Regional Economic Diversification as a Determinant of Regional Exports

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Abstract

Literature has followed two tracks relative to agglomeration impacts on economic activity. The first suggests that localization economies emerge mainly in urban areas with concentration of economic activity. The second suggests that urbanization economies emerge in urban areas with diversity of the economic activity. This paper aims at testing for these hypotheses using regional economic diversity measured by an entropy index and Herfindahl-Hirschman index in synergy with urbanization. It applies data for the 13 regions of Greece, for the period 1998-2008. Our results imply the presence of *localization economies* rather than *Jacobs/urbanization economies* in urbanized regions and the opposite for the less urbanized regions.

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1. INTRODUCTION

One of the European Union's strategic aims is the acceleration of economic convergence across states and regions: "The mission of the Directorate General for Regional Policy is to strengthen economic, social and territorial cohesion by reducing disparities between the levels of development of regions and countries of the European Union." Since exports have long been recognized by literature as a driving force for economic growth, either at national or regional level (Beine and Coulombe, 2007; Gao, 2004), identifying the factors that affect regional exports may have significant policy implications for European regional policy.

The impact of agglomeration economies on regional innovation, productivity and growth has been extensively examined by literature. The Marshallian track of literature argues that the regional sectoral specialization contributes to innovation and growth because of local labor pool and low transaction cost of intermediate goods markets while knowledge diffuses more easily between firms within the same industry (*localization economies*). On the other hand, followers of the Jacobs' track (Jacobs, 1969) argue that knowledge diffuses more efficiently between firms in different sectors because firms are eager for new and fresh ideas, which usually are present in other industries and consequently this type of agglomeration economies flourish in large urban areas (*urbanization economies*).

Aim of this paper is to investigate the role of the spatially constraint external agglomeration economies on the regional exports of Greece, a semi-industrialized country with specific spatial characteristics that will be discussed later. The paper puts in scrutiny the hypothesis that regional economic diversity, considering simultaneously the urbanization of regional population, has a positive impact (Jacobs, 1969) or a negative impact (Marshall, 1920) on regional exports. It employs annual

regional data for the period 1998-2007 for the 13 NUTS-II regions of the country. The hypothesis of the paper is tested using an entropy index and a Herfindhal-Hirschman index for the diversity of the regional economic activity in *synergy* with an urbanization index. We found that the impact of the diversity of the regional economic activity on exports decreases with the increase in urbanization levels of regional population. This finding is an indication of existence of *localization economies*.

The paper is organized as follows. The second section explains the theoretical framework used in this study. The third section presents the data and the empirical results. Finally, the fourth section offers some concluding remarks.

2. THEORETICAL BACKGROUND AND HYPOTHESES SETTING

Literature has identified some of the driving forces of regional exports. For example, infrastructure and transport costs seem to be robust determinants of regional exports (Fujita and Thisse, 1996; Lado et al., 2001; Wu, 2007; Granato, 2008) but not in a monotonic way, as Lado et al. (2001) note, because transport infrastructure is especially needed at the early stages of the export sector development. The spatial location of regions has been used as a proxy for the transport cost since it is a factor of the density of the transport system and consequently negatively affecting the intensity of trade flows and exports (Nicolini, 2003; WU, 2007). In a similar approach, Matthee and Naude (2008) find that the distance from export hubs to affect regional exports in South Africa and Nicolini (2003) argues that sharing borders with export destination countries are of strategic importance.

Human capital explains the regional export variability in the case where exports are skill intensive and, thus, strongly related to human capital (Aitken et al., 1997) but Hodgkinson (2008) states that the impact of labor skills is significant only for the fast export growth firms. Grasjo (2008) indicates that the accessibility to human capital is the factor that drives regional export performance the most because of innovation, new ideas, creativity, as Anderson and Johanson (2010) argue.

Knowledge and R&D investment have a positive impact on firm's competitiveness in international markets (Greenhalgh et al., 1994) while Becchetti and Rossi (2000) find that technological variables are the hidden factor generating the positive relationship between geographical agglomeration and export performance implying that technological innovation indirectly affects regional exports. However, Grasjo (2008) notes that local accessibility to business and university R&D to a large extend are crowded out by the accessibility to human capital in the case of Swedish municipalities confirming that R&D investment is not sufficient to explain and determine export performance (Hodgkinson, 2008).

Foreign direct investment contributes to the explanation of the cross provincial export variation in China (Sun, 2001) but this contribution is not uniform since the influence on the exports of coastal provinces is higher than that of central provinces and insignificant in the case of the western provinces. This result implicitly implies that the distance from exports hubs is relevant, as Matthee and Naude (2008) found.

An augmented gravity model is used by Erickson and Hayward (1991) to explain exports at the US state level and by Gil et al. (2008) to explain the regional exports variation in Spain. Finally, Cronovich and Gazel (1998) find a statistically significant correlation between regional exchange rate and regional exports.

