit-Stiglitz-Iceberg framework by Behrens et al. (2006), Behrens et al. (2007) and Behrens (2011). Thus, Behrens et al. (2007) develop a two-country/four-region model based on Ottaviano et al. (2002), whose main result is that lower international trade costs promote regional redispersion when inter-regional transport costs are high enough, i.e., similar results to Krugman & Livas (1996) and opposite results to Paluzie (2001), Montfort & Nicolini (2000) and Crozet & Koenig-Soubeyran (2004). The key to Behrens et al. (2007) results lies in an additional pro-competitive effect derived from the variable mark-ups that are allowed for in Ottaviano et al. (2002) model. Agglomeration of competing firms in a region imposes a downward pressure on prices and acts as an additional dispersion force.

However, in a similar Ottaviano et al. (2002) setting, but allowing for different structures of interregional trade flows, Behrens (2011) develops a two-country/three-region model and finds that the impact of decreasing international trade costs on the regional distribution of economic activities crucially depends on the value of transport costs internal to the country. Trade liberalization in developing countries with poor

internal infrastructures is likely to increase regional disparities, while developed countries with good infrastructures are likely to experience regional redispersion.

In the same Ottaviano et al. (2002) setting, in a model of two countries/two regions, Behrens et al. (2006), introduce an asymmetry in the internal regions of one of the countries, one region has preferential access to foreign markets (the transportation gate), as in Crozet & Koenig-Soubeyran (2004) and Brülhart et al. (2004). In the other country, both regions have the same international accessibility. They obtain three main results. First, compared with a situation without gate regions, the gate-less country is more likely to be agglomerated when its trade partner is gated. So, the presence of gated regions makes the economic geographies of countries interdependent. Second, the gated country is more likely to be agglomerated when its partner is dispersed. Finally, agglomeration in the gate region occurs when the gated country is well integrated, whereas agglomeration in the landlocked region occurs when it is poorly integrated. Hence, the impact of remoteness depends on the interplay between international trade barriers and intranational trade costs. The authors argue that their model fits well with the Mexican experience after NAFTA, that led to a dispersion of economic activities away from Mexico City towards the North (at the border with the U.S.).

Atsumi (2010) uses a different economic geography model to explain an important shift in the location of economic activities in Japan in the nineteenth century, when the silk fabric industry moved from western Japan (Kyoto and Osaka) to eastern Japan (Tokyo) after the opening up to international trade in 1859. He modifies the footloose entrepreneur model by Forslid and Ottaviano (2003) giving a broader role to the agriculture sector. In Atsumi's model, this sector produces both final goods and raw materials (raw silk) and it also incurs in trade costs. It is also assumed that raw silk can only be produced in eastern Japan. Estimating feasible parameters from historical studies and applying them to the model, Atsumi (2010) proves that previous to the trade liberalization, agglomeration in eastern Japan was not a feasible equilibrium and hence the majority of silk fabric located in western Japan. Then, he introduces in the model international trade of textiles in which Japan exports raw silk and imports woolen and cotton fabrics. The difference with the previous models lies both in the reasons for the heterogeneity of the internal regions (raw silk can only be produced in eastern Japan) and in the pattern of international trade. In this model, trade liberalization affects

import competition in fabrics (impacting negatively in the silk fabric firms in western Japan that operate at higher costs) and rises the price of raw silk due to its exports (increasing the market size of western Japan). The combination of these two effects will provoke that the majority of silk fabric firms agglomerate in eastern Japan after the opening up to international trade, which is consistent with historical evidence.

Thus, the theoretical literature has reached no consensus on whether international trade liberalization increases concentration of economic activities within a given country or whether dispersion occurs as the country progressively opens to trade. In addition, it is not clear whether border regions would benefit or not from integration processes. This could depend on the previous pattern of concentration, the degree of trade liberalization, the size and sectoral composition of the foreign market (Crozet & Koenig-Soubeyran, 2004, Brülhart et al., 2004) or the degree of integration of the domestic market (Behrens et al. 2006). Therefore, empirical analysis is crucial to shed some light on this issue.

The main empirical approach consists in testing the NEG predictions of home market and backward (demand) linkage effects: the better a region's access to large markets, the higher its factor prices, output, or a mix of both. The price channel of this effect predicts the existence of regional wage gradients, with nominal wages decreasing with transport costs from industrial centers, and their possible reversal following changes in trade regimes. When focusing on output variables, adjustments are driven by the number of firms and regions with good access to markets end with a higher share of employment or production in differentiated goods.

Hanson was the first to test for such theoretical predictions in his analysis of the relocation of economic activity towards the U.S-Mexico border area following the NAFTA agreement. In Hanson (1996a, 1997), information on the regional structure of wages in Mexico is used to check whether relative nominal wages decrease with distance from industrial centers (Mexico City and the Mexican northern border region), whether wage gaps reduce with trade barriers, and whether this leads to employment shifts in border regions. Whereas the author finds strong support for the hypothesis that relative wages decline with distance from Mexico City, no evidence of a structural break in this relationship is found after the trade reform. Hanson (1996b, 2001) focuses on the existence of NAFTA effects on the Southern US states bordering Mexico. He

finds strong support for the hypothesis that the expansion of Maquiladoras output in Mexican border cities has positively contributed to the growth of manufacturing employment in US border cities. Hence, the US-Mexico frontier area would be on the way to become a binational regional production network for the North American market.

As regards the EU, the emphasis has been mostly put on assessing the impact of the enlargement to the large block of Central and Eastern Europe (CEE) countries. The interest in focusing on the recent EU enlargement is that, as the borders of CEE countries become internal to the EU, economic activities could shift towards Eastern border locations, eventually at the expense of Western border regions. In this respect, a few studies follow the same approach as Hanson. For instance, Brakman et al. (2004), using a data set for 441 German districts for the years 1992 and 1995, estimate wages as a market potential function and find that border districts experience lower wages than others. Moreover, this is not the result of a misspecification due to the absence of foreign demand in the specification estimated. In the same spirit, Brülhart & Koenig-Soubeyran (2006) find evidence of wage and employment regional gradients in the Czech Republic, Hungary, Poland, Slovenia, and Slovakia, for the period 1996-2000. Their results are consistent with both a central-planning explanation, leading to a discrete wage advantage for the capital region, and a market-based NEG model, leading to wage and employment gradients with distance from economic centers. The authors compare then the gradients of accession and incumbent EU countries. They find that concentration in the capital regions is significantly stronger in the former and that nominal wages are higher in the border regions of incumbent EU countries. Hence, they conjecture that market forces would likely favor Eastern border regions too. In a slightly different approach, Brülhart et al. (2004) analyze how the changes in relative market access arising from EU enlargement are likely to affect peripheral regions of pre-enlargement member states. Their estimates suggest that enlarging the EU to firstly ten and secondly thirteen new countries increase the per capita incomes of Objective 1 regions only slightly.

In the same vein, another interesting case study is that of Spain which has been analyzed in a series of papers by Julio Martinez-Galarraga, Elisenda Paluzie, Jordi Pons and Daniel A. Tirado. Tirado et al. (2006) verified the existence of a wage gradient in 1920 centered

on Barcelona (the peninsula's main industrial center in the interwar years). This gradient had taken shape in the preceding decades in a situation where the first stages of the industrialization process in Spain were accompanied not only by the integration of the internal market resulting from heavy investment in railways and ports facilities, but also by increasing integration into the international markets, especially with the introduction of a liberal trade policy. This reached its peak in the 1880s. However, with the Canovas tariff of 1892, Spain gradually initiated a protectionist path that lasted until the second half of the twentieth century. Thus, Tirado et al. (2013) examined whether this gradient changed at a time when protectionist policies intensified after the introduction of the Cambó tariff in 1922. It is therefore the opposite of the case studied by Hanson (1997) as regards the Mexican economy, which was characterized by economic liberalization from the mid-1980s. Using wage data for four points in time (1914, 1920, 1925 and 1930), 7 industrial sectors and 47 Spanish provinces, their results confirmed the existence of a wage gradient centered on Barcelona over the period 1914-1930. The parameter estimated for the variable associated with distance was both significant and negative. However, and this is the most important contribution, the results also showed that its absolute value is lower in the observations for the wage variable for 1925 and 1930. This means that the relative market potential of Barcelona was decreasing in line with the gradual closing of the Spanish economy. In other words, the growing importance of the internal market due to regulation of the external market weakened the economic centrality of Catalonia and strengthened that of other regions away from the coast, favoring provinces that had a better location from which to supply products to and obtain raw materials from the Spanish internal market. Therefore, during the 1920s the wage gradient centered on Barcelona, a province located close to the French border, weakened. Moreover, the shift towards protectionist trade policies might also explain the relative rise in that period of inland areas such as Madrid, which, due to their location in the geographical center of the peninsula, were better placed to supply the protected domestic market.

These protectionist policies continued throughout much of the twentieth century, not just from 1892 and during the interwar period but also in the early years of the Franco dictatorship with its policy of autarky. With the 1959 Liberalization and Stabilization Plan, the Spanish economy finally initiated a path of trade and capital account liberalization that culminated with Spain's entry into the EU in 1986. In this context, Pons

et al. (2004) analyzed the existence of a wage gradient centered on Barcelona in the period 1955-1995, studying whether it became stronger over time, i.e., in parallel with the Spanish economy's re-opening, using the same empirical strategy as Tirado et al. (2013). The parameter estimated for the relationship between relative regional salaries and the distance to Barcelona was both negative and significant, thus confirming the existence of a wage gradient. Also, the evolution of the absolute value estimated for this parameter, identified through interactions with temporal dummy variables, was growing over time. The results therefore confirmed the existence of a wage gradient centered on Barcelona throughout the period analyzed. The results also confirmed that the gradual opening-up of the economy reinforced, *ceteris paribus*, the centrality of Barcelona as the main industrial region in Spain.

Also, in Western Europe, the works by Overman and Winters (2005, 2011) explore whether the UK accession to the EEC, which reoriented trade towards the ports located in the South-East of the UK, impacted the location of manufacturing activities. Firstly, they find that the share of employment in each TWWA (UK travel to work area) falls with distance from Dover. To capture the EEC accession effects, they interact time period dummies with distance to Dover and show that the locations closer to Dover, although they lost initially, gained ground later in the period. Secondly, they regress regional employment by industry on a measure of export market access and of import competition, calculated from port trade data. They find a positive coefficient on market access for almost all industries and more mixed results for the import competition variable. Even though accession did eventually encourage manufacturing activities to relocate towards the South-East, some industries also retreated north-westwards because of increased import competition. Finally, using a shift-share analysis, they show that South-Eastern ports are strongly specialized in trade oriented towards the Western side of Europe.

In Asia, similar stories have been documented. Kanbur & Zhang (2005) analyze the driving forces behind the changes in China's regional inequality over half a century (1952-2000). They find that regional inequality is mainly caused by three key policy variables-the ratio of heavy industry to gross output, the degree of decentralization, and the degree of openness. Pernia & Quising (2003) use data on the Philippines's 14 regions over the period 1988-2000, a period in which significant liberalization measures were introduced. Although economic openness affected regional economic growth positively, spatial

imbalance persisted with the continuing dominance of the Metro Manila region that increased its share in national GDP.

