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### **Keywords:**

Agglomeration externalities, productivity, urbanisation, tertiarisation, Latin America

### **JEL codes:**

O54, L80, O18, L60

# Agglomeration externalities in Ecuador. Do urbanisation and tertiarisation matter?

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## Abstract

The paper investigates whether the tertiarisation and the rapid urbanisation faced by developing countries favour agglomeration economies. Focusing on Ecuadorian cantons, a productivity equation is estimated using the GMM model with instruments controlling for endogeneity. The varying impact of industrial concentration, diversity, competition and density across industries is investigated and for the first time, the implication of the level of urbanisation on agglomeration externalities is studied. Stronger effects are found for services. The threshold of urbanisation at which diversity, density and competition agglomeration externalities all generate positive effects was 33% while they seem challenged by congestion in highly urbanised cantons.

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## 1 Introduction

The theoretical and empirical literature on agglomeration is extensive. The channels by which agglomeration economies translate into economic efficiency have been widely debated (see Rosenthal and Strange, 2008), stressing the potential role played by local diversity, specialisation and competition.

However, the survey by De Groot et al. (2015) points to the fact that attempts

to understand these various types of agglomeration economies mainly focus on developed countries, despite that the nature of the agglomeration externalities in developing countries seems to be a relevant issue. Indeed, one can expect agglomeration to have a differentiated effect on developing countries in comparison with developed ones because of the different conditions under which these agglomeration externalities take place. Actually, at the country level, the literature does not provide clear evidence of the existence of a monotonic relationship between sectoral diversification and income. Imbs and Wacziarg (2003) detected a robust U-curved relationship between specialisation and GDP per capita. Interpreting this relationship as a causality, diversification could be a major driving force of economic development for countries at intermediate stages of development.

A better understanding of the driving forces at work behind agglomeration in developing countries is therefore requested in order to identify the sectoral organisation that maximizes its productivity effects. Indeed, identifying whether specialisation, diversity and competition accelerate or impede local growth contains some important public policy issues. To this aim, it is important to identify the impact of the industrial structure on firms' performances at a local level. Indeed, it can be questioned whether industrial diversity, which seems to have positive effects on macroeconomic performance, generates similar effects on a more spatially disaggregated level. Income inequality between regions is a significant concern in developing countries, particularly in Latin America. Their industrial structure is frequently presented as part of the explanation for the economic gap between regions. Poor regions suffer from an excess of specialisation, the firms located therein having too few opportunities to benefit from inter-industry relationships. The immediate policy recommendation would be to encourage the emergence of an industrial diversification dynamics in these regions. Such recommendation must be systematically based on robust empirical evidences that the industrial structure of regions has a significant impact upon local growth.

A rising literature tries to fill this gap but there is still little empirical evidence for developing countries at the regional or individual level (see. Combes and Gobillon (2015), Chauvin et al. (2014)). In most cases, evidence is provided on the impact of both specialisation (often measured through industrial concentration) and diversity, and when studied, on the competition effect. As detailed below, the underlying mechanisms remain however poorly explored so far.

At the regional level, Ghani et al. (2013) point to a higher productivity in Indian districts that display a positive role played by the initial level of specialisation for employment growth. For the Indonesian case, Widodo et al. (2015), based upon firm-level data, observe that local specialisation increases firm's technical efficiency while diversity would reduce it. Ercole and O'neill (2016) stress the role of industrial linkages, pointing to the positive impact of related variety for Indonesia. In the Chinese case, Ning et al. (2016) put special emphasize on the role of agglomeration effects on the level and spillovers effects of FDI. Their results reveal positive impact of specialisation, diversity and competition. As for the Latin American case, Da Silva Catela et al. (2010) show that both diversity and specialisation have positive effects on the real average wage per worker at the municipality level in Brazil. In Chile, Saito and Gopinath (2009) found that more productive firms in the food industry locate in regions where other food industry plants agglomerate and in regions that combine industrial diversification

with a large market.

More recently, Simões and Freitas (2014) and Barufi et al. (2015) explore, respectively, the drivers of agglomeration economies on regional and individual wages in Brazil. They both find mixed evidence of specialisation-based and diversity-based agglomeration forces although specialisation prevails in the study conducted by Barufi et al. (2015).

These investigations focus however on the manufacturing industry only (Barufi et al. (2015) being however a noticeable exception). The rising share of service sector in developing economies (reaching more than 50% for instance in Latin America) leads to seek a better understanding about how the change of industrial structure in these countries may shape agglomeration economies. For developed countries, Combes (2000) shows that the impact of the local economic structure differs in industry and services: while employment density, competition, sectoral specialization and diversity have a negative impact on growth in manufacturing industries, diversity and density exhibit positive effects on service industries. If the same picture occurs in developing countries, this means that the tertiarisation of these countries would reinforce their agglomeration economies.