Even though agglomeration economies have been used in research to explain various regional economic phenomena, such as growth (Glaeser et al., 1992; Boschma and Iammarino, 2009), productivity (Henderson et al., 2003; Frenken et al. 2007), employment and unemployment (Frenken et al., 2007) and innovative activity (Boschma and Iammarino, 2009), their role on regional exports has not been thoroughly examined, at least in the emerging and developing economies.

Following Parr et al. (2002), externalities could take the form of scale, scope and complexity and constitute the bases of agglomeration economies, if the requirement of spatial proximity with respect to the related activities is fulfilled. Parr et al. (2002) named those externalities *spatially constraint externalities* since they arise when similar firms are co-located. These economies of scale, *localization economies*, have their source in the "*Marshallian trinity*": a) "A localized industry gains great advantage from the fact that it offers a constant market for skill." Hence, by concentrating a number of firms in an industry at the same location, allows the creation of a labor market pooling for specialized skills, b) "Subsidiary trades grow up in the neighborhood". Localization allows the provision of intermediate goods specific to an industry in a greater variety and lower transaction and transportation costs, and c) "[I]f one man starts a new idea, it is taken by others and combined with suggestions of their own and thus it becomes the source of further new ideas." Information and knowledge diffuses more easily locally.

Firms located in a regional industrial district share some common characteristics: i) small size, ii) high degree of specialization, iii) flexible division of labour force, iv) vertical cooperation and horizontal competition, and v) innovative capacity and creativity enhanced by geographical proximity (Bellandi, 1996 cited in Becchetti and Rossi, 2000). For example, firms located in the same area, in their effort to keep and

expand their customer base, bolster competition, which dictates product quality improvement through innovation. Porter (1990) asserted that these are driving forces for firms to gain competitiveness in international markets. Indeed, Becchetti and Rossi (2000) find that the export performance of small-medium firms, mostly operating in traditional and specialized sectors, improves by locating in geographically agglomerated area. Besides, firms located in industrial districts (specialized or not in the leading manufacturing activity of the district) export more and have higher added value than firms located elsewhere (Becchetti et al., 2007) while small firms with limited internal resources are more sensitive to external spillovers (Lozza and Galliano, 2003). Hence, if an industry is subject to Marshall's *localization economies,* producers are likely to cluster together primarily in few cities specialized in trade goods production in just that activity contributing to the international competitiveness of firms. Indeed many standardized manufacturing activities such as textiles, food process, furniture, and steel tend to be found disproportionately in smaller specialized metro areas (Henderson, 2003). However, this could be the case in large mature industrialized economies like the US and is open to discussion whether this applies in the case of small semi-industrialized peripheral economy.

Knowledge, being part of the innovation and competitiveness circle, leads to exports increase. Recent literature notes that spatial agglomeration of firms and geographical concentration of information generating informational spillovers may play an important part in shaping national and regional patterns of comparative advantage (Fujita and Thisse, 1996; Lozza and Galliano, 2003; Koenig et al., 2009). For Koening et al. (2010) the proximity to other exporters may bring benefits like positive information externalities, cost-sharing opportunities, and mutualised actions on export

markets. The importance of geographical proximity in knowledge diffusion has been revealed in several studies. According to Krugman (1991) knowledge spillovers are more probably to exist in highly urbanized regions than in low ones. First, universities and technical universities are usually located in highly urbanized areas. Second, urban areas provide the ground floor for informal meetings between the operating personnel of different firms and sectors, facilitating the speed-up of tacit knowledge spillovers.

Hence, the larger the urbanization is the higher the knowledge diffusion. But, does knowledge diffuse inside the same industry or across industries?

Knowledge spillovers, the third component of the agglomeration economies (Marshall, 1920), are more controversial than the first two. The followers of the Marshallian track assume that knowledge more easily diffuses within industry, that is, knowledge accumulated by one firm helps other firms' technologies in the same industry. In this case, regional specialization facilitates information and knowledge transmission leading to higher regional firms' competitiveness.

Contrary to the Marshallian track, Jacobs (1969) argue that industrial variety-diversity rather than specialization is more important for growth because there is cross sectoral interchange of different ideas (*Jacobs/urbanization economies*). This argument is verified by many examples, where industrial sectors adopted technologies which were already implemented in other sectors. Because knowledge spillovers are dynamic externalities (Glaeser, et al., 1992), variety leads to spillovers from sector to sector improving sectoral productivity, increasing exporting activity and hence the *spatially constraint economies of scope* in the terminology of Parr et al. (2002) prevail. Even more, exports and trade are, in their turn, major vehicles for the sharing and transfer of international knowledge (Grasjo, 2008). Moreover, provided that the information owned by the firms is different, the benefits of communication generally increase as

the number of firms involved rises (Fujita and Thisse, 1996). Therefore, as Henderson (2003) and Frenken et al. (2007) argue if an industry is subject to *Jacobs/urbanization economies*, to thrive it needs to be in a more divers and larger local environment. A better knowledge of foreign markets may have a positive impact at microeconomic level on the export performance of firms. Proximity to other exporters may bring benefits like positive information externalities, cost-sharing opportunities and mutualised actions on export markets (Koenig et al, 2009; Lozza and Galliano, 2003). Especially, for small firms, being members of exporting groups or being located in a geographically agglomerated area offer a different way of learning.