Therefore, studies focusing on the empirical estimation of the backward linkage, both in its factor price version (wages) and in its quantity version (employment or production) indicate that regions bordering larger and richer markets do seem to benefit from economic integration with them (with examples as the North of Mexico, Catalonia in Spain and the Southeast of the UK). By contrast, the results for regions bordering poorer markets are more mixed. Some of them, like the South of the US, experience positive effects and others, particularly in Eastern Europe, are negatively affected.

Another empirical approach to study this issue has used the gravity model of trade. Distance, by increasing trade costs, not only affects wages and employment, but it also reduces the volume of trade, as testified by the empirical success of the gravity model. If this model has been overwhelmingly used to analyze issues such as the effects of currency unions or regional trading agreements on countries, it has been much less investigated at the regional scale. Coughlin & Wall (2003) is one of the few studies that assesses the differential regional effects of trade liberalization in the gravity framework. It shows that while NAFTA led to an overall increase by 15% of the US exports to Mexico and Canada, its effects on states were quite differentiated. Following NAFTA, 28 (36, respectively) states experienced a more than 10% rise in exports towards Mexico (Canada, respectively), while 8 (4, respectively) states experienced the opposite counterpart fall. Hence, the diversity of results across states reveals the issue of studying the impact of integration on the intra-country geography of economic activities. However, Coughlin and Wall (2003) neither analyze in depth the characteristics of the states, nor focus on the differential effects of NAFTA on border states.

By contrast, Lafourcade & Paluzie (2011) investigate the specific trade performance of French border regions and its evolution over the period 1978-2000. They develop a gravity framework in which European integration is captured by the alleviation of both trade and FDI barriers and use it as an instrument to compare the relative trade performance of regions according to their geographical position. They found that once controlled for bilateral distance, origin- and destination-specific characteristics, French border regions

trade on average 73% more with neighboring countries than predicted by the gravity norm. The regions perform even better if they have good transport connections with these countries. However, French border regions at the periphery of Europe experienced a downward trend over the period that was partly due to the decrease in the propensity of Spanish and Italian foreign affiliates to trade with their home countries, and that could also be explained by the fact that the French border regions located at the border with Spain and Italy did not benefit from any major cross-border developments in this period, whereas their infrastructure connections with the north of France improved considerably.

Finally, another empirical approach is that of Sanguinetti & Volpe Martincus (2009), who use a direct trade policy instrument (tariffs) to assess its effects on the internal geography of Argentina. Like many Latin American countries, Argentina abandoned in the 1980's the import substitution policies and initiated a process of trade liberalization. To assess if lower tariffs had favored a dispersion of economic activity away from Buenos Aires, they use an extended version of Midelfart-Knarvik et al. (2000 a, b) that includes an explicit interaction between the distances from each region's capital to Buenos Aires city and sectoral tariffs. Their hypothesis, which is confirmed by their results, based on a sample of 24 regions and 125 industrial sectors over the years 1985 and 1994, is that with lower tariffs the benefits associated with proximity to the main economic center of the country, Buenos Aires, are reduced. *Ceteris paribus*, sectors facing less protection tend to be located at a higher distance from the main domestic market. In a similar setting, Volpe Martincus (2010) assesses the impact of trade liberalization and the MERCOSUR trade agreement in the internal geography of Brazil over the 1990's but using an output measure as sectoral openness instead of tariffs. His results show that trade openness favored location in states closer to Argentina, Brazil's main trade partner in MERCOSUR, and that this effect increased over the decade studied. Moreover, trade liberalization reinforced the tendency of industries to locate in states with better infrastructure and weakened demand linkages.

In this paper, we will follow Sanguinetti & Volpe Martincus (2009) approach to analyze how trade policy affected industrial location in Ecuador in the period 2000-2010.

3. Data and descriptive evidence

3.1 Database

The data used in the construction of variables for the econometric models come from official sources of information for 20 industrial sectors located in 20 Ecuadorian provinces for the years 2000 and 2010. The industrial sectors analyzed are food - except for alcoholic and non-alcoholic beverages -, beverages, tobacco, textiles, clothing, leather industry, wood, furniture and accessories, paper, chemical substances, other chemical substances, rubber, plastic, glass, non-metallic minerals, iron and steel, metallic products, machinery, material and transport; and other industries. Information is standardized to the International Standard Industrial Classification (ISIC), Rev 4.[4]

The study includes 20 of the 24 provinces of the Republic of Ecuador: Azuay, Bolívar, Cañar, Carchi, Cotopaxi, Chimborazo, El Oro, Esmeraldas, Guayas, Imbabura, Loja, Los Ríos, Manabí, Morona Santiago, Pastaza, Pichincha, Tungurahua, Zamora Chinchipe, Sucumbíos and Orellana. Excluded from the analysis are Galápagos and Napo on not presenting information in the years studied; while Santa Elena and Santo Domingo de los Tsáchilas (cantons created in 2010) are considered within the provinces of Guayas and Pichincha.

In order to describe the location of manufacturing activity in Ecuador, we use employment data from the annual survey of manufacturing and mining provided by the National Statistics and Censuses Institute on the level of 4 digits in accordance with the International Standard Industrial Classification ISIC, Rev 4.

To obtain data on tariffs by industrial activity, a large digitization effort was made. Thus, we had to select from among 90,000 tariff subheadings in 20 industrial categories of the Harmonized Commodity Description and Coding System of the Customs

[4] Appendix 1 shows the standardization of codes as a result of merging three industrial classifications analyzed by the Ministry of Foreign Trade - Common Tariff Nomenclature of the Andean Community NANDINA, Central Bank of Ecuador - National Accounts Industrial Classification (CICN)-, and the International Standard Industrial Classification (ISIC).

Cooperation Council, expressed in Ad-Valorem (percentage terms of the customs value of the commodity). [5]

Once the tariff averages have been obtained for each industrial activity, we calculate two types of tariffs considering the methodology of the Central Bank of Ecuador (Tamayo, 1997).

The first type is the nominal average tariff by industrial activity expressed in the following equation.

$$NATG_{gj} = \frac{\sum_{j=1}^{ng} t_{gj}}{n_g} \qquad (1)$$

where $NATG_{gj}$ is the nominal average tariff by industrial sector, t_{gj} are the tariff rates in percentages by industrial sector and n_g is the total tariff headings of that industrial sector.

The second type are average tariffs weighted by industrial activity, resulting from the average of the rates effectively applied weighted by the proportion of imports per industrial activity and province, expressed in equation 2.

$$WATG_{gj} = \frac{\sum_{j-1}^{ng} t_{gj} * mCIF_{gj}}{MCIF_{gj}} \qquad (2)$$

where $APPG_{gj}$ is equal to the average tariff weighted by industrial sector, t_{gj} are the tariffs corresponding to the group, $mCIF_{gj}$ are the imports in *CIF* values by industrial activity; and $MCIF_{gj}$ is the total value of imports corresponding to that industrial activity.[6]

[5] The sources of information are described in Appendix 2.

[6] The weightings of the imports are calculated using the databases provided by the Internal Revenue Service (SRI) for the corresponding years. The tariff rates are averaged for each industrial activity.

3.2 Tariffs and location of the manufacturing activity in Ecuador

Table 1 presents the average tariffs in 2000 and 2010 by sectors.

Table 1. Industrial tariffs, 2000 and 2010

Text heading	Average tariffs 2000	Average tariffs 2010
Food, except beverages	17.92	19.56
Beverages	19.22	19.77
Tobacco	16.67	23.75
Textiles	17.75	17.30
Clothing except footwear	20	16.45
Leather industry and substitutes	16.67	15.68
Wood, except furniture	12.50	12.66
Furniture and wooden accessories	18.38	18.94
Paper / publishing products	11.82	12.01
Chemical substances	5.65	4.34
Other chemical products	7.52	6.35
Rubber products	10.32	9.02
Plastic products	16.82	15.39
Glass products	12.04	12.19
Other non-metallic minerals	14.06	14.11
Iron and steel	10.50	10.96
Metallic products, except machinery	13.47	12.03
Machinery, devices and accessories	8.66	7.26
Material and transport	12.00	9.36
Other industries	17.00	17.68

Source: Own elaboration. Details on aggregation and sources are given in appendix 1 and 2.

In half of the 20 sectors, the average tariff decreased and in the other half it increased. The sectors that experienced a decrease in the tariff were textiles, clothing, leather industry, chemical substances, other chemical products, rubber products, plastic products, metallic products, machinery, devices and accessories; and material and transport. The sectors that saw their tariffs increase were food, beverages, tobacco, wood, furniture, paper, glass products, other non-metallic minerals, iron and steel, and other industries.

In fact, substantial unilateral tariff reductions in Ecuador were performed basically at the beginning of the 1990's. Preferential trade agreements were another way to liberalize trade. In this respect, the signature in 2002 with the USA of the Andean Trade Preference Agreement and Drug Eradication (ATPDEA) was a milestone, as the US was Ecuador's and the Andean Community's main trade partner.

To analyze the changes in industrial location during this period, we calculate the share of each region in Ecuador's manufacturing employment in each sector for the years 2000 and 2010. Formally,

$$S_{ikt} = \frac{X_{ikt}}{\sum_{i=1}^{N} X_{ikt}} \quad (3)$$

Where x_{ik} is the level of employment of industry *i* in province *k* in time *t* and *N* is the number of provinces.

Employment is selected because it is one of the most important variables in economic policy, it being possible to use other variables such as production or aggregate value for this calculation. We likewise chose as the geographic unit 20 provinces of Ecuador, with the exception of Galápagos, Napo, Santa Elena and Santo Domingo. The reasons for the exclusion were detailed in section 3.1.

The distribution of these location shares, which characterizes the spread of manufacturing sectors over space, in the years 2000 and 2010, is shown in figures 1 and 2.

The high bars close to the origin indicate that the majority of Ecuadorian provinces present little or no industrial activity. Manufacturing industry is very unequally distributed across provinces, and this inequality increased during the period analyzed. The provinces with high participation are Pichincha, Guayas and Azuay. These regions are active in various industrial sectors and concentrated 78.43% and 79.3% of national employment in the years 2000 and 2010, respectively, while the regions close to these areas increased the concentration of employment from 16.55% to 17.6%. The cities of Quito, Guayaquil and Cuenca are the capitals of these provinces. Quito, as the country's administrative political capital, has influence in the mountains, center, north and Amazon. Guayaquil, as the main port and economic and financial center of Ecuador, has high influence on the coast from the south in the provinces of El Oro, Los Ríos and Manabí; and Cuenca has influence in the southern region of the country and the Amazon.