In addition, one of the most striking fact in developing countries is the drastic increase in the level of urbanisation and, compared to developed countries, developing countries face huge disparities in terms of urbanisation rate at the regional level. Such features are also likely to shape agglomeration economies. The intuition is twofold. First, a critical mass of urban population may be required to enjoy the potential benefits of agglomeration. A certain level of urbanisation would guarantee the existence of minimum transport and telecommunication infrastructures and banking, financial services or other specific services that matter for the emergence of externalities (Henderson, 2000). Secondly, one may expect the existence of an optimal city size which maximizes the economy's per capita output net of congestion losses (Bertinelli and Black, 2004). Therefore, in a context of increasing spatial concentration of economic activities, a major challenge for developing countries is to reinforce the role of their urban systems as drivers of economic growth (Duranton, 2015). It is thus worth investigating whether agglomeration economies vary according to the local level of urbanisation.

In order to explore these issues, this paper studies the emergence and nature of agglomeration effects in the Latin American context. Total factor productivity is regressed on specialisation, diversity and competition indexes while controlling for the effect of density. In order to explore the underlying features that condition the emergence and nature of agglomeration effects, separate estimates of the agglomeration effects in the service and manufacturing industries are provided. Whether a critical threshold of urbanisation would be required in order to benefit from agglomeration effects is then assessed.

Empirical evidence is driven from Ecuadorian cantons. Indeed, Ecuador constitutes a suitable case study as this country shares numerous common characteristics with most of the Latin American countries, such as its industrial composition and its urbanisation process. In Ecuadorian regions, 25% of the total economic activity take place in the primary activity sector (22% in average in Latin America), 20% in the manufacturing sector (resp. 22% in Latin America) and 55% in the service industry

(resp. 57% in Latin America). Most importantly, the services industry in Ecuador recorded an average growth rate of 1.5% (resp. 0.4% in Latin America) in the 2000 decade while the manufacturing industry recorded a 0.9% (resp. 0.5% in Latin America). This shows that Ecuador might be experiencing a process of tertiarisation. The urbanisation process is also similar to the Latin American one. Due to the fact that emerging countries are far from being fully urbanised, the urbanisation growth is rapid (Henderson, 2003). The annual average growth rate of urbanisation is around 2,2% in Latin America and around 3,2% in Ecuador.

In addition, when measuring agglomeration economies, one concern is endogeneity. This problem is not systematically addressed in the studies mentioned above (Combes and Gobillon, 2015). In this study, one major source of endogeneity that must be controlled is the existence of circular causality between local productivity and the type of externalities estimated. In this purpose, the instrumental variables method is implemented. Estimates are provided using the GMM model and instrument the endogenous variables with a threat index, long lagged population density and spatial lags.

This empirical work is mainly based on the 2010 Economic Census of Ecuador which contains information declared in 2009. By aggregating company data, a two-digit industry database is built on the cantonal level. Based on 7,803 canton and industry pairs, our results support Porter's externalities which argue that the combination of a diverse industrial environment and strong competition leads to positive productivity effects. In this line, specialisation is then detrimental. The magnitude of the externalities from diversity is positive and significant in the service industry, pointing to higher agglomeration forces when tertiarisation raises. Economies of density, measured by the density of firms and employees at the canton and industry levels, are found for the manufacturing sector. Competition leads to local productivity gains, especially for manufacturing sectors. More importantly, the regressions highlight the fact that diversity-based externalities increase with the level to which cantons are urbanised. In contrast, the effects of density and competition are non-monotone across the levels of urbanisation, producing both positive and negative effects. The latter suggest the presence of congestion diseconomies in some cantons.

The rest of the paper is organised as follows. Section 2 presents the various indicators used to identify the different types of externalities and provides statistical facts highlighting the sectoral and spatial organisation of economic activities in Ecuador. Section 3 focuses on the specifics of the model and the econometric methodology. The results are discussed in Section 4, separating first the service and manufacturing industries and distinguishing then the effects according to the levels of urbanisation. The main conclusions are presented in Section 5.