Finally, local demand is, according to Porter (1990), a significant factor that explains the international competitiveness of national and regional firms. The urbanization level is related to the regional demand in the Porter's framework because consumers organize their shopping itinerary with low transportation cost. Consumers exploit "economies of scale" when they are shopping in urban areas. This is the home market effect where concentration of demand encourages agglomeration (Rosenthal and Strange, 2003).

Summarizing the above discussion, we set the hypothesis to be tested in this paper: *localization economies* occur in industrial districts or cluster of cities, that is urbanized areas, and the regional economic activity is concentrated in few sectors (diversity is limited); *Jacobs/urbanization economies* occur in high urbanized areas but associated with high diversity of regional economic activity.

3. EMPIRICAL RESULTS AND DISCUSSION

3.1. The model and definitions

Based on the discussion of the previous section, we derive eq. 1, which is the model to be estimated for the region *i* at year t.

$$EXP_{it} = a_1 DEA_{it} + a_2 DEA_{it} * URBAN_{it} + \mathbf{aCV} + e_{it} \qquad (1)$$

where EXP_{it} is the logarithm of per capita regional exports in region *i* and year *t* is time, DEA_{it} is the regional economic activity diversity, $URBAN_{it}$ is the urbanization index, a_1, and a_2 are the parameters to be estimated, **CV** is the vector of control variables, **a** is the vector of the respective parameters for estimation, and e_{it} is the regression's error term. Aim of this paper is to examine the impact of the diversity of the regional economic activity on regional exports by considering simultaneously the synergy of urbanization. This synergistic effect is captured by the $DEA_{it} * URBAN_{it}$ interaction term.

In general, the literature presents conflicting evidence about the effect of scale externalities depending on the specification used to identify scale effects, the level of data aggregation and the extent to which estimation deals with potential sources (Henderson, 2003). Rosenthal and Strange (2004) review the measures used to control for the *Jacobs/urbanization economies*. The most common measures are indices related to the size of the city and specialization indices. For example, Henderson (2003) uses a specialization metric from the national average to measure the existence of diversity at MSA level.

However, specialization indices are raising some concerns about their interpretation, for example the absolute versus relative effects. A different measure to control for *Jacobs/urbanization economies* is diversity of the regional economic activity index. Henderson et al. (1995) used a Herfindhal-Hirschman Index of employment diversity

at the MSA level while Rosenthal and Strange (2003) used the Herfindhal-Hirschman Index based on zip code employment. According to Rosenthal and Strange (2004) the diversity indices capture the absolute level of employment diversity in a given region and it is very much in the spirit of Jacobs.

Following Rosenthal and Strange (2004), we use an index for the diversity of regional economic activity to proxy the *urbanization or localization economies* since the diversity indices are of trajectory type. For example, a low value of a diversity index implies that the regional economic activity is concentrated in one or very few sectors. This could be an indication of *localization economies*. On the other hand, a high value of the diversity index signals the existence of *Jacobs / urbanization economies*.

We use two alternative measures for the diversity of regional economic activity. The first measure is the *entropy index*. Let s_{ij} stand for the share of the sector's j employment in total employment of region i. The entropy index for region i is computed as:

$$E_{it} = -\sum_{j=1}^{n} s_{ijt} \ln s_{ijt}$$

Where E_{it} is the entropy index in region i at time t and s_{ijt} is the share of the sector's j $(j=1,\ldots,n)$ employment in total employment in region i at time t.

If the region has equal sized shares of all sectoral employment ($s_{ij}=1/n$), the entropy index reaches the maximum value $ln(n)$, which is rising with n. In this case, the region exhibits "complete" diversity of economic activity. If, on the other hand, the region is fully specialized in one sector (no diversity) the entropy index takes the value $ln(1)=0$. Hence, the entropy index increases with higher diversification and decreases with specialization (Frenken, 2004).