Figure 1. Distribution of sectoral employment by province. Year 2000

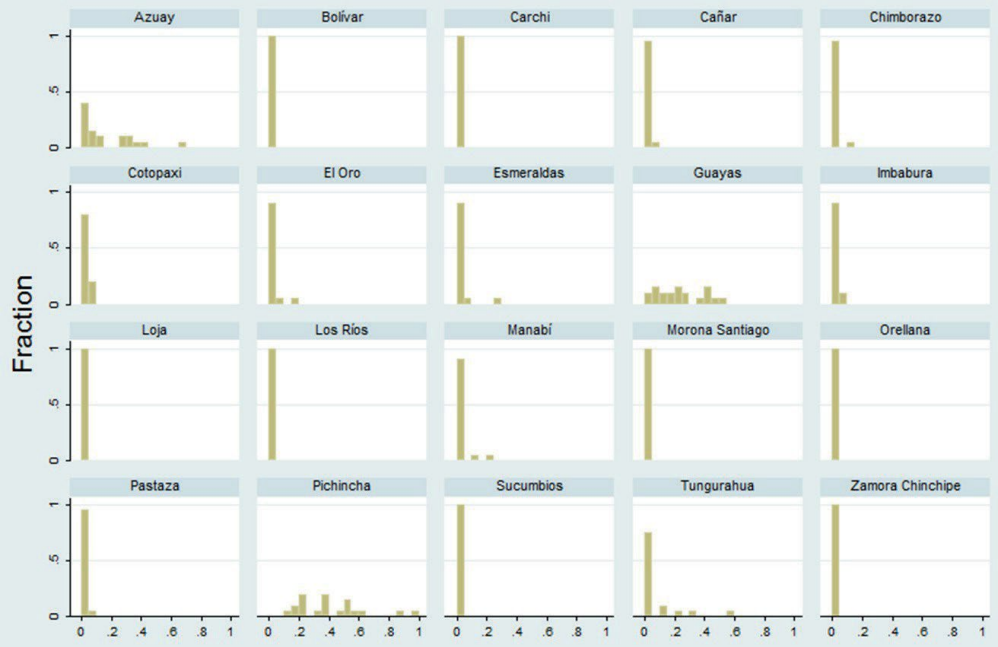
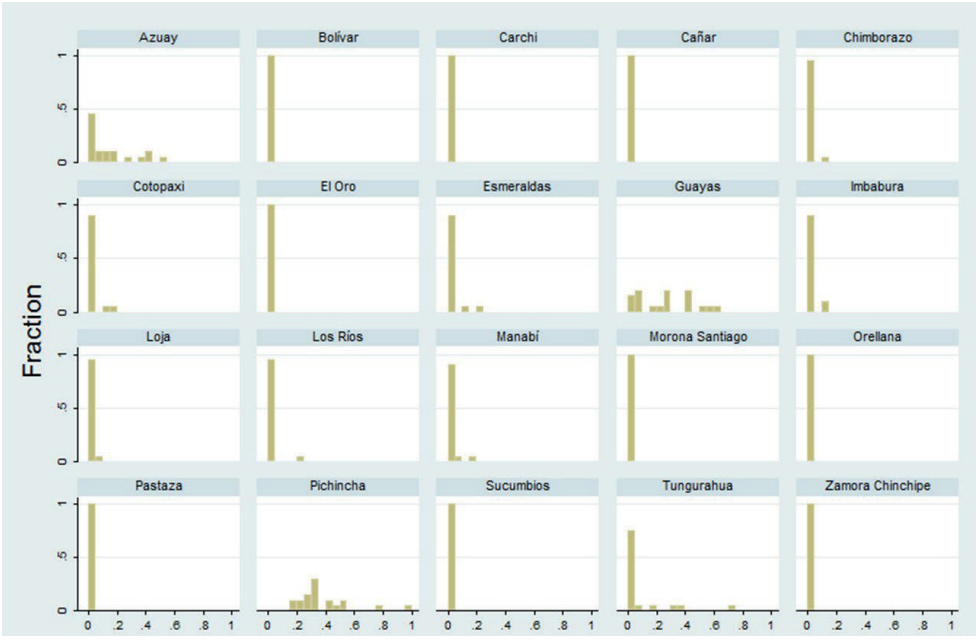


Figure 2. Distribution of sectoral employment by province. Year 2010



On analyzing distributions of employment between industrially active provinces and the nearby regions, we observe that the distribution of employment goes down in the provinces of Pichincha and Azuay; while Guayas increases its index for spatial location of manufacturing employment from 0.231 in 2000 to 0.265 in 2010. Pichincha presents the highest employment location index in the two years, with indices of 0.41 and 0.39,

respectively.

Provinces close to Pichincha, such as Cotopaxi, Tungurahua, Imbabura, Chimborazo and Esmeraldas, present changes in the indices for location of manufacturing employment in the periods analyzed. Thus, Cotopaxi reduces its index for the spatial location of manufacturing employment from 0.019 to 0.0187 in 2010, as does Chimborazo, which goes down from 0.0098 to 0.0086. On the other hand, the industries of Tungurahua, Imbabura and Esmeraldas increase the index for spatial location of manufacturing employment, from 0.078 in 2000 to 0.091 in 2010 for Tungurahua, from 0.011 to 0.017 for Imbabura; and Esmeraldas from 0.018 to 0.019.

Los Ríos, Manabí, El Oro and Bolívar, provinces closest to Guayas, present variability in the indices for spatial location of employment. This index goes up in Los Ríos and Bolívar, while these indicators go down in Manabí and El Oro.

Regions close to the province of Azuay, such as Cañar, Loja, Morona Santiago and Zamora Chinchipe, display changes in the indices for spatial location of manufacturing employment. Thus, manufacturing employment goes down in Cañar and Morona Santiago, and goes up in Loja and Zamora Chinchipe.

As an initial approach to answer our research questions, we obtain the simple correlation coefficient between employment shares and sectorial tariffs of manufacturing activity for each province, for the years 2000 and 2010 jointly and individually for each year. Results are shown in Tables 2 and 3. Table 2 shows the correlation coefficients between sectorial employment shares and Nominal Average Tariff by Group (NATG) and table 3 shows the correlation between sectorial employment shares and the Weighted Average Tariff by Group (WATG).

The analysis performed for the two types of tariff - simple and weighted - present different readings. Thus, for the first approach the correlation coefficients are negative for Quito and five provinces close to the capital of the country, Pastaza, Sucumbíos, Cañar, Azuay and Zamora Chinchipe. This preliminary result is the opposite of that found by Sanguinetti and Volpe Martincus (2009) for Buenos Aires. In the case of Ecuador, the industries with high tariffs do not tend to be more concentrated in the capital of the country and its neighboring regions. On the other hand, the degree of relations between employment shares and Nominal Average Tariff by Group is positive for Guayaquil, Los Ríos, Manabí, El Oro, Bolívar, Chimborazo, Tungurahua,

Cotopaxi, Morona Santiago, Loja, Esmeraldas, Imbabura, Orellana and Carchi. Thus, industries with a high level of tariffs tend to be located to a greater extent in these regions.

Table 2. Correlation between employment shares and Nominal Average Tariff by Group

Province	Distance to Quito	2000-2010	2000	2010
Pichincha	0	-0.0846	0.0111	-0.1402
		(0.5204)	(0.9629)	(0.5555)
Cotopaxi	70	0.7326	0.8685	0.7266
		(0.0000)*	(0.0000)*	(0.0003)*
Tungurahua	111	0.1997	0.1139	0.2115
		(0.1260)	(0.6324)	(0.3707)
Imbabura	112	0.4248	0.6098	0.3878
		(0.0007)*	(0.0043)*	(0.0911)*
Chimborazo	165	0.0760	0.2373	0.0206
		(0.5640)	(0.3138)	(0.9312)
Bolívar	204	0.0216	0.1720	0.0735
		(0.8700)	(0.4684)	(0.7580)
Pastaza	213	-0.0125	-0.0153	-0.0763
		(0.9246)	(0.0490)	(0.7492)
Carchi	239	0.5166	0.8239	-0.0211
		(0.0000)*	(0.0000)*	(0.9295)
Sucumbios	265	-0.0257	-0.0526	
		(0.8454)	0.8256	
Esmeraldas	300	0.0444	-0.0828	0.1028
		(0.7359)	(0.7285)	(0.6662)
Orellana	300	0.7113*	1.0000*	
		0.0000	0.0000	
Los Ríos	327	0.8012	0.9263	0.7861
		(0.0000)*	(0.0000)*	(0.0000)*
Manabí	329	0.6830	0.9958	0.8474
		(0.0000)*	(0.0000)*	(0.0000)*
Morona Santiago	347	0.2910	0.9966*	-0.0482
		(0.0241)	(0.0000)*	(0.8401)
Guayas	390	0.1848	0.0670	0.2066
		(0.1575)	(0.7789)	(0.3821)
Cañar	391	-0.0555	-0.0748	-0.0361
		(0.6736)	(0.7539)	(0.8798)
Azuay	432	-0.0903	-0.1582	-0.0715
		(0.4924)	(0.5052)	(0.7644)
El Oro	527	0.1733	0.3278	0.1105
		(0-1854)	(0.1582)	(0.6429)
Loja	640	0.4202	0.6738	0.3768
		(0.0008)	(0.0011)	(0.1015)
Zamora Chinchipe	698	-0.1060 (0-4200)	-0.1230 (0.6053)	-0.1252 (0.5991)

Note: Distance in Km^2 between the city of Quito and provincial capitals. The significance levels of coefficients are in parentheses. * Significant at 10%

The correlations obtained between employment shares and Weighted Average Tariff by

Group (activity and region) (WATG) - the second approach - present changes in the correlations obtained on including volume of imports by industrial sector. The results shown in table 3 present positive and significant correlations for the city of Quito (0.78). Thus, industries with high tariffs tend to be located in central regions and other regions close to the capital of the Republic, such as Cotopaxi (0.99), Tungurahua (0.60), Imbabura and Chimborazo (0.94) and Carchi (0.99). Guayaquil shows a high positive and significant correlation like Quito (0.63). Cuenca, the capital of the province of Azuay, presents a negative coefficient of -0.058. Thus, when the correlation is calculated with the weighted average tariff, we confirm similar results as to those obtained by Sanguinetti and Volpe Martincus (2009) for Argentina. The differences in the correlations obtained between the two types of tariff for Quito are explained by the proportion of imports made by industrial activity and province. In 2010, the provinces of Guayas, Pichincha and Manabí carried out 42%, 28% and 21% of the imports, respectively.

In general, the data indicate the existence of a positive and negative correlation between the variables employment shares and tariffs, which demonstrates that trade policies affected the location of industrial activity in some way.

In the next section, we will present the econometric models which explain the factors of location and impact of trade policy.