## **2 Spatial and sectoral distribution of economic activities in Ecuador**

### **2.1 Measures of agglomeration externalities**

The 2010 Economic Census of Ecuador includes information on 511,130 firms. It covers all localities with more than 2,000 inhabitants, with the exception of rural ar-

eas. By aggregating firm data<sup>1</sup>, an industrial database is constructed with two-digit ISIC industries (International Standard Industrial Classification). The resulting sample data covers 78 industries including manufacturing and service activities (Appendix A). Despite the availability of data on a very disaggregated geographical scale, using information on the block and city levels would induce too many missing industries. For this reason, data are aggregated at the cantonal level. Ultimately, the resulting panel data covers 78 industries and 221 cantons. Even after this aggregation, however, some industries are not present in all cantons. More specifically, on average 42 industries are absent in each canton.

The average performance of a given sector in a given canton is measured by the total factor productivity. Alternatively, we could restrict our analysis to the labor productivity<sup>2</sup>. It would result in an incomplete picture of the sectoral efficiency sources as a large number of sectors under consideration are capital intensive. Moreover, it is well known that some externalities directly translate into efficiency gains in the use of capital. For instance, sectoral diversity offers a better productive environment by enlarging the inputs market and improving the matching with the needs of firms. The Levinsohn and Petrin (2003)'s method is used. Following this method, the productivity measure is consistent and the simultaneity problem between production and the unobservable productivity is correctly treated. To estimate productivity, firm level data is first considered for the following production function of firm  $i$ .

$$\ln rev_i = \ln L_i \beta_L + \Phi(\ln K_i, \ln inp_i) + \epsilon_i \quad (1)$$

where  $rev_i$  is the level of revenue,  $L_i$  is the number of employees,  $K_i$  is the assets value and  $inp_i$  is the materials value (including electricity, packaging, raw materials, etc.) of firm  $i$ . The term  $\hat{\Phi}$  is approximated with a polynomial in  $(K_i, inp_i)$  capturing the TFP. In order to be consistent with the level of data availability for the other variables, the resulting TFP at the firm level is averaged by industry and canton.

The Marshall-Arrow-Romer (MAR) view of externalities considers that the productive efficiency of a particular industry in a given region is mainly boosted by the possible interactions within the industry in this region. Put differently, spatial proximity facilitates within industry knowledge transmission and technological appropriation. As it is standard in the literature, a relative specialisation index for each pair of sector-canton is built (see. Glaeser et al. (1992); Beaudry and Schiffauerova (2009)). The index measures the share of the canton's employment devoted to the given industry. Note that this measure is the regular location quotient which describes the industrial concentration. To control for the size of the sectors at the canton level and identify to what extent a canton is concentrated in a given sector compared to the country, it is normalised to the share of national employment allocated to this sector. The industrial concentration index is thus as follows:

$$spe_{s,c} = \frac{empl_{s,c}/empl_c}{empl_s/empl} \quad (2)$$

where  $empl_{s,c}$  is the employment in sector  $s$  in canton  $c$  and  $empl$  the national employment.

Unlike MAR theory, Jacobs (1969) sees industrial diversity of a particular region as the main source of externalities. To capture the degree of sectoral diversity faced by sector  $s$  in canton  $c$ , the inverse of the Herfindahl index is built. Formally:

$$div_{s,c} = \frac{1}{\sum_{s'=1, s' \neq s}^S (empl_{s',c}/(empl_c - empl_{s,c}))^2} \quad (3)$$

where  $S$  is the number of industries. When industries are numerous and of equal size in a region, the value of this index reaches its maximum. Based on this measure, diversity externalities are understood as the effects on productivity due to the presence of different industries<sup>3</sup>. In addition, it is worth noting that industrial concentration and diversity calculated in this way are not necessarily opposed to one other. A canton may host a very large share of a sector and a broad number of other industries as well. Such a canton is therefore both specialised and diversified (Panne and Beers, 2006).

In accordance to MAR theory, Porter (2010) argues that specialisation is the main source of externalities but that the market structure matters. Unlike a local monopoly, competition produces emulation and fosters the adoption of the best organization and/or technologies. To approximate these competition effects, full use of the firm level data is made. This enables characterising the size distribution of firms within sector  $s$  in canton  $c$ . After a normalisation at the country level, we have:

$$comp_{s,c} = \frac{1/\sum_i^N (empl_{i,s,c}/empl_{s,c})^2}{1/\sum_i^N (empl_{i,s}/empl_s)^2} \quad (4)$$

where  $empl_{i,s,c}$  is the employment of firm  $i$  belonging to sector  $s$  and located in canton  $c$ , and  $empl_{i,s}$  is the employment of firm  $i$  in sector  $s$  at the country level. It is worth noting that this measure of competition is close to the industrial concentration measure. However, the latter shows the employment concentration in given industries, whereas competition shows the strength of firms within an industry that allows them obtaining productivity gains through innovation.