The entropy index has two dimensions: the share and the variety of the regional sectoral activity (Audretsch et al., 2010). Variety, according to Audretsch et al. (2010), refers to "richness", that is the sectors that are present in the specific region and the distribution of those different sectors within the regional economic activity. Raw data reveal that not all sectors are present in the exporting activity of every region. As Frenken (2004) points out entropy index has been used at the regional level in order to measure regional industrial diversification because of its decomposition property. Industrial sectors at 2-digit level belong also to upper level categories, for example manufacturing, agriculture and services. According to Jacquemin and Berry (1979) and Frenken et al. (2007), the total entropy index is a weighted average of the diversification within the upper level categories and the diversification across those categories. Consequently, entropy index, by considering these two dimensions, is an adequate measure for the diversity of regional economic activity very close to the spirit of Jacobs because it takes into consideration even the very small industrial shares which according to Jacquemin and Berry (1979) they are largely ignored by the Herfindahl-Hirschman index.

The second index is the *Herfindahl - Hirschman Concentration Index (HHI)* across sectors:

$$HHI_i = \sum_{j=1}^{n} s_{ij}^2$$

where s_{ij} is the share of the sector's j employment in total employment of region i. The HHI ranges from 0 - the shares of all sectors in total regional activity are equal - to 1 - the regional economic activity consists of one sector only. As Audretsch et al. (2010) argue that the use of *HHI* as a measure of regional economic activity diversity is a good alternative to entropy index, even though by weighting the highest sectoral share disproportionately high, the index is largely determined by the share of the

dominant sector and fails to capture the two dimensions, share and variety, as the entropy index. Urbanization of regional population, $URBAN_{it}$, is proxied, as proposed by some researchers, by an urbanization index. As the urbanization index increases, population is concentrated in urban areas. The interaction term between economic diversity and urbanization has been introduced in our equation in order to test for the hypothesis that diversity's impact on exports is related with urbanization or vice versa (Henderson, 2003).

The vector **VC** of the control variables includes variables that have been used in similar cases in literature. Hence, previous literature has proxied the regional demand level and quality using the regional *per capita GDP* or alternatively the *GDP*, as we have mentioned in the previous section. It is worth mentioning that Cronovich and Gazel (1998) use the state's GDP as a proxy for the supply factors and found positive correlation with state's exports for the US.

We use two alternative measures to assess the impact of human capital on regional exports: the employment in high technology sectors (*LEM* in our data set) and the students in tertiary education over active population (*TERT* in our data set). The expected sign, according to literature, is positive.

Finally, we test for geographic factors, as suggested by literature. First, we employ a dummy variable (*LandLOCK* in our data set) which takes the value 1 if the region is landlocked and 0 otherwise. Second, we use a dummy variable (*ISL* in our data set) which takes the value 1 if the region is island and 0 otherwise. These variables are time invariant.

3.2. The data and methodology

The empirical estimation employs annual data for the period 1998-2007 for the 13 regions of Greece. Panel data analysis is applied because of several benefits discussed in literature. The data are from various sources: *regional exports* (denoted as EXP in our data set) are from the Greek International Business Association and the rest of the variables are from Eurostat. The *diversity indices* were calculated using data for sectoral employment at NACE 2-digit classification of Eurostat. The *urbanization index* is the percentage of total households of region living in urban areas. We use the share of employment in high technology sectors over total employment (denoted as *LEM* in our data set) and the ratio of students in tertiary education over regional population (denoted as *Tertiary* in our data set) as a proxy for *human capital*.

Insert Table 1

Table 1 shows the averaged over time statistical data for the 13 regions of Greece. It is evident that the most populated region is Attiki (where Athens, the capital of Greece, is the main urban area). Attiki is also the richest region and covers the highest share of regional export over national exports. Only one region is landlocked, Western Macedonia, and four regions are island regions, North Aegean, South Aegean, Crete and Ionian Islands.

Insert Table 2

The descriptive statistics of the explanatory variables are reported in Table 2.

Insert Table 3

Table 3 provides the correlation matrix. The level of correlations indicates that problems of multicollinearity are not likely to be manifested in the regression models.

3.3. Empirical results

The empirical results of the equation (1) are presented in tables 4 and 5. Table 4 reports the estimated model using the entropy index as a measure for the diversity of regional economic activity and table 5 reports the estimated model using the HHI. In each table we present 5 modes. For these modes, the Hausman test suggested the use of the Random Effects methodology and, therefore, we only report the Random Effects (RE) estimations. The RE estimations are also preferable to Fixed Effects due to the time invariant variables in our data set. Furthermore, since the objective of this paper is to estimate the impact of the agglomeration economies the treatment of the unobserved effects as random or fixed is not of relevance (Wooldridge, 2002, p.252).

Insert Table 4

Table 4 summarizes the estimation results using the entropy index. The overall performance is quite good with mode 5 showing the best performance. Consequently, we proceed to the discussion of the individual parameters estimations.