Table 3. Correlation between employment shares and Average Tariff Weighted by Group

Province	Distance to Quito	2000-2010	2000	2010
Pichincha	0	0.7756 (0.0000)*	_	0.7747 (0.0001)
Cotopaxi	70	0.9974 (0.0000)*	_	0.9974 (0.0000)
Tungurahua	111	0.5999 (0.0000)	-0.1050 (0.6595)	0.5677 (0.0090)
Imbabura	112	0.0419 (0.7972)	_	-0.0410 (0.8636)
Chimborazo	165	0.9358 (0.0000)	_	0.9358 (0.0000)*
Bolívar	204	_	_	_
Pastaza	213	-0.0265 (0.8709)	_	-0.0545 (0.8195)
Carchi	239	0.9974 (0.0000)*	_	0.9974 (0.0000)
Sucumbios	265	_ _	_	_
Esmeraldas	300	0.4329 (0.0053)*	_	0.4129 (0.0704)*
Orellana	300	0.0643 (0.6935)		0.0209 (0.9304)
Los Ríos	327	0.9653 (0.0000)*	_	0.9648 (0.0000)*
Manabí	329	0.9652 (0.0000)*	_	0.9650 (0.0000)*
Morona Santiago	347	-0.0258 (0.8742)	_	-0.0525 (0.8259)
Guayas	390	0.6251 (0.0000)*	_	0.6154 (0.0039)*
Cañar	391	_	_	_
Azuay	432	-0.0583 (0.7210)	0.3577 (0.1215)	-0.0714 (0.7649)
El Oro	527	0.3931 (0.0121)	_	0.3605 (0.1184)
Loja	640	0.0906 (0.5782)	_	0.054 (0.8190)
Zamora Chinchipe	698	_	_	_

Note: Distance in Km^2 between the city of Quito and provincial capitals. The significance levels of coefficients are in parentheses. * Significant at 10%

4. Empirical Methodology

We will use the same strategy developed by Sanguinetti and Volpe (2009) as an extension of Midelfart-Knarvik et al. (2000a, b), which allows to explicitly assess the impact of trade policy in the location of manufacturing activities.

Midelfart-Knarvik et al. (2000a,b) consider that industrial location is the result of multivariate interactions between regional and industrial characteristics. That is to say that industries which make intensive use of a certain "factor" tend to be located in regions which are relatively abundant in this "factor". Hence, location patterns are driven by the interactions between industry and region characteristics. Regions might differ in their abundance in capital, natural resources, market size, etc.; and industries differ across a number of characteristics such as factor intensities, intermediate inputs intensity, returns to scale, etc...

Sanguinetti and Volpe (2009) extend Midelfart-Knarvik et al. (2000a,b) framework by including an additive interaction term between the distance of each region to the economic centre of the country and sectoral tariffs. The expected coefficient of this interaction term should be negative to capture the fact that with lower trade variables the influence of cost and demand linkages is weaker, thus the benefits of proximity to the main economic centre of the country are reduced, as predicted in the theoretical literature by Krugman & Livas (1996).

In the same vein, we will obtain a set of 11 interactions resulting from 18 variables: 9 regional characteristics and 9 industrial characteristics. Table 4 presents the interaction terms and their expected signs. In our case, the distances to be considered are distance to Quito and distance to Guayaquil as those are the two main economic centres of Ecuador.

Table 4. Interaction variables

Regional characteristics	Distance Quito and/or Guayaquil Market Potential Industrial base Agricultural abundance Abundance of natural resources Skilled Labor Industrial promotion Infrastructure	
Industrial characteristics		Tariff rates Economies of scale Intermediate consumption intensity Intermediate demand bias Agriculture intensity Natural resources intensity Labor intensity Skilled Labor intensity Transport intensity
Interaction terms	(1) Distance to Quito and/or Guayaquil (2) Market potential (3) Industrial base (4) Industrial base (5) Agriculture abundance (6) Natural resources abundance (7) Labor scarcity (8) Skilled labor abundance (9) Industrial promotion (10) Industrial promotion (11) Infrastructure	* Tariffs - (*) *Economies of scale + *Intermediate consumption intensity + * Intermediate demand bias + * Agriculture intensity + * Natural resources intensity + *Labor intensity - (**) * Skilled labor intensity+ * Transport intensity - (***) * Economies of scale + * Transport intensity +

(*) The expected sign is negative, since a higher proportion of location is expected in the regions far from Quito and/or Guayaquil in the industries with lower tariffs. (**) The expected sign is negative, because an inverse measure of the Labor abundance is used (that is to say, in relation to the production of the salaries). (***) These terms of interaction are not included together. (****) The expected sign is negative, because

we use an inverse measurement of the footlooseness of industries (transport intensity)

The distances to Quito and/or Guayaquil by road in kilometres are calculated from the heads of cantons. These two economic centres present a high concentration of industrial employment. For 2010, the two provinces encompass 63% of the country's total industrial employment: Pichincha concentrates 34% of industrial employment, and Guayas 29%.

The market potential for each province is obtained using the index proposed in Harris (1954). Two variables are required: market and distance. Income, Gross Domestic Product (GDP) or population could be used to measure the market. The equation will have the following characteristics:

$$Mp_i = \sum \left(\frac{X_j}{d_{ij}} \right) \qquad (4)$$

For our calculation X_j is a ratio obtained from the Gross Domestic Product (GDP) of province *j* over the manufacturing GDP of province *j*; *dij* measures the distance between the most important province in economic terms *i* and the province analyzed *j*.

The industrial base is calculated between the gross value added (GVA) of each industry and the total sum of GVA of the economic activities of the same region; the highest industrial activity in relation to the region is chosen. The activity "manufacture of products from the refinancing of oil and other products", the main activity for the provinces of Esmeraldas, Sucumbíos and Orellana, is not considered. For these provinces the second productive activity in importance is considered.

Agricultural abundance is obtained calculating the ratio between the use of land for agriculture and the total surface area of each province. Three surface areas are selected: permanent crops, temporary crops and cultivated pastures. Fallow land, natural pastures, moorland, mountains and forests are not considered. The intensity of agriculture is calculated, obtaining the ratio of agricultural inputs in relation to production.

Oil reserves in m^3 in relation to the population from 15 to 64 years old is the variable chosen to obtain the variable natural resources abundance; the equivalence of one barrel of oil is 0.16 m^3. Natural resources intensity is obtained through the ratio between

the value of fuel used by each industry and the production of each industry.

The scarcity of Labor is obtained as the ratio between the average industrial salary of each sector and province, and the average industrial salary on a national level. Meanwhile, the intensity of skilled Labor relates the employed population with tertiary studies (higher education level) to the total Labor employed in each industrial sector.

Industrial promotion, as a binary variable, takes the value of one when the industrial sector benefits from industrial promotion policies, and the value of zero otherwise. Two selection criteria are considered prior to defining the binary variable: total exports and sector with highest imports which benefited, in accordance with the Industrial Promotion Law (Articles 12, 13 and 14).

Considering that the industries which intensively use transport tend to be located in provinces with better physical infrastructure, we calculate this variable choosing the land route, it being possible to use air or sea routes or other alternative variables such as use of electricity and communication.

The equation used relates paved routes to the state road network in Km^2, while the intensity of the transport measures the relationship between investment in transport equipment carried out by each of the country's industries and the total transport offered in the country (registered vehicles).

In relation to economies of scale, following Kim (1995) the indicator is obtained which measures the average size of industry *i* starting from total employment ε_{ij} and from the number of companies NC_{ij} that each industry has in the provinces.

$$ESC_i = \frac{\sum_j L_{ij}}{\sum_j NC_{ij}} \qquad (5)$$

The variable intensity of intermediate consumption (ICI) measures intermediate consumption as a proportion of the production generated by sector *i* in the whole country, at market prices.

$$ICI_i = \frac{\sum j(X_{ij} - VA_{ij})}{\sum jX_{ij}} \qquad (6)$$

Where X_{ij} is the total production of industry *i* in region *j*, VA_{ij} is the aggregate value of

industry *i* in province *j*; the difference between the two variables is the intermediate consumption of sector *i*, *ICI.*

In order to obtain the bias of intermediate demand we use domestic sales in relation to exports for each industrial sector and province.

Appendix 3 summarizes the definition of all these variables and the sources of the raw data used to construct them.

Manufacturing location patterns across provinces in Ecuador will be explained by the interaction between distance to Quito and/or Guayaquil, and the matching interactions between region characteristics and industry characteristics. The basic specification that we will estimate is described in Equation (7).

$$In\, S_{ikt} = \alpha + \sigma \text{dist}_i \tau_{kt} + \sum_{\mathcal{Z}} \beta(\mathcal{Z}) \theta_{it}(\mathcal{Z}) \varpi_{kt}(\mathcal{Z}) + \varepsilon_i + \delta_k + \gamma_t + \mu_{ikt} \qquad (7)$$

Where $In\, S_{ikt}$ is the natural logarithm of the location ratio of manufacturer *i* in province *k* in time *t,* $\text{dist}_i \tau_{kt}$ is the distance between the main cities Quito and/or Guayaquil and the weighted average tariff of industrial sector $(\mathcal{Z})$, are the interactions between θ_{it}regional characteristics and ϖ_{kt} industrial characteristics, ϵi is the industrial fixed effect, δ_k is the provincial fixed effect; and, γ_t is the fixed effect of time. Finally, μ_{ikt} is the standard error.

The empirical model applied is Ordinary Least Squares (OLS) estimated pooling by industry, province and year. We consider 20 industries, 20 provinces and two periods of time, with a total of 800 observations.

We consider the distance from the two main Ecuadorian cities, Quito and Guayaquil; and two types of tariff, simple (*NATGg*) and weighted (*WATGgj*). In each of these four cases, we use eight alternative specifications including different subsets of the interaction variables. We thus construct thirty-two regressions, from among which we will select the model or models which explain the dependent variable with the greatest acceptability.

We also perform robustness tests of maximum likelihood estimation (simple selection model *MLE*), standard errors clustered on regions and standard errors clustered on

industries.

5. Estimation and results

5.1 Basic results

Tables 5 and 6 report the estimated coefficients between the variables distance Guayaquil or Quito, respectively, and simple sectorial tariffs (NATG); and nine interactions between regional and industrial variables, estimating eight alternative specifications.

The coefficient of determination (R^2) increases as a result of adding variables (from 0.74 to 0.81), thus as indicated by Greene (1997), the contribution of the new variables to the fit of the regression more than offsets the correction for the loss of additional degrees of freedom. The interaction terms distance to Guayaquil and sectoral tariffs, and distance to Quito and sectoral tariffs are not significant in any of the eight specifications. The estimated coefficient on the interaction between market potential and scale economies has the expected positive sign but is only significant in one of the specifications of the model, while that on the interaction between industrial base and industrial inputs intensity has the expected sign (positive) and is significant in all specifications. This result indicates that cost linkages are important determinants of industrial location in Ecuador. With the exception of skilled Labor abundance and skilled Labor intensity, classical theory factors do not seem to explain industrial location in Ecuador. On the contrary, the interactions between transport intensity and infrastructure, and between industrial promotion and transport intensity are significant.