Moreover, abundant and recent literature provides evidences on the effect of density on local productivity (see Combes and Gobillon, 2015). Most existing studies use employment density as an explanatory variable. Formally, it is computed as follows:

$$empl\_den_{s,c} = \frac{empl_{s,c}/area_c}{empl_s/area} \quad (5)$$

Observe that a high employment density value may reflect both the presence of few big firms or the existence of a large number of competitive firms. Both configurations may produce positive externalities as they may emerge from both individual interactions in a given firm or between firms. Consequently, we provide the following alternative index which measures density of operating firms in sector  $s$  and canton  $c$ :

$$den_{s,c} = \frac{f_{s,c}/area_c}{f_s/area} \quad (6)$$

where  $f_{s,c}$  is the number of firms in sector  $s$  located in canton  $c$  and  $area_c$  is the area of canton  $c$  in square kilometres. At the denominator,  $f_s$  is the number of firms of sector  $s$  and  $area$  is the total surface of the country.



## 2.2 Spatial statistics of Ecuador

The dynamism of the Ecuadorian economy lies in its large share of service and manufacturing industries, which in 2010 represented 20% and 55% of national production, respectively. Such an economic structure is common to other developing countries in Latin America (Hernández et al., 2016; ECLAC-ILO, 2012). This study thus contributes to a better understanding of agglomeration externalities in these countries.

In Ecuador, the share of population living in urban areas was 67.8% in 2010. However, this share hides strong intra-regional heterogeneity. In terms of cantons, the proportion of the population living in urban areas is, on average, 38.9%. This means that there are many more cantons with rural population than cantons with urban population. Figure 1 presents the spatial concentration of economic activities in cantons using firms density (a) and employment density (b). The darker areas correspond to denser cantons. It can be observed that spatial patterns are fairly similar across density measures. Denser cantons are mainly located in the Sierra region of the country, while the less dense cantons are located in the eastern region which has large territories occupied by the rain forest. On the national average, the mean (employment) density of firms in cantons is 3.9 firms (12 workers) per square kilometre and the standard deviation is 13.35 (40), which indicates high heterogeneity between cantons. In the north, the main centre is the capital, Quito (1 in Figure 1), which records a density of 23 firms (121 workers) per square kilometre. Three centres can be distinguished in the coastal region: Guayaquil (2 in Figure 1), Manta (3 in Figure 1) and Machala (6 in Figure 1) which have densities of 20 (100), 28 (121) and 32 (117) firms (workers) per square kilometre, respectively. Another centre of economic activity is Ambato (4 in Figure 1), recording 18 firms (59 workers) per square kilometre. In the south, the main centre is Cuenca (5 in Figure 1) which has a density of nine firms (36 workers) per square kilometre. In addition, Figure 1 shows higher firm and employment densities in cantons which are close to the economic centres.

*Insert*

*Figure 1. Density of economic activities in cantons*

*1 (a) Firms density by canton*

*1 (b) Employment's density by canton*

The two following figures present the profile of cantons in terms of industrial diversity and productivity.

*Insert*

*Figure 2. Diversity and productivity of cantons*

*2 (a) Diversity*

*2 (b) Productivity*

Basic comparison between Figures 2a and 2b indicates a similarity: *ceteris paribus*, denser cantons exhibit a high level of industrial diversity. Moreover, the closer the cantons are to urban centres, the higher their level of diversity. As expected, the three major urban centres have higher productivity rates than the national average: the capital, Quito (1 in Figure 1), Guayaquil (2 in Figure 1) and Cuenca (5 in Figure 1). The correlation between diversity and density at the cantonal level is 0.24, which is significant. Similarly, density and productivity are correlated, with a significant coef-

ficient of 0.15. Overall, highly diversified cantons are larger in terms of economic size (Henderson, 1997). As shown in Figure 3, larger cantons present a wider variety of economic activities. The correlation coefficient between size, measured by total employment, and diversity index is 0.5087.

*Insert*

*Figure 3. Canton size vs diversification*

## 3 Econometric methodology

### 3.1 Econometric issues related to agglomeration economies

In productivity regressions involving agglomeration variables, endogeneity problems may emerge for two reasons (Combes and Gobillon, 2015). On the one hand, endogeneity arises when omitted variables affect both agglomeration and productivity. For instance, a high level of productivity in a given industry might be caused by good local conditions, such as transport infrastructures, services and other facilities, which, in turn, increase the level of agglomeration in the region. On the other hand, endogeneity can emerge from a bidirectional causality, when local agglomeration is determined by local productivity and, in turn, determines it.