The estimated coefficient of GDP is statistically significant and positive in all modes but that of GDP per capita has ambiguous sign. This result is similar to those found in literature (Cronovich and Gazel,1998; Nicolini, 2003; Matthee and Naude, 2008).These measures have been used in literature as a proxy for level of regional demand assuming, as Porter (1990) suggested, that high and qualitative local demand is a significant factor in developing regional competitive advantage. In our example,

the elasticity of exports with respect to GDP is close to 0.7, indicating that a 1% growth of regional GDP is associated with a 0.7% increase in regional exports (table 4, mode 5).

Previous research has shown that the proximity to export hubs is positively correlated to exports (ports are the main export hubs) (Matthee and Naude, 2008). In our estimations, the island dummy is statistically significant with a negative sign. This result is attributed to the low quality ports of the Greek islands, which probably are not suitable for international trade. Radelet and Sachs (1998) point out that it is not only the existence of ports that contributes to the regional or national export but to a certain extent the quality of these ports. The ports of Greek islands are suitable for local passenger transportation, but their quality is low and not advantageous for exports transportation. Besides, Greek islands have changed their production portfolio by shifting from the tradeable goods activities, manufacturing and agriculture, to tourism industry.

The estimated coefficient of the landlocked dummy is non-statistically significant. We should mention that only one region, Western Macedonia, is landlocked. Previous studies on that region (Varsakelis, 2007; 2009) have shown that the main destinations of its exports are the neighboring countries, Albania, FYROM and Serbia. Hence, our finding indicates that land locking could be a constraint for regional exporting activity in the case of a non-border region.

Human capital indices, the share of tertiary education students as a percentage of regional population and the logarithm of employment in high technology sectors, were found statistically significant and positive but they differ in size. In particular, the elasticity of the employment in high tech sectors is 0.164 (table 4, mode 5) while, using the means in the mode 5 of table 4, the elasticity of the share of tertiary

education students as a percentage of regional population is 0.47. It appears that the overall education level is more important in explaining the regional exports variation because its effects are spread throughout all exporting sectors and not only in high tech sectors.

The estimated coefficient of the entropy index is statistically significant and positive in all but modes 2 and 3. The estimated coefficient of the urbanization index is also positive and strongly statistically significant in all modes.

However, the interaction term introduced entails that the partial marginal effect of the urbanization index depends on the values of the *ENTROPY* index and *vice versa*. The partial derivative of the depended variable *LEXP* with respect to *HURBAN* is:

$$\frac{\partial LEXP}{\partial HURBAN} = \hat{a}_2 + \hat{a}_9 \cdot ENTROPY \qquad (2)$$

Since our interest is the sign over a range of the *ENTROPY* index, there is no need to estimate the value of partial marginal effect and we proceed with the sign of (2). To be more precise about the effect of urbanization of regional population on regional exports we can use direct tests to determine the critical values of the *ENTROPY* above (below) which an increase in *HURBAN* guaranties a positive (negative) effect on exports.

According to Fieller's theorem, since $\hat{a}_2$ and $\hat{a}_9$ follow a normal distribution, the distribution of a linear combination of normally distributed random variable is itself normal that is $(\hat{a}_2 + \hat{a}_9 \cdot ENTROPY) \sim N(0,\sigma^2)$ (BEYENE and MOINEDDIN, 2005)

where $\sigma^2 = (Var(\hat{a}_2) + 2Entropy \cdot Cov(\hat{a}_2, \hat{a}_9) + Entropy^2 Var(\hat{a}_9))$

According to Hirschberg and Lye (2005; 2007) for $w^*=\frac{\hat{a}_2}{\hat{a}_9}$, where *w* stands for *ENTROPY*, the upper and lower critical values of a 100(1-a) % confidence interval are the roots of the quadratic equation $kw^2+2lw+c$ where:

$$k=\hat{a}_9-t_{a/2}^2 Var(\hat{a}_9)$$

$$l=-(t_{a/2}^2 Cov(\hat{a}_2,\hat{a}_9)-\hat{a}_2\cdot\hat{a}_9)$$

$$c=\hat{a}_2-t_{a/2}^2 Var(\hat{a}_2)$$

To be more precise about the effect of urbanization of regional population (*HURBAN*) on regional exports, we can use direct tests to determine the critical values (c_U and c_L) of the *ENTROPY* above (below) which an increase in urbanization guaranties a positive (negative effect) on exports. If *ENTROPY* is between c_U and c_L, the sign of $\frac{\partial LEXP}{\partial HURBAN}$ is uncertain or its value is zero. Using the estimations of the mode 5 of table 4, we found the two roots, $c_U=r_1=0.702$ and $c_L=r_2=-1.443$. These values suggest that the partial derivative is 0 for *ENTROPY* values between -1.443 and 0.0702, negative for *ENTROPY* values greater than 0.0702 and positive for Entropy values less than -1.443. However, only the values greater than 0.0702 overlap the actual range of the *ENTROPY* index since the *ENTROPY* takes positive values only. Thus, we can conclude that the effect of urbanization of regional population on exports is negative for values of *ENTROPY* greater than 0.0702. This finding suggests that the impact of urbanization on exports is positive but its effect is reduced with the increase of the diversity of regional economic activity.