The results of the estimations with weighted tariffs (WATG) are shown in tables 7 and 8. Again, the coefficient of determination indicates a strong explanatory capacity of the model, which increases when a new variable is added (0.74 to 0.81). Interaction between distance to Guayaquil and weighted tariffs shows mixed results. It is positive and significant for two specifications only. By contrast, the interaction between distance to Quito and weighted tariffs is positive and significant in all eight specifications.

According to the likelihood criteria ($p>|t|$) p value associated with the t-statistic, or

input likelihood indicated by redundant and significant variables[7]; and goodness of fit of the data to the multiple linear regression model through the R^2, we chose results from table 8 for analysis, assessment and selection of models.

The fact that the interaction between distance to Quito and sectorial tariffs is positive and significant indicates that the industries which were less protected tended to be concentrated closer to Quito. The effect is economically small. Thus, the increase by one in the standard deviation between distance to Quito and tariffs is associated with an increase of 0.02% in the share of regional employment.

This evidence rejects our hypothesis "Low tariff rates favoured the location of industry far from the metropolitan district of Quito" and are opposed to those found by Sanguinetti and Volpe Martincus (2009) for Argentina. In Ecuador, the industries need to be close to the large internal sources of demand for production and supplies of inputs, and trade liberalization did not favour a redispersion of the economic activity away from the capital. The opposite seems to have happened, concentration in Quito was reinforced, while it doesn't seem to have had an effect in Guayaquil, the second economic centre of the country.

The estimated coefficient of the interaction between industrial base and intensity of intermediate consumption is positive and significant. This result provides evidence in favour of the hypothesis that the cost links are important determinants of location in Ecuador. In particular, the industries with intensive intermediate industrial use in the production processes show a tendency to be located in the provinces with relatively big industrial bases, minimizing supplier costs. However, the interaction between industrial base and intermediate demand bias is negative and non-significant, and therefore a large-sized industrial base does not appear to have acted as a factor of attraction for industrial sectors which sell a large part of their production to the sector. The interaction between market potential and scale economies is only positive and significant when the two other economic geography interactions are not included in the model.

[7] Significant effects of the dependent variable (**p>|t|)** lower than 0.05 and **t>**2.

Classical trade theory factors do not seem to explain well industrial location in Ecuador, similarly to what Sanguinetti & Volpe Martincus (2009) found in Argentina. Thus, the interaction between the abundance of natural resources and intensity of natural resources and the interaction between Labor scarcity and Labor intensity have the expected positive sign but are insignificant. The interaction between agricultural abundance and agricultural intensity is negative, contrary to our expectations, and significant. Hence, industries that use intensively agricultural inputs are not located in the abundant land areas. Volpe Martincus (2010) obtains the same result for Brasil. The reason for this counterintuitive result, which is valid both for Ecuador and Brasil, is that these industries might exhibit a higher bias to final demand and as agricultural abundant provinces are the less populated, they prefer to let transport costs fall on input provision and locate closer to consumers. The only comparative advantage interaction that has the expected sign and is significant is the interaction between skilled Labor and intensity of skilled Labor. In Ecuador, industries that use skilled workers intensively tend to locate in provinces with a well-educated Labor force. This result is also obtained by Volpe Martincus (2010) for Brasil but there is no evidence of this interaction in the case of Argentina.

The interaction between transport intensity and industrial promotion is significant but doesn't have the expected negative sign. Thus, industries intensive in transport services tend to locate in provinces that have an industrial promotion policy in place, while we would expect these industries to be less mobile. As for the interaction between transport intensity and infrastructure it is positive, as expected, and significant. Hence, industries intensive in transport services tend to be located in regions equipped with good road infrastructures. This was not the evidence found for Argentina. Finally, the interaction between industrial promotion and scale economies is not significant..

5.2 Robustness tests: strength of results

Our estimation results might be affected by several econometric problems.[8] In this section we address some of these problems. In particular, we will address the possible problems of selection bias, correlation of disturbances across space and omission of variables.

5.2.1 Sample selection model, standard errors clustered on provinces and standard errors clustered on industries.

Considering that the selection bias of the sample is probably a problem in our Ordinary Least Squares (OLS) models, we proceed to re-estimate the model using maximum likelihood (MLE).

To correct the selection bias, we will use the Heckman approach. All of the variables with regional and industrial characteristics are included as explanatory variables in the equation selected. As in Sanguinetti & Volpe Martincus (2009) the percentage of provincial tax over revenue will be the selection variable. We justify the choice of selection variable on being a measurement of regional tax capacity highly correlated with size.

The results of the estimation are shown in columns 1 and 2 of table 9. The behaviour of the variables is similar as that found in the OLS model and there are no systematic differences between the estimated coefficients. This test suggests that our results are robust for the estimation procedure and does not distort the estimations. It would therefore be possible to continue to work with the original sample.

To address the problem of correlation of disturbances across space we will correct the spatial dependence in standard errors using standard errors clustered on provinces and on industries (columns 3, 4, 5 and 6 of table 9). The models are not affected by these clusters, presenting consistency in results.

[8] Multicollinearity does not appear to be a problem in our estimations. The estimation of coefficients and Standard errors remain stable.

Table 5. OLS - Distance to Guayaquil – Simple tariffs (NATG)

Regional characteristics	Industrial characteristics	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Distance to Guayaquil	Tariffs	0,00362	0,00334	-0,00527	-0,00553	-0,00109	0,00429	-0,00468	0,00168
		(0,00865)	(0,00840)	(0,00853)	(0,00852)	(0,00828)	(0,00765)	(0,00853)	(0,00761)
Market potential	Scale economies		0,0146**	0,00219	0,00518	0,00697	0,00395	0,00592	0,00293
			(0,00670)	(0,00677)	(0,00800)	(0,00772)	(0,00768)	(0,00781)	(0,00768)
Industrial base	Intermediate consumption intensity			3,329***	3,427***	3,349***	3,415***	3,564***	3,630***
				(0,445)	(0,446)	(0,446)	(0,428)	(0,458)	(0,437)
Industrial base	Intermediate consumption intensity				-6,29e-10	-1,35e-09	-1,16e-09	-8,52e-10	-7,43e-10
					(7,88e-10)	(8,65e-10)	(7,19e-10)	(8,07e-10)	(6,84e-10)
Agricultural abundance	Agriculture intensity	-0,00619**	-0,00605**	-0,00567**	-0,00572**	-0,00579**	-0,00445*	-0,00590**	-0,00447*
		(0,00278)	(0,00275)	(0,00258)	(0,00258)	(0,00253)	(0,00261)	(0,00251)	(0,00259)
Natural resources abundance	Natural resources intensity	0,605	0,620	0,696	0,715	0,659	0,518	0,715	0,557
		(0,728)	(0,727)	(0,669)	(0,676)	(0,653)	(0,675)	(0,679)	(0,702)
Labor scarcity	Labor intensity	0,274	0,338	0,104	0,0931	0,0830	0,238	0,00574	0,168
		(0,789)	(0,803)	(0,727)	(0,727)	(0,731)	(0,746)	(0,718)	(0,733)
Skilled Labor	Skilled Labor intensity	-2,50e-09***	-2,49e-09***	-2,22e-09***	-2,25e-09***	-2,21e-09***	-2,20e-09***	-2,20e-09***	-2,18e-09***
		(6,07e-10)	(5,72e-10)	(6,18e-10)	(6,21e-10)	(5,90e-10)	(5,82e-10)	(6,11e-10)	(5,99e-10)
Industrial promotion	Transport intensity					0,0137**	0,0121**		
						(0,00577)	(0,00582)		
Infrastructure	Transport intensity						0,0240***		0,0257***
							(0,00613)		(0,00685)
Industrial promotion	Scale economies							0,00315	0,00327
								(0,00235)	(0,00220)
Year fixed effects		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant		-1,343***	-2,069***	-2,072***	-2,106***	-2,430***	-2,383***	-2,427***	-2,429***
		(0,356)	(0,543)	(0,500)	(0,493)	(0,489)	(0,482)	(0,489)	(0,473)
Observations		290	290	290	290	290	290	290	290
R-squared		0,738	0,741	0,785	0,786	0,795	0,809	0,789	0,805
Robust standard errors in parentheses									
*** p<0,01, ** p<0,05, * p<0,1									

Table 6. OLS - Distance to Quito- Simple tariffs (NATG)

Regional characteristics	Industrial characteristics	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Distance to Quito	Tariffs	-0,00157	-0,00174	0,00373	0,00345	0,00162	0,00127	0,000748	1,93e-05
		(0,00675)	(0,00680)	(0,00634)	(0,00634)	(0,00632)	(0,00621)	(0,00622)	(0,00614)
Market potential	Scale economies		0,0147**	0,00211	0,00489	0,00685	0,00390	0,00583	0,00296
			(0,00674)	(0,00681)	(0,00807)	(0,00778)	(0,00777)	(0,00783)	(0,00772)
Industrial base	Intermediate consumption intensity			3,319***	3,406***	3,350***	3,452***	3,535***	3,641***
				(0,446)	(0,444)	(0,437)	(0,415)	(0,455)	(0,429)
Industrial base	Intermediate consumption intensity				-5,82e-10	-1,34e-09	-1,15e-09	-8,29e-10	-7,49e-10
					(8,10e-10)	(8,72e-10)	(7,01e-10)	(8,25e-10)	(6,79e-10)
Agricultural abundance	Agriculture intensity	-0,00611**	-0,00596**	-0,00586**	-0,00590**	-0,00587**	-0,00451*	-0,00595**	-0,00447*
		(0,00277)	(0,00275)	(0,00256)	(0,00256)	(0,00252)	(0,00259)	(0,00251)	(0,00259)
Natural resources abundance	Natural resources intensity	0,595	0,610	0,718	0,734	0,668	0,529	0,719	0,558
		(0,724)	(0,724)	(0,665)	(0,672)	(0,649)	(0,672)	(0,678)	(0,701)
Labor scarcity	Labor intensity	0,280	0,348	0,0755	0,0703	0,0661	0,202	0,0150	0,160
		(0,800)	(0,815)	(0,740)	(0,742)	(0,741)	(0,745)	(0,737)	(0,740)
Skilled Labor	Skilled Labor intensity	-2,49e-09***	-2,48e-09***	-2,23e-09***	-2,26e-09***	-2,20e-09***	-2,18e-09***	-2,21e-09***	-2,18e-09***
		(6,13e-10)	(5,78e-10)	(6,17e-10)	(6,20e-10)	(5,93e-10)	(5,92e-10)	(6,09e-10)	(6,03e-10)
Industrial promotion	Transport intensity					0,0137**	0,0118**		
						(0,00572)	(0,00570)		
Industrial promotion	Scale economies							0,00316	0,00325
								(0,00239)	(0,00221)
Infrastructure	Transport intensity						0,0236***		0,0255***
							(0,00604)		(0,00678)
Year fixed effects		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant		-1,152***	-1,706***	-1,929***	-1,946***	-2,138***	-2,058***	-2,194***	-2,144***
		(0,316)	(0,456)	(0,429)	(0,428)	(0,416)	(0,404)	(0,429)	(0,410)
Observations									
R-squared		290	290	290	290	290	290	290	290
Robust standard errors in parentheses		0,738	0,741	0,785	0,785	0,795	0,808	0,789	0,805
*** p<0,01, ** p<0,05, * p<0,1									