In this study, endogeneity concerns can arise from the industrial concentration variable. High sectoral productivity in one canton is likely to attract more firms from the same sector to that canton. This encourages more externalities from specialisation, which will be reflected in higher productivity. As a consequence of the bidirectional nature of the relationship, the variable encompassing the industrial concentration will be endogenous.

In terms of externalities from diversity, the impact of local productivity in a particular industry on the level of industrial diversity of one canton is, a priori, not obvious. Typically, it depends on whether the productivity gains of a given industry which spill-over across sectors are such that they boost their attractiveness. If so, local productivity in a given industry would lead to a more diversified local economy. In the other direction, according to Jacobs, a more diverse industrial environment is beneficial for the exchange of ideas across industries and the emergence of innovations, which, in turn, foster productivity gains. Consequently, the endogeneity of local industrial diversity by reverse causality remains to be tested.

Regarding local industrial competition, the externalities arising from competition described by Porter may boost innovation within the same industry, but the opposite direction of the relationship is unclear. Local industrial productivity may boost competition through the entry of new firms attracted by the local profitability of existing firms. However, firms would rather locate in places where competition is not strong. Hence, the endogeneity of this variable also needs to be tested.

## 3.2 Specification of the model

In terms of the aforementioned issues of endogeneity, the feasible efficient two-step GMM estimator is used in the regressions. This estimator is efficient (more than 2SLS estimator<sup>4</sup>) in the presence of heteroskedasticity. Thus, it provides consistent estimates by dealing with both potential endogeneity and heteroskedasticity.

The model estimating the effect of each type of externality upon the productivity level of a specific industry  $s$  in a given canton  $c$  is as follows.

$$(TFP_{s,c}) = \alpha + \beta_1 spe_{s,c} + \beta_2 div_{s,c} + \beta_3 comp_{s,c} + \beta_4 den_{s,c} + \gamma_2 p_2 + \dots + \gamma_l p_l + \lambda_2 s_2 + \dots + \lambda_l s_l + selection_{s,c} + u_{s,c} \quad (7)$$

where  $(TFP_{s,c})$  is the Total Factor Productivity in industry  $s$  in canton  $c$ , estimated using the Levinsohn and Petrin (2003)'s method. To control for unobserved heterogeneity, l-1 province fixed effects given by  $p_2 \dots p_l$  are introduced as well as sector fixed effects given by  $s_2 \dots s_l$ . The term  $selection_{s,c}$  is a control variable which allows us to address the issue regarding the presence of many zeros in the database (all cantons do not account for the same number of economic activities). This is the inverse of Mill's ratio, computed using the estimates of a selection equation (see Appendix C) proposed by Heckman (1979).

In order to correct the endogeneity issue derived from the circular causality of the endogenous variables, a set of instruments  $Z_i$ , assumed to be uncorrelated with the error ( $cov(Z_i, u_{s,c}) = 0$ ), is used.

First, the 1990 population density (*pop 90*) is used as an instrument. The long-term lagged variable is useful to remove the simultaneity that arises from contemporaneous effects. It is unlikely to be correlated with the error term at time  $t$  since it was generated at an earlier point in time (Combes et al., 2010). The endogenous variables are also instrumented with their spatial lags (*spe\_spatial*, *comp\_spatial*, *den\_spatial*, *div\_spatial*). In order to compute the spatial lags, the inverse distance weight matrix is built using the coordinates of the capital of each canton. The spatial lags are likely to be relevant instruments since neighbouring cantons could affect one canton's level of industrial concentration, diversity, density or competition, but the extent to which neighbours' agglomeration externalities could affect the level of productivity of one canton cannot be immediately assumed. It is worth noting that the introduction of the spatial dimension of these instruments somehow controls for possible spatial correlation in the model. The squares of the endogenous variables could be considered as good instruments because they explain the current patterns of endogenous variables. However, only the density squared ( $den^2$ ) passes the validity test.

Another interesting instrument is the natural threat index of cantons (*threat*) which takes into account causes of natural disasters in each canton. This variable has been compiled on the basis of a joint research study produced by the System of Economic Indicators (SIISE), Oxfam International and Cooperazione Internazionale (COOPI). This index is assumed to be a reasonable instrument because it is correlated with all the endogenous variables. The level of industrial concentration, diversity and density of regions is related to their degree of risk exposure.

In order to have consistent estimates of the productivity equation (7), the instrumental variables must meet two specific properties. First, they must be highly correlated with instrumented variables (relevance condition), and second, a valid instrument has to be exogenous (orthogonality condition). Although the latter cannot be directly tested, the former is readily testable through the following analysis of correlation coefficients between the endogenous variables and their instruments shown in Table 1.