The partial marginal effect of the *ENTROPY* index depends on the values of urbanization index:

$$\frac{\partial LEXP}{\partial ENTROPY} = \hat{a}_1 + \hat{a}_9 \cdot HURBAN \qquad (3)$$

To be more precise about the effect of diversity (*ENTROPY*) on regional exports we can use direct tests to determine the critical values (c_U and c_L) of the *HURBAN* above (below) which an increase in diversity guaranties a positive (negative effect) on exports. If *HURBAN* is between c_U and c_L, the sign of $\frac{\partial LEXP}{\partial ENTROPY}$ is uncertain or its value is 0. Applying the above methodology in the results of mode 5, we estimated the roots $c_U = r_1 = -0.67$ and $c_L = r_2 = 0.074$. Hence, if the urbanization index is smaller than $c_L = -0.067$ the total impact of diversity on exports is positive. On the other hand, if the urbanization index is greater than $c_U = 0.074$ the total impact of economic diversity is negative. These values suggest that the partial derivative is 0 for *HURBAN* values between -0.067 and 0.074, negative for *HURBAN* values greater than 0.074 and positive for *HURBAN* values less than -0.67. However, only the values greater than 0.074 overlap the actual range of the urbanization index since the *HURBAN* takes values between 0 and 1. Thus, we conclude that the effect that effect of diversity (*ENTROPY*) on exports is negative for values of *HURBAN* greater than 0.074. Thus, the impact of diversity of regional economic activity decreases with the size of regional urbanization.

The above analysis with regards to the impact of interaction on partial derivatives suggests that the diversification and urbanization move at the opposite direction. The effect of urbanization decreases with the increase in diversity of the regional economic activity and the impact of diversity decreases with the rise in urbanization. Hence, in the case of Greek regions and the specific period examined, in the regions which are highly urbanized the agglomeration economies on exports are passing through low diversity that is in few sectors which probably exhibit comparative

advantages in international markets. We conclude that Greek regional exports are better explained be the *localization economies* rather than *Jacobs/urbanization economies*. In big cities, the labor pool is higher than in the less urbanized areas and the transaction costs of inputs acquisition is lower. On the other hand, in regions with small urbanization rates the labor market pool is smaller, the specialized labor pool is also smaller, and the existence of high transaction costs in inputs market is higher due to communication and transportation costs. Hence, due to these costs, large sectors are usually concentrated in highly urbanized areas while in the less urbanized areas the economic activity consists of small diversified sectors.

For a further robust check, we replaced our original entropy diversity measure by the alternative, HHI. We note that the relation between entropy and HHI index is negative. Hence, the expected sign for the estimated coefficient is negative, that is when diversity increases the exports increase. Table 5 reports the estimated model using the HHI for regional sectoral diversity. We, again, present 5 modes. For these modes, the Hausman test suggests the use of the Random Effects (RE) methodology and, therefore, we only report the Random Effects (RE) estimations. The overall performance is quite good with mode 4 showing the best performance among all. Hence, we proceed to the discussion of the individual parameters estimations.

Insert Table 5

As it can be seen from table 5, in comparison with table 4, the alternative diversity measure leads to marginal changes in the control variables and the urbanization variable, while the estimated coefficient of the HHI has the correct negative sign even

though the coefficient of the HHI deviates from the coefficients of the entropy index. This deviation is due to the fact that HHI ranges from 0 to 1, while the entropy index ranges from 0 to *ln(n)*. We also attribute the deviation between the two diversity measures to the fact that the entropy index is richer in information about the diversity of the regional economic activity than HHI, as discussed previously.

The agglomeration variable (*HURBAN*) is also statistically significant, indicating the importance of the agglomeration economies on exports. The interaction terms, however, between agglomeration economies and sectoral diversity is not statistically significant.

Finally, the estimated coefficients of the control variables are the same as in table 4 with the exception of the variables used for the human capital, the share of tertiary education students as percentage of regional population and the logarithm of the employment in high technology sectors. In these modes the human capital is statistically significant, at least at 5% level of significance, with positive sign indicating that the higher the human capital in a region, the higher the regional export activity.

4. CONCLUSIONS AND POLICY IMPLICATIONS

Literature has followed two main tracks relative to agglomeration impacts on economic and consequently exporting activity. If an industry is subject to Marshall's *localization economies*, producers tend to cluster together mostly in few cities specialized in trade goods production contributing to the international competitiveness of firms. On the other hand, if an industry is subject to *Jacobs/urbanization economies*, to prosper it need to be in a more divers and larger local environment.