Table 7. OLS- Distance to Guayaquil – Weighted tariffs (WATG)

Regional characteristics	Industrial characteristics	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Distance to Guayaquil	Tariffs	0,000202**	0,000186**	7,37e-05	7,22e-05	2,26e-05	1,62e-05	6,30e-05	4,85e-05
		(7,87e-05)	(8,01e-05)	(7,03e-05)	(7,11e-05)	(7,15e-05)	(7,02e-05)	(6,97e-05)	(6,74e-05)
Market potential	Scale economies		0,0120*	0,00153	0,00431	0,00668	0,00379	0,00515	0,00241
			(0,00654)	(0,00666)	(0,00780)	(0,00768)	(0,00769)	(0,00761)	(0,00755)
Industrial base	Intermediate consumption intensity			3,199***	3,289***	3,311***	3,423***	3,443***	3,572***
				(0,454)	(0,451)	(0,447)	(0,421)	(0,462)	(0,437)
Industrial base	Intermediate consumption intensity				-5,81e-10	-1,33e-09	-1,15e-09	-8,08e-10	-7,28e-10
					(8,05e-10)	(8,71e-10)	(7,01e-10)	(8,17e-10)	(6,73e-10)
Agricultural abundance	Agriculture intensity	-0,00601**	-0,00591**	-0,00566**	-0,00571**	-0,00579**	-0,00444*	-0,00588**	-0,00445*
		(0,00277)	(0,00275)	(0,00259)	(0,00259)	(0,00254)	(0,00261)	(0,00252)	(0,00259)
Natural resources abundance	Natural resources intensity	0,605	0,617	0,694	0,711	0,658	0,521	0,711	0,556
		(0,727)	(0,727)	(0,670)	(0,676)	(0,653)	(0,676)	(0,678)	(0,701)
Labor scarcity	Labor intensity	0,255	0,309	0,124	0,116	0,0877	0,219	0,0260	0,161
		(0,782)	(0,793)	(0,732)	(0,733)	(0,728)	(0,730)	(0,724)	(0,724)
Skilled Labor	Skilled Labor intensity	-2,46e-09***	-2,45e-09***	-2,24e-09***	-2,27e-09***	-2,21e-09***	-2,19e-09***	-2,21e-09***	-2,18e-09***
		(6,00e-10)	(5,72e-10)	(6,12e-10)	(6,15e-10)	(5,93e-10)	(5,93e-10)	(6,07e-10)	(6,03e-10)
Industrial promotion	Transport intensity					0,0136**	0,0117**		
						(0,00579)	(0,00575)		
Industrial promotion	Scale economies							0,00311	0,00319
								(0,00237)	(0,00219)
Infrastructure	Transport intensity						0,0236***		0,254***
							(0,00605)		(0,00676)
Year fixed effects		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant		-1,346***	-1,938***	-2,100***	-2,136***	-2,428***	-2,314***	-2,447***	-2,375***
		(0,306)	(0,500)	(0,472)	(0,468)	(0,463)	(0,452)	(0,467)	(0,448)
Observations		290	290	290	290	290	290	290	290
R-squared		0,745	0,746	0,786	0,786	0,795	0,808	0,789	0,806
Robust standard errors in parentheses									
*** p<0,01, ** p<0,05, * p<0,1									

Table 8. OLS- Distance to Quito - Weighted tariffs (WATG)

Regional characteristics	Industrial characteristics	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Distance to Quito	Tariffs	0,000194***	0,000190***	0,000166***	0,000166***	9,92e-05*	9,80e-05*	0,000155***	0,000142***
		(6,78e-05)	(6,82e-05)	(5,12e-05)	(5,19e-05)	(5,10e-05)	(5,23e-05)	(4,92e-05)	(4,85e-05)
Market potential	Scale economies		0,0140**	0,00190	0,00467	0,00639	0,00342	0,00537	0,00255
			(0,00655)	(0,00658)	(0,00777)	(0,00762)	(0,00764)	(0,00760)	(0,00755)
Industrial base	Intermediate consumption intensity			3,236***	3,324***	3,311***	3,415***	3,458***	3,571***
				(0,425)	(0,426)	(0,429)	(0,406)	(0,437)	(0,414)
Industrial base	Intermediate consumption intensity				-5,81e-10	-1,22e-09	-1,03e-09	-7,88e-10	-7,07e-10
					(8,60e-10)	(9,07e-10)	(7,44e-10)	(8,67e-10)	(7,22e-10)
Agricultural abundance	Agriculture intensity	-0,00575**	-0,00563**	-0,00535**	-0,00540**	-0,00558**	-0,00424	-0,00557**	-0,00419
		(0,00278)	(0,00276)	(0,00259)	(0,00260)	(0,00254)	(0,00265)	(0,00252)	(0,00264)
Natural resources abundance	Natural resources intensity	0,591	0,606	0,684	0,700	0,659	0,522	0,701	0,549
		(0,726)	(0,726)	(0,670)	(0,676)	(0,656)	(0,679)	(0,679)	(0,701)
Labor scarcity	Labor intensity	0,416	0,476	0,260	0,251	0,173	0,303	0,160	0,282
		(0,801)	(0,816)	(0,744)	(0,745)	(0,736)	(0,737)	(0,736)	(0,735)
Skilled labor	Skilled labor intensity	-2,44e-09***	-2,42e-09***	-2,20e-09***	-2,23e-09***	-2,20e-09***	-2,17e-09***	-2,18e-09***	-2,15e-09***
		(5,82e-10)	(5,48e-10)	(5,88e-10)	(5,91e-10)	(5,81e-10)	(5,81e-10)	(5,85e-10)	(5,83e-10)
Industrial promotion	Transport intensity					0,0115*	0,00964		
						(0,00596)	(0,00593)		
Industrial promotion	Scale economies							0,00285	0,00294
								(0,00232)	(0,00216)
Infrastructure	Transport intensity						0,0235***		0,0250***
							(0,00609)		(0,00661)
Year fixed effects		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant		-1,258***	-1,787***	-1,937***	-1,958***	-2,116***	-2,040***	-2,205***	-2,160***
		(0,312)	(0,448)	(0,426)	(0,423)	(0,417)	(0,409)	(0,425)	(0,409)
Observations		290	290	290	290	290	290	290	290
R-squared		0,746	0,748	0,790	0,791	0,796	0,810	0,793	0,809
Robust standard errors in parentheses									
*** p<0,01, ** p<0,05, * p<0,1									

5.2.2 Omitted variables

Another potential problem in our estimation is the omission of relevant variables. As we have seen in Section 2, proximity to foreign markets might have a strong impact on the internal geography of countries. Trade liberalization in Ecuador has been mainly centred on a regional block, the Andean Community, and within this block Ecuador's main partner is Colombia. Hence, Colombia is one of the most important markets for Ecuador in view of its proximity, its income and its size. Thus, the statistics for exports, imports and balance of trade on an intra-community level for the period 2000 to 2010 show that the weight of Colombia in the foreign trade of Ecuador is higher than that of Bolivia and Peru, its other partners in the Andean Market. In the years 2000 and 2010 Colombia exported to Ecuador 53% and 60% and imported 48% and 44% of the total, respectively. For its part, in the same period Ecuador exported 47% and 37% of the total goods to Colombia, while the volume of imports from Colombia amounted to 86% and 66% of the total imports, respectively.

To ensure that the estimated coefficient of interaction between distance from Quito and sectorial tariffs captures the direct impact of trade policy and does not in actual fact reflect the inter-regional differences in access to important foreign markets, we include in the equation an additional variable which interacts with regional distance to Colombia, specifically Bogotá, with the aim of knowing whether the models selected present changes or similar effects to the results presented in previous tables. The results of the estimation presented in table 10 indicate that the interaction between tariffs and distance to Bogotá is not significant. However, the inclusion of this possible omitted variable implies that the interaction distance to Quito and tariffs ceases to be significant. The results are not, therefore, completely conclusive, although it is possible that part of the effect of the distance to Quito in actual fact reflects the greater geographical proximity of Quito to the Colombian market.

Table 9. Robustness test: Maximum likelihood estimation; standard error by regions and standard error by industry

		Maximum likelihood estimation (MLE)		Standard error cluster province		Standard error cluster industry	
		Model 3	Model 8	Model 3	Model 8	Model 3	Model 8
Regional characteristics	Industrial characteristics	1	2	3	4	5	6
Distance to Quito	Tariffs	0.000**	0.000*	0.000*	0.000**	0.000*	0.000*
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Market potential	Scale economies	0.002	0.003	0.002	0.003	0.002	0.003
		(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Industrial base	Intermediate consumption intensity	3.282***	3.626***	3.236***	3.571***	3.236***	3.571***
		(0.42)	(0.43)	(0.74)	(0.77)	(0.51)	(0.45)
Base industrial	Intermediate demand bias		-0.000		-0.000		-0.000
			(0.00)		(0.00)		(0.00)
Agriculture abundance	Agriculture intensity	-0.006*	-0.004	-0.005	-0.004	-0.005	-0.004
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Natural resources abundance	Natural resources intensity	0.735	0.588	0.684	0.549	0.684	0.549
		(0.53)	(0.51)	(0.78)	(0.86)	(0.80)	(0.83)
Labor scarcity	Labor intensity	0.050	0.086	0.260	0.282	0.260	0.282
		(0.61)	(0.58)	(0.60)	(0.61)	(0.86)	(0.85)
Skilled labor	Skilled labor intensity	-0.000***	-0.000***	-0.000***	-0.000***	-0.000**	-0.000**
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Industrial promotion	Transport intensity						
Industrial promotion	Scale economies		0.003*		0.003		0.003**
			(0.00)		(0.00)		(0.00)
Infrastructure	Transport intensity		0.025***		0.025***		0.025***
			(0.01)		(0.00)		(0.01)
Fixed effects		Si	Si	Si	Si	Si	Si
Fixed effects province (Quito)		Si	Si	Si	Si	Si	Si
Fixed effects industry (Alimentaria)		Si	Si	Si	Si	Si	Si
Constant		-1.295*	-1.571**	-1.937**	-2.160**	-1.937***	-2.160***
		(0.53)	(0.48)	(0.62)	(0.61)	(0.33)	(0.35)
Observations		800	800	290	290	290	290
R-squared				0.790	0.809	0.790	0.809

Note: The dependent variable is the location logarithm defined in equation 1. Columns (1) and (2) present results using the sample selection model estimated by maximum likelihood. The zero observations are not considered. Regional characteristics are used in the selection of the equation. These characteristics are: agricultural abundance, abundance of minerals, scarcity of labor, abundance of skilled labor, potential market, industrial base, distance to Quito, infrastructure and percentage of tax over total regional tax. The latter is a measurement of regional tax capacity, highly correlated to size, and is the variable excluded. The last report on the statistics of the Hausman test indicates that, under the null hypothesis, there are no significant differences between the coefficients estimated with LS and sample selection methods. Columns (3), (4), (5) and (6) report the estimated regressions with standard error clustered on regions and industries. The zero observations are excluded in this case.