*Insert*

*Table 1. Validity tests of instruments*

Threat index, 1990 population density and squared density are highly correlated with all the endogenous variables, proving to be relevant instruments. The spatial lags of diversity, competition and density are correlated with some of the endogenous variables. In contrast, the spatial lag of industrial concentration is not correlated with any of the endogenous variables. Therefore, it is not considered as instrument.

The orthogonality condition is tested after the estimations through the C statistic or so called 'difference in Sargan' statistic whose null hypothesis is that suspected and additional instruments are valid. As shown in Table 1, the null hypothesis cannot be rejected, so instruments are valid.

## 4 Results

Prior to discussing the results of the estimates, the endogeneity test (Sargan-Hansen statistic) of the variables of agglomeration externalities is presented in Table 2. According to the results, the null hypothesis that industrial concentration and firms' density are exogenous is rejected. They are therefore treated as endogenous variables. Diversity is treated according to the exogeneity test and competition is exogenous and is treated as such.

*Insert*

*Table 2. Endogeneity test for agglomeration variables*

The robustness checks (shown at the bottom of Table 3) of homoscedasticity<sup>5</sup>, over-identification, weakness of instruments, spatial correlation and colinearity (see Appendix B) verify that estimations are reliable. Potential selection bias in the sample is also controlled for by introducing the inverse Mill's ratio, computed using the estimates from a Probit model (see Appendix C). It is worth noting that since there are more instrumental variables than endogenous variables ( $Z > X$ ), the GMM estimator is appropriate and more efficient than the 2SLS estimator.

### 4.1 Sectoral composition, density and local productivity

Table 3 shows the estimation results. Column (1) records the estimates of the model using the whole sample. These regression results do not account for industrial heterogeneity. Sectors might be very different in terms of productivity dynamics and backward and forward linkages. A distinction is then made between manufacturing (column 2) and service<sup>6</sup> activities (column 3)<sup>7</sup>.

*Insert*

*Table 3. Estimation of the effect of agglomeration and industry structure on productivity*

At global level, productivity gains arising from sectoral diversity are important and significant on the whole sample. This result is in accordance with other studies focusing on Brazil and Chile which show that diversity is the most important driver of productivity (Da Silva Catela et al., 2010; Saito and Gopinath, 2009). In particular, the positive effect is present in the the service industry. Indeed, the existence of a large variety of activities is often beneficial for the emergence and development of many service industries both for supply and demand linkages and the collaborative environment it offers.

The tertiary sector seems to be ongoing in this economy, encouraged by agglomeration economies (Meliciani and Savona, 2014). Service industries have become intermediate inputs for other industries. Thus, the geographical proximity and concentration of customer industries are crucial. Besides, positive effects of diversity at the canton level might arise from knowledge spillovers across industries. As firms provide services to many industries, they can obtain information about what other firms in their own field or even in other fields are doing and the process of imitation and cross-fertilisation takes place.

By contrast, negative effects of both specialisation and diversity-based externalities arise in the manufacturing industry. As recent works show, the effect of agglomeration externalities would depend on the life cycle of the industry (Boschma et al., 2005; Greunz, 2004; Forni and Paba, 2002). In this case, it seems that the manufacturing firms in Ecuador are producing standard and mature products. In that sense, neither specialisation nor diversity externalities favour their level of productivity. This could be due to the low quality of transport infrastructure and low levels of innovation impeding to generate significant MAR and Jacobs' externalities.

Regarding the effect of competition, results confirm the existence of Porter externalities. A high level of sectoral competition at the canton level in any sector leads to productivity gains. The positive effect is particularly strong in the manufacturing sector suggesting that local competition is more strongly transformed into emulation and productivity gains in this sector.

As in the great majority of papers devoted to the estimation of agglomeration economies, the local density of firms boosts productivity (Melo et al., 2009). For Ecuador, the elasticity of productivity with respect to density is significant in the manufacturing sector only, where it reaches around 5.2%. While international comparisons must be interpreted very cautiously because of different methodological approaches, Ciccone and Hall (1996) and Ciccone (2002) found that economies of density in Europe and the US measured by the effects of employment density are 4.5% and 5%, respectively. The results obtained for developing countries are usually higher, ranging between 5% and 11%. In particular, according to Melo et al. (2009)'s meta analysis, South American countries tend to experience around 5.6% higher density effects than Europe. Although, Ecuador achieved a 5.2% elasticity in 2010 according to our results, further investigation for recent years is needed. Other South American countries confirm higher estimated productivity elasticities to density such as Brazil with 11% (Henderson, 1988; Da-Mata et al., 2007), Chile with 0.09 (Saito and Gopinath, 2009) and in Colombia (Duranton, 2016) with 0.05 (elasticity of wages to respect to popu-

lation). There may be specific mechanisms operating in these countries which induce higher levels of labour productivity, such as the demographic bonus and internal migration whose complementary nature between unskilled and skilled workers produces positive effects (Combes et al., 2013).