Aim of this paper was to test for the significance of the two tracks using data for the 13 regions of Greece, for the period 1998-2007. Our empirical analysis suggests that the impact of diversity decreases along with the increase in urbanization levels. Hence, our results imply the presence of *localization economies* rather than *Jacobs/urbanization economies* in the case of highly urbanized regions while in less urbanized regions it seems that diversity is a more pro-exports production structure. As Boschma and Iammarino (2009) point out exporting occurs in almost all manufacturing industrial sectors and as in less urbanized regions the economic activity consists of small diversified sectors the variety-based trade is developed. On the other hand, in the urbanized regions of Greece industrial specialization seems to be more pro-exports production structure. The significant shares of industrial sectors such as pharmaceuticals, chemicals and petroleum products in Greece's exports suggest the existence of exporting infrastructure (e.g. ports, public administration facilities) which usually exists in highly urbanized regions. Hence, specialization is associated with high urbanization because of the lower exporting cost.

Our empirical findings have significant policy implications for the local, regional, national and supra-national (European Union) industrial policy. President Obama and European Union leaders have declared that export's development should emerge as the core strategic issue in order to ensure the long term economic growth potential and improve the economic welfare. The existence of industrial districts may prove essential in the increase of regional exports supporting the Becchetti et al. (2007). Given the structural characteristics of the Greek domestic market, where the vast majority of the companies (94%) are very small and small enterprises (European Commission, 2009) and specialized to a certain degree, if organized in regional industrial districts, it could result in higher value added production and enhanced

exports. Hence, the establishment of regional and local industrial clusters in high urbanized regions may prove catalytic in the effort for export promotion. In addition, industrial and technological policy should establish mechanisms for the facilitation of knowledge spillovers between firms in the less urbanized regions.

References

Aitken B., Hanson G.H. and Harrison A.E. (1997), "Spillovers, foreign investment and export behavior", *Journal of International Economics*, 43, 103-132

Anderson M. and Johanson S. (2010), "Human capital and the structure of regional export flows", *Technology in Society*, DOI: 10.1016/j.techsoc.2010.07.006.

Audretsch D., Dohse D., and Niebuhr A. (2010), "Cultural diversity and entrepreneurship: a regional analysis for Germany", *Annals of Regional Science*, 45, 55-85.

Bauer P.W. and Eberts R.W. (1990), "Exports and regional economic restructuring", *Regional Science Perspectives*, 20, 39-53.

Becchetti l. and Rossi S.P.D. (2000), "The positive effect of industrial district on the export performance of Italian firms", *Review of Industrial Organization*, 16, 53-68.

Becchetti L., Panizza A. and Oropallo F. (2007), "Role of industrial district externalities in export and value-added performance: Evidence from the population of Italian firms", *Regional Studies*, 41, 601-621.

Beine M. and Coulombe S. (2007), "Economic integration and the diversification of regional exports: Evidence from the Canadian-US Free Trade Agreement", *Journal of Economic Geography*, 7, 93-111.

Beyene J. and Moinedin R. (2005), "Methods of confidence interval estimation of a ratio parameter with application to location quotients", *MBC Medical Research Methodology*, 5, DOI:10.1186/1471-2288-5-32.

Borschma R. and Iammarino S. (2009), "Related variety, trade linkages, and regional growth in Italy", *Economic Geography*, 85, 289-311.

Cronovich R. and Gazel R. (1998), Do exchange rates and foreign direct incomes matter for exports at the state level?" *Journal of Regional Science*, 38, 639-657.

Erickson R.A. and Hayward D.J. (1991), "The international flows of industrial exports from US regions", *Annals of the Association of American Geographers*, 81, 371-390.

Frenken K. (2004), *Entropy statistics and information theory*, in Hanush H. and Pyka A. (eds), "The Elgar Companion to Neo-Schumpeterian Economics", Edward Elgar: Cheltenham.

Frenken K., Van Oort, F. and Verburg, T. (2007), "Related variety, unrelated variety and regional economic growth", *Regional Studies*, 41, 685-697.

Fujita M. and Thisse J-F (1996), "Economics of agglomeration – cities, industrial location and regional growth", *Journal of the Japanese and International Economies*, 10, 339-378.

Gao T. (2004), "Regional industrial growth: evidence from Chinese industries", *Regional Science and Urban Economics*, 34, 101-124.

Gil S., Llorca R. and Martinez Serrano J.A. (2008), "Measuring the impact of regional export promotion: The Spanish case", *Papers in Regional Science*, 87,139-146.

Glaeser E.L., Kallal H.D., Scheinkman J.A., and Shleifer A. (1992), "Growth in cities", *The Journal of Political Economy*, 100,126-1152.

Granato M.F. (2008), "Regional export performance: First nature, agglomeration and destiny? The role of infrastructure", Downloaded from: http://www.caf.com/attach/17/default/FlorenciaGranato,Regional,export performance.pdf .