Table 10. Robustness test: inclusion of variable

Regional characteristics	Industrial characteristics	Model 3		Model 8	
Distance to Quito	Tariffs	0.000		0.000	
		(0.00)		(0.00)	
Distance to Bogotá	Tariffs	0.000		-0.000	
		(0.00)		(0.00)	
Market potential	Scale economies	0.002		0.003	
		(0.01)		(0.01)	
Industrial base	Intensity intermediate consumption	3.225	***	3.575	***
		(0.44)		(0.42)	
Industrial base	Intermediate demand bias			-0.000	
				(0.00)	
Agricultural abundance	Agriculture intensity	-0.005	*	-0.004	
		(0.00)		(0.00)	
Natural resources abundance	Natural resources intensity	0.683		0.549	
		(0.67)		(0.70)	
Labor scarcity	Labor intensity	0.258		0.282	
		(0.75)		(0.74)	
Skilled Labor	Skilled labor intensity	-0.000	***	-0.000	***
Industrial promotion	Transport intensity	(0.00)		(0.00)	
Industrial promotion	Scale economies				
				0.003	
Infrastructure	Transport intensity			(0.00)	
				0.025	***
Fixed effects year				(0.01)	
		Si		Si	
Fixed effects province (Quito)		Si		Si	
Fixed effects industry (Food)		Si		Si	
Constant		-1.946	***	-2.158	***
Observations					
R-squared					

6. Conclusions

The econometric results based on a sample of 20 provinces and 20 industrial sectors in two periods of time, 2000 and 2010, suggest that trade policy did not substantially modify the patterns of location of manufacturing in Ecuador during this period. If anything, it only reinforced, a little, the concentration of economic activities in Quito.

Ecuador is an interesting case study because it has two economic centres of similar size

(Quito, the capital, and Guayaquil) which is different from other Latin American countries as Mexico or Argentina. At the same time, the trade liberalization policies followed a similar path as those in other Latin American countries that dismantled the import substitution regime. Since the theoretical literature on the effects of trade liberalization in the internal geography of countries is not conclusive, empirical applications are key to better understand the mechanisms that drive this phenomenon.

Our results show that the coefficient on the interaction between distance to Quito and sectorial tariffs is positive and significant, although very small in magnitude. We find weaker evidence of a positive interaction between distance to Guayaquil and sectorial tariffs. Hence, the industries which were less protected tended to be located in the two main economic centres of the country, and the concentration in Quito was reinforced. The results are opposite to those predicted in the theory by Krugman & Livas (1996) and Behrens et al. (2007) and more in line with those predicted by Monfort & Nicolini (2000), Paluzie (2002), Crozet & Koenig-Soubeyran (2004) and Brülhart et al. (2004).

The fact that Quito, in addition to being the capital of Ecuador, is the Ecuadorian city closest to its main foreign market, Colombia, would explain why the trade liberalization policy, highly focused on the Andean common market, strengthened the cluster of economic activity in the region of Quito instead of dispersing it to other Ecuadorian regions.

Empirically, the results differ from those obtained for other Latin American countries such as Mexico and Argentina, which experienced a de-concentration of economic activity following liberalization (Hanson, 1996a and 1997; Sanguinetti & Volpe Martincus, 2009). But in the case of Mexico it can be explained by its internal geography with respect to foreign markets. Thus, redispersion in Mexico meant a de-concentration of activity in Mexico City in favour of the regions in the North close to the U.S. border, taking advantage of the free trade agreements with the United States. On the other hand, other results are consistent with those obtained by Volpe Martincus (2010) for Brazil, where industries that face lower barriers to foregn trade tended to locate in Brazilian regions closer to Argentina, Brazil's main partner in MERCOSUR.

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Appendix 1. Standardization NANDINA codes. Industrial Classification National Accounts (CICN) and ISIC version 4 and tariffs by sector

#	Code NANDINA	Code CICN	Description	Code ISIC 4
1	16.01/16.02/16.03	011001	Processing and conservation of meat	1010-1075
2	16.05	012001	Processing and conservation of “camaron”	1020-1075
3	16.04/16.05	013001	Processing of fish and other processed aquatic products	1020
4	15.01/15.02/15.03/15.04/15.05/1506/15.07/15.08/15.09/1510/15.11/15.12 /15.13/15.14/15.15/15.16/15.17/15.18/1520/15.21	014001	Production of oils and greases of plant and animal origin	1040
5	04.01/04.02/04.03/04.04/04.05/04.06/0410	015001	Production of dairy products	1050
6	19.03/19.04	016001	Production of mill products	1061-1062
7	19.05/21.02	016002	Production of bakery products	1071
8	19.01/19.02/	016003	Production of noodles and other starchy products	1074-1075
9	17.01-17.02-17.03-	017001	Production and refining of sugar	1072
10	17.04-18.01-18.02-18.03-18.04-18.05-18.06	018001	Production of cocoa, chocolate and confectionery products	1073
11	23.01/23.08/23.09	019001	Production of food products for animals	1080
12	21.01/	019002	Production of coffee	1079
13	20.01/20.02/20.03/20.04/20.05/20.06/20.07/20.08/21.03/21.04/21.05/21.0 6/22.09	019003	Production of other miscellaneous food products	1079-1075-1030
14	22.03/22.04/22.05/22.06/22.07/22.08/	020001	Production alcoholic beverages	1101-1102-1103
15	20.09/22.01/22.02/	020002	Production non-alcoholic beverages	1104
16	24.01/24.02/24.03	020003	Production of tobacco products	1200
17	5004/5005/5006/50.07/51.06/51.07/51.08/51.09/51.10/51.11/51.12/51.13/ 52.04/52.05/52.06/52.07/52.08/52.09/52.10/52.11/52.12/53.06/53.07/53.0 8/53.09/53.10/53.11/54.01/54.02/54.03/54.04/5405/5406/5407/54.08/55.01 /55.02/55.03/55.04/55.05/55.06/55.07/55.08/55.09/55.10/55.11/55.12/55.13 55.14/55.15/55.16/56.01/56.02/56.03/56.04/56.05/56.06/56.07/56.08/ 57.01/57.02/57.03/57.04/57.05/58.01/58.02/58.03/58.04/5805/58.06/58.07 /58.08/5809/58.10/58.11/59.01/59.02/59.03/59.04/5905/59.06/59.07/5908 /5909/59.10/59.11/60.01/60.02/60.03/60.04/60.05/60.06/63.01/63.02/63.03 /63.04/63.05/63.06/63.07/6308/6309/63.10.	021001	Manufacture of thread, yarn; textiles and clothing	1311-1312-1313-1391-1392-1393-1394-1399

18	61.01/61.02/61.03/61.04/61.05/61.06/61.07/61.08/61.09/61.10/61.11/61.12 /61.13/61.14/61.15/61.16/61.17/62.01/62.02/62.03/62.04/62.05/62.06/62.07 /62.08/62.09/62.10/62.11/62.12/62.13/62.14/62.15/62.16/62.17.	021002	Manufacture of articles of clothing	1410-1420-1430
19	42.01/42.02/42.03/42.04/42.05/42.06/43.01/43.02/43.03/64.01/64.02/64.03 64.04/64.05/64.06/	021003	Manufacture of leather, leather products and footwear	1511-1512-1520
20	44.01/4402/44.03/44.04/4405/44.06/44.07/44.08/44.09/44.10/44.11/44.12 /44.13/4414/44.15/4416/4417/44.18/44.19/44.20/44.21/45.01/4502/45.03 /45.04/46.01/46.02.	022001	Production of wood and of wooden products	1610-1621-1622-1623-1629
21	4701/4702/47.03/47.04/47.05/47.06/47.07/48.01/48.02/48.03/48.04/48.05 /48.07/48.08/48.09/48.10/48.11/48.12/48.13/48.14/48.15/48.16/48.17/48. 18 48.19/48.20/48.21/48.22/48.23/49.01/49.02/4903/4904/49.05/49.06/49.07 49.8/49.09/4910/49.11/	023001	Manufacture of paper and paper products	1701-1702-1709-1811-1812-1820-5811-5812-5813-5819
22	29.01/29.02/29.03/29.04/29.05/29.06/29.07/29.08/29.09/29.10/2911/29.12 29.13/29.14/29.15/29.16/29.17/29.18/29.19/29.20/29.21/29.22/29.23/29.24 /29.25/29.26/29.27/29.28/29.29/29.30/29.31/29.32/29.33/29.34/29.35	024001	Manufacture of refined oil products and others	1910-1920
23	28.01/2802/2803/28.04/28.05/28.06/2807/2808/28.09/2810/28.11/28.12/ 28.13/28.14/28.15/28.16/2817/28.18/28.19/28.20/28.21/2822/28.23/28.24 /28.25/28.26/28.27/28.28/28.29/28.30/28.31/28.32/28.33/28.35/28.35/28.36 28.37/28.39/28.40/28.41/28.42/28.43/28.44/28.45/28.46/2847/2848/28.49 28.50/28.51/28.52/28.53/31.01/31.02/31.03/31.04/31.05/38.01/38.02/ 38.04/38.05/38.06/3807/38.08/38.09/38.10/38.11/38.12/3813/3814/38.15 /3816/3817/3818/3819/3820/3821/3822/38.23/38.24/38.25/39.01/39.02/ 39.03/39.04/39.05/39.06/39.07/39.08/39.09/3910/39.11/39.12/39.13/39.14	025001	Manufacture of basic chemical substances, fertilizer and primary plastics	2011-2013-2021

45

Note 1*:* The NATIONAL SUB-HEADING: 10 digits and presents the following structure: digits 1 and 2 (chapter); digits 1,2,3 and 4 (Heading of the Harmonized System); digits 1,2,3,4,5, and 6 (Sub-heading of the Harmonized System); digits 1,2,3,4,5,6,7 and 8 (sub-heading NANDINA); and digits 1,2,3,4,5,6,7,8,9 and 10 (National Sub-heading)

Note 2: Work was carried out with four digits "Harmonized System"

Source: Compiled by author considering Official Records of the Central Bank of Ecuador

Appendix 2. Sources of information for determination tariffs by industrial activity