## 4.2 Does urbanisation matter?

The preceding sections allow accurately observing the existence of agglomeration benefits for industries in Ecuador’s cantonal economies. However, one of the specific feature of developing countries is their strong regional heterogeneity in terms of urbanisation. Ecuador is no exception: in terms of urbanisation, the distribution of cantons is skewed (see figure 4). The second quartile is 0.33, i.e., there are 110 cantons of a total of 221 cantons with an urban population which is lower than 33%.

*Insert*

*Figure 4. Histogram of urbanisation of cantons in Ecuador*

Given the heterogeneity of Ecuadorian cantons, it is worth investigating whether the externalities identified in the preceding sections are shaped by the level of urbanisation (*urban\_rate*) of the cantons. The intuition is twofold. First, a critical mass of urban population would be required to enjoy the potential benefits of agglomeration. Secondly, one may expect the existence of an optimal city size which maximizes the economy’s per capita output net of congestion losses (Bertinelli and Black, 2004).

Through an analysis which disaggregates the entire sample into different levels of urbanisation, measured by the share of urban settlements<sup>8</sup>, light is shed on two aspects: i. the relationship between the magnitude of externalities and the level of urbanisation and ii. the threshold of urbanisation at which agglomeration externalities decline.

In order to determine the threshold values, the level of urbanisation is first set at 33%, which is the median of the sample. Some simulations have then been run changing the level of urbanisation and identify two threshold values: 46% and 61%, at which the significance of agglomeration externalities change. In Table 4, the estimates for different levels of urbanisation are presented: lower than 33% (column1); larger than 33% (column 2); larger than 46% (column 3) and larger than 61% (column 4).

*Insert*

*Table 4. Agglomeration effects vs. the level of urbanisation*

Firstly, urbanisation mainly alters the effects of diversity and density externalities. The sensitivity of these variables could be due to their relationship with urban systems. Cities host a great diversity of industries and density of activities. The effect of competition also changes throughout the urbanisation process. In contrast, the effects of specialisation externalities measured through our industrial concentration index slightly change with levels of urbanisation.

The results in column (1) of Table 4 indicate that when a region faces low levels of urbanisation, externalities from diversity and density economies do not occur. This could be explained by the fact that regions with low levels of urbanisation do not provide an appropriate environment for the interaction of different industries since

communication and transport infrastructures are still embryonic and the provision of services is scarce. By contrast, the competition is a significant source of positive externalities at low urbanised cantons. As these cantons are small, monopolist firms may not be interested in locating there. Then, knowledge and information could be diffused more easily in small cantons so that high competition can promote positive externalities.

On the other hand, the results suggest that externalities from industrial concentration negatively affect cantons at low and medium levels of urbanisation. The negative effect might arise from the primary sector which represent a large share of the economic activity at those levels of urbanisation.

The results in column (2) suggest that as a canton urbanises, the conditions for diversity externalities improve. A more urbanised environment can benefit from the concentration of different industries for many reasons. First, industrial dynamism is improved through the provision of services and in turn productivity is enhanced. Second, urban areas benefit from better communication and transport infrastructures, which facilitate cooperation, cross-fertilisation of knowledge between firms of different industries. In addition, an urbanised environment offers a larger variety of schools and universities which enhances the recruitment of more skilled workers and facilitates job turnover between industries.

Simulations show that at higher levels than 33%, the density effect becomes positive and significant. However, we can assume that there is a certain level of urbanisation leading to negative effects of firm density on productivity because of congestion diseconomies in big cities. In order to test this hypothesis, the model was run with several levels of urbanisation above 33% and the positive effect of density ceases to be significant at 61% urbanisation rate (fourth column). It turns to be negative and significant at high levels of urbanisation. This result shows clear evidence of congestion effects in larger agglomerations.

The externalities derived from competition are no longer positive for levels of urbanisation higher than 46%. They become significantly negative in cantons with levels of urbanisation above 61%. This negative effect means that competition may become detrimental for firm productivity. As competition heightened, land costs and input prices increase, while firms' market power decreases, inducing lower productivity for firms located in highly urbanised environment.

## 5 Conclusions

Estimating a productivity equation using the GMM model with instruments to control for endogeneity, we investigate whether the tertiarisation and the rapid but uneven urbanisation faced by developing countries would favour agglomeration economies.