Year 2000

- Executive Decree No. 655 (R.O.141 of August 15, 2000, which eliminated the Safeguard Clause Tariff for imports in Value Customs.
- Executive Decree No. 1531 according to R.O. 332 of 03/12/1999 which established the national import tariffs for sub-heading 5201 products.
- Ruling 383 of the General Management of the Ecuadorian Customs Cooperation of 14/06/2000 which established the application of Declaration ,00,00 in 0% for a maximum quota of 6,000 metric tons.
- Executive Decree No. 1329 (R.O. 296 of 12/10/1999, which enacted the Agreement on Expansion and Acceleration of Ecuador – Peru Trade, included new processes of exemptions on imports of products originating in Peru; however, the goods contained in Appendix 2 of this Decree will be subject to the exemption periods and percentages determined in Decree No. 692 R.O. 166 03/10/1997. Therefore, the products included in Appendices 3, 4 and 9 of Decree 992 and which appear in the aforementioned list of exceptions of Decree 1329.
- Executive Decree No. 1514 R.O. 328 29/11/1999 which implemented Tax Incentives for the province of Loja.
- Executive Decree No. 692 (R.O. 166 03/10/1997 which enacted the Programme of Exemptions on Imports Originating in Peru, a programme which includes all NANDINA Sub-headings (except chapter 98, with exemption scales which extend until the year 2005, divided into 10 appendices. Appendices 1 to 10 were processed in the Appendix tariff of imports of products originating in Peru for 1999, applying the different preferences established in Decree 692 to the Ad-valorem Tariff Rates in force from 22 February 1999 Executive Decree No. 609, R.O. 140 supplement of 03/03/1999. The percentage to pay is the result of the multiplication of both factors.
- Decree No. 833-A according to R.O. 185 of 06/05/1999 which eliminated the safeguard clause for Andean Intraregional Trade, including Peru. The imports of products originating in this country do not therefore pay the safeguard clause tariff rate.
- Law Reforming the Foreign Trade and Investments Law LEXI R:o, 156 of 25/03/1999, which modified the payment of the CORPEI fee both for imports and for exports, and the exports from the private sector lower than or equal to USD3,333.00 FOB must contribute USD5.00 those exports from the private sector above US3,333.00 FOB must contribute 1.5, per thousand; all imports below USD20,000.00 FOB must contribute US5.00 and those above or equal to US20,000.00 FOB must contribute 0.25 per thousand.

- Agreement of the Finance Ministry No. 057 according to R.O. 32 of 27/03/1997 which issues the list of drugs for Human and Veterinary use, which will only be levied with 1% due to safeguard clause concept.
- Agreement of the Finance Ministry No. 058 according to R.O. 32 of 27/03/1997 which issues the list of Raw Materials for the preparation of drugs for human and veterinary use, which will only be levied with 1% due to safeguard clause concept. These products must be imported by the pharmaceutical laboratories authorized by the Ministry of Health; otherwise, they must pay the tariff rate according to the corresponding tariff level.
- Agreement of the Finance Ministry No. 059 19/03/1997 which issues the list of Agricultural Inputs, which will only be levied with 1% due to Safeguard Clause concept.
- Executive Decree No. 3573 R.O. 894 second supplement of 29/02/1996, which reforms the Tariff as follows:

*Replaces the Ad-Valorem Tables to which the imports of oil by-products are subject

**Creates Ad-valorem tables for sub-headings 2710,00,49,10 (Diesel 1) and the 2710,00,49,20 (Diesel 2); and,

*** Restructures the tariff nomenclature as follows:

8504.10.00	8504.10.00.10
	8504.10.00.90
8539.22.10	8539.22.10.10
	8539.22.10.90
8539.39.10	8539.39.10.10
	8539.39.10.90
9405.40.10	9405.40.10.10
	9405.40.10.90

Year 2010

- Executive Decree No. 479, published in Official Register No. 291 of 1 October 2010, which modifies the Tariff Nomenclature, by virtue of the issuing of Decisions 675, 703, and 722 of the Andean Community of Nations (CAN), which have not been reflected in the National Tariff of Imports in force and which must be incorporated into national legislation. Gazette No. 194 of the Customs of Ecuador, the same one which specifies the application of Executive Decree 479, and its start date on 4 October 2010.
- End of the tariff deferral at 0% of 54 sub-headings, included in Executive Decree 1243 published in R.O. No. 403 of 14 August 2008.

2102.20.00	3004.50.20	3917.23.10	8201.90.10
2302.10.00	3004.90.30	3917.29.91	8208.40.00
2309.90.20	3203.00.15	3917.32.91	8413.70.21
2309.90.30	3203.00.19	3917.33.10	8413.70.29
2501.00.92	3808.50.00.19	3917.39.10	8413.91.90
2712.10.10	3008.50.00.21	4016.93.00	8419.31.00
2817.00.10	3008.50.00.31	4016.99.30	8424.81.31
2923.20.00	3008.91.11	5911.90.10	8424.90.90
2924.29.40	3008.91.92	8201.10.00	8428.32.00
3004.10.20	3008.91.93	8201.20.00	8437.10.90
3004.20.20	3008.91.94	8201.30.00	8437.80.19
3004.32.20	3008.92.19	8201.40.10	8438.80.20
3004.39.20	3008.93.19	8201.40.90	
3004.40.20	3917.21.10	8201.50.00	

- Executive Decree No. 424, published in R.O. No. 245 of 28 July 2010, by means of which the importing of wheat, wheat flour, wheat groats and meal is deferred to 0%, according to the terms of Ruling No. 570 of the COMEXI.

- Executive Decree No. 438, published in R.O. No. 255 of 11 August 2010, which modifies the tariff on new rubber tyres, classified in sub-headings 4011,10,10; 4011,20,10 and 4011,20,90, establishing an Ad- Valorem of 0%, and a specific tariff of US$ 0.90 per kg, Net for the first two sub-headings, and US$ 1.20 per kg, net for the remaining two, according to the terms of Ruling No. 568 of the COMEXI.

- Executive Decree No. 439, published in R.O. No. 256 of 12 August 2010, which establishes a tariff deferral of 0%, for the importing of rechargeable batteries, classified in the following sub-headings:

8506.10.11	8506.40.10	8506.80.10	8539.31.20
8506.10.19	8506.40.90	8506.80.90	8539.31.30
8506.10.91	8506.50.10	8507.30.00	8539.31.90
8506.10.99	8506.50.90	8507.40.00	
8506.30.10	8506.60.10	8507.80.00	
8506.30.90	8506.60.90	8539.31.10	

- Executive Decree No. 446, published in the Supplement of R.O. No. 255 of 11 August 2010, the same which includes a National Complementary Note in chapter 85, in relation to the CKDs of cell phones; in addition, sub-heading 8517,12,00 is opened up corresponding to: Mobile phones (cell phones) and those of other wireless networks, according to the terms of Ruling No. 574 of the COMEXI.

- Executive Decree No. 398, published in R.O. 229 of 6 July 2010, which modifies the structure of the Tariff Nomenclature for sub-headings 4907,00,90 and 8523,40,29; in addition, the tariff for the importing of sub-headings 4907,00,90,10 and 8523,40,29,10 is deferred to 0%.

- Executive Decree No. 404, published in R.O. 235 of 14 July 2010, the same which defers the tariff for the importing of sub-heading 0511,91,20,00 corresponding to fish waste to 0%.

- Executive Decree No. 367, published in the Second Supplement of the Official Register 203 of 31 May 2010, which establishes a mixed Tariff: Specific (US$ 6 per pair) and Ad- Valorem (10%), for the importing of footwear, according to the terms of Ruling No. 550 of the COMEXI.

- Executive Decree No. 368, published in the Second Supplement of the Official Register of 31 May 2010, which defers to 0% the ad-valorem for sub-heading 8438,30,00 which corresponds to Machinery and equipment for the sugar industry, under the terms of Ruling 558 of the COMEXI.

- Executive Decree No. 372, published in the Second Supplement of the Official Register 203 of 31 May 2010, which establishes a mixed Tariff: Specific (US$ 5.5 per Kg, Net) and Ad-Valorem (10%), for the imports of textiles included in chapters 61,62 and 63, with the exception of sub-heading 6307,90,30 (protection masks) according to the terms of Ruling No. 552 of the COMEXI.

- Executive Decree No. 375, published in the Supplement of the Official Register 206 on 03 June 2010, which establishes a new scheme of tariff percentages, for the importing of hybrid vehicles classified in sub-heading 8703,90,00,91. These modifications were included in accordance with the provisions of Gazette No. 92 of the Customs of Ecuador and the validity of the tariff measure is applicable to Customs Declarations submitted starting from 04 June 2010.

- Executive Decree No. 286, published in R.O. No. 163 of 1 April 2010, which establishes the deferral of the tariff rate for sub-headings 9028,30,10 (Single-phase electricity meters), and 9028,30,90 (Other electricity meters), for a period of one year.

Appendix 3. Explanatory variables, econometric model. Years 2000 and 2010

Variables	Definition	Years	Source
	Provincial characteristics		
Agricultural abundance	Percentage of land used for agriculture in each province	2000, 2010	SINAGAP
Abundance of natural resources	Oil reserve in thousands of cubic metres/population between 15 and 65 years old	2000,2010	OPEC/INEC
Scarcity of labour	Average industrial salary of the region/average national industrial salary	2000,2010	INEC-CENEC*
Abundance of skilled labour,	Population at least with tertiary studies	2000,2010	INEC-CENEC *
Potential market	Measurement of access to the markets (Harris index, 1954)***	2000,2010	BCE **
Industrial base	Provincial (industrial) GDP		BCE
Infrastructure	Paved routes per province 1000 km^2/ state road network by province in km^2 ****	2000,2010	MOP
Distance to Quito	Distance to the city of Quito in km		IGM
Industrial promotion	Binary variable: 1 for regions benefiting and 0 otherwise	2000,2010	SRI *****
Provincial taxes	Own income/total taxes	2000,2010	SRI*****
	Industrial characteristics		
Intensity in agriculture	Agricultural inputs /production value	2000,2010	INEC-CENEC*
Intensity in natural resources	Mineral inputs/ production value	2000,2010	INEC- CENEC*
Intensity in labour	Labour compensation/production value	2000,2010	INEC-CENEC*
Intensity and skilled labour	Employees with at least tertiary education/ total employees	2000, 2010	INEC-CENEC*
Economies of scale	Size of average establishment (average number of employees per plant)	2000,2010	INEC-CENEC *
Intensity in intermediate consumption,	Intermediate manufacturing entries/ production value	2000,2010	INEC-CENEC*
Bias of intermediate demand	Percentage domestic sales in relation to exports	2000,2010	SRI- INEC-CENEC*
Tariffs	Average tariffs on the level of 4 digits ISIC	2000,2010	SENAE******

Notes:
*Annual manufacturing survey
**National Accounts
***The potential market for each province is captured through the index proposed by (Harris, 1954)
****The National Road Network is classified according to its jurisdiction into: State Road Network, Provincial Road Network and Cantonal Road Network. For this calculation the RVE (State Road Network) is considered
*****Internal Revenue Service Planning Department.
****** Database
Abbreviations:
SINAGAP: National Information System on Agriculture and Livestock, Aquaculture and Fishing OPEC: Organisation of Petroleum Exporting Countries INEC: National Institute of Statistics and Censuses CENEC: Economic National Census
MOP: Ministry of Public Works SRI: Internal Revenue Service BCE: Central Bank of Ecuador SENAE: National Customs Service of Ecuador MAG: Ministry of Agriculture and Livestock