The results show that diversity externalities matter more than specialisation externalities, supporting Jacobs' externalities. The strong presence of diversity externalities coming from the concentration of different industries is explained by the fact that most industries in the country interact with one another, leading to high backward and forward linkages. Therefore, the exchange and mixture of ideas from different industries is facilitated in such a diverse industrial environment.

In addition, the innovation-inducing effect of competition promulgated by Porter's theory appears to be relevant not only at the general level but also at the sectoral level. Conversely, cantons and industries do not benefit from localisation economies. This means that there is, in fact, rivalry between diversity and specialisation externalities. In terms of the economies of density, measured by firm spatial concentration, the estimated elasticity of productivity with respect to density is 5% on the cantonal and industrial scale.

More importantly, these agglomeration economies are sensitive to the rising share of service industries in developing countries and to the increase in their urbanisation level. The particularities of the industries determine the specific effects of agglomeration externalities on their productivity. The service industry benefits the most from the agglomeration of different industries. There might be two reasons for that: on one hand, their output is not devoted to a specific industry, and on the other hand, knowledge spillovers in this industry are very likely to be due to a wide sales network. The nature and therefore the magnitude of agglomeration forces would thus evolve as service industries rise. The manufacturing industry benefits more from the geographical proximity of firms and workers within the same industry. The increasing share of service industry in developing countries, boosted by agglomeration economies, enlarges in return agglomeration economies.

For the first time, this study presents the impact of the level of urbanisation upon agglomeration externalities. The results show that no significant diversity effect is recorded in cantons whose urbanisation level is under 33%. As a canton urbanises, several changes occur. The threshold at which diversity, competition and density agglomeration externalities generate positive effect was identified at an urbanisation rate of 33%. At higher rates of urbanisation than 46%, the positive effect of competition disappears, which means that in highly urbanised cantons, congestion effects would prevail.

Our results may have interesting implications for policy makers. Urbanisation should be supported as long as it increases agglomeration economies, and public infrastructures should be developed to reduce the risk of congestion effects. Moreover, as service industries develop, diversity would become a more prevailing agglomeration force. Public actors could thus accompany the tertiarisation of the economy with support for the diversification of local activities in order to strengthen this prevailing source of agglomeration economies.

It is worth noting however that additional research investigations would be requested to assess congestion effects, to observe more recent years and to take into account the dynamic nature of the urbanisation and tertiarisation processes. In addition, due to a large amount of missing values at the firm level, very few variables were available to explain the variability at the firm level, preventing to run reliable estimations on individual data. As a consequence, this study relies on an empirical strategy based on aggregated data. Even if Melo et al. (2009)'s meta analysis shows that there is no difference between aggregated and individual data results, future researches should try to get individual data to grasp more precisely agglomeration economies.



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## Notes

<sup>1</sup>Another strategy consists in using firm-level data. However, some variables at the firm level, needed to explain the individual variability, are generally missing. Thus, only one variable (lifetime) is available to explain the variability at the firm level. Consequently, such a strategy is not adequate for econometric reasons.

<sup>2</sup>Previous versions of the article focuses on the labor productivity. They are available upon request

<sup>3</sup>Note that diversity externalities can also be derived from the so called Related Variety, which is the interaction between sub-industries within one industry (Frenken et al., 2007). In the present study, evidence on the diversity externalities originated in the interchange between different industries is provided. However, estimations using Related variety measures were also conducted. Two measures were tested: i) RV at the cantonal and sectoral level based on Frenken et al. (2007) and ii) RV at the cantonal and sectoral level based on the standard measure. Due to the sensitivity of the results to the measure used (Frenken vs Standard), they are not presented here but are available upon request.

<sup>4</sup>Ordinary Least Squares (OLS) and Two Stages Least Squares (2SLS) estimation methods were also used. By comparing, the 2SLS and GMM estimations show quite similar results in terms of coefficients signs and magnitudes while the OLS estimation differs regarding the sign of the competition effect.

<sup>5</sup>Enough evidence is found to reject the null hypothesis of the Pagan-Hall general test. The estimates are then presented with standard errors which are robust to arbitrary heteroskedasticity.

<sup>6</sup>The classification of industries is shown in Appendix A

<sup>7</sup>The differences in the coefficient estimates between both industries are statistically significant according to the Chow test. The F statistic of the test is 59.54 and the p-value is 0.000.

<sup>8</sup>According to the Population and Housing Census of 2010, urban settlements are defined by provincial and cantonal capitals under the political and administrative division of the country. Rural areas include parish capitals, other towns, peripheries and sparsely populated settlements