Grasjo U. (2008), "University-educated labor, R&D and regional export performance", *International Regional Science Review*, 31, 211-256.

Greenhalgh C., Taylor P. and Wilson R. (1994), "Innovation and export volumes and prices – a disaggregated study", *Oxford Economic Papers*, 46,102-135.

Henderson J.V., Kuncoro A. and Turner M. (1995), "Industrial development in cities:, *Journal of Political Economy*, 103,1067-1085.

Henderson J.V. (2003),Marshall's scale economies, *Journal of Urban Economics*, 53, 1-28.

Head K. and Mayer T. (2004), *The empirics of agglomeration and trade*, in: Henderson J.V. and Thisse J.F. (Eds), "Handbook of Regional and Urban Economics", vol.4, Elsevier B.V.

Hirschberg J. and J. Lye (2005), "Interactions in regressions", Department of Economics, The University of Melbourne, Research Paper no. 952.

Hirschberg J. and J. Lye (2007), "A reinterpretation of interactions in regressions" Department of Economics, The University of Melbourne, Research Paper no. 1015,.

Hodkinson A. (2008), "What drives regional export performance? comparing the relative significance of market determined and internal resource factors" , Australasian *Journal of Regional Studies*, 14, 27-51.

Jacobs J. (1969), The Economy of Cities. Random House: New York.

Jacquemin, A.P. and Berry, C.H (1979), "Entropy measure of diversification and corporate growth", *Journal of Industrial Organization*, 27, 359-369.

Koenig P., Mayneris F. and Poncet S. (2010), "Local export spillovers in France", *European Economic Review*, 54,622-641.

Krugman P. (1991), Geography and Trade, Leuven University Press and MIT Press.

Lado N., Martinez-Ros E. and Valenzuela A. (2001), "Explaining export regional involvement through marketing strategy: The case of Spanish companied exporting to Latin America", Business Economics Series.

Lozza E.C. and Galliano D. (2003), "Local spillovers, firm organization and export behaviour: evidence from the French food industry", *Regional Studies*, 37, 147-158.

Marschall A. (1920),Principles of Economics, MacMillan: London.

Matthee M. and Naude W. (2007),"The determinants of regional manufactured exports from a developing country", WIDER, United Nations University Research Paper no. 2007/10.

Nicolini R. (2003), "On the determinants of regional trade flows", *International Regional Science Review*, 26,447-465.

Parr J.B., Hewings G.J.D., Sohn J., and Nazara S. (2002), "Agglomeration and trade: Some additional perspectives", *Regional Studies*, 36, 675-684.

Radelet S and Sachs J. (1998),"Shipping costs, manufactured exports, and economic growth",downloaded from:http://admin.earth.columbia.edu/sitefiles/file/about/director/pubs/shipcost.pdf.

Rosenthal S.S. and Strange W.C. (2003), "Geography, industrial organization, and agglomeration". *Review of Economics and Statistics*, 85, 377-393.

Rosenthal S.S. and Strange W.C. (2004),*Evidence on the nature and sources of agglomeration economies*, in Henderson J.V. and Thisse J.F. (Eds), "Handbook of Regional and Urban Economics", vol.4, Elsevier B.V.

Sun H. (2001), "Foreign direct investment and regional export performance in China", *Journal of Regional Science*, 41, 317-336.

Varsakelis N.C. (2007),*The economy of Florina prefecture*, in Koliopoulos I. and Michailidis I. (Eds), "Florina Prefecture: A Tomography", Society of Macedonian Studies Editions: Thessaloniki.

Varsakelis, N.C. (2009),*The economy of Kastoria prefecture*, in Koliopoulos I. and Michailidis I. (Eds), "Kastoria Prefecture: A Multidisciplinary Analysis", Society of Macedonian Studies Editions: Thessaloniki.

Zinnes C., Eilat Y. and Sachs J. (2001), "The gains from privatization in transition economies: Is "change of ownership" enough?", *IMF Staff Papers*, 48 (Special Issue), 146-170.

Wooldridge (2002). Econometric Analysis of Cross-Section and Panel Data, MIT Press: Cambridge MA.

Wu Y. (2007), Export performance in China's regional economies, *Applied Economics*, 39, 1283-1293.

TABLE 1- *Some Stylized Facts*

Region-NUTS II	*Regional GDP per capita (a)*	*Regional GDP (b)*	*Active Population (1000)*	*Exports' Share in National Exports*	*Island Region*
East Macedonia and Thrace	11081.82	6715.95	260.25	0.04	NO
Central Macedonia	13200	25096.36	807.45	0.26	NO
Western Macedonia (c)	13436.36	3953.50	120.51	0.02	NO
Thessalia	12318.18	9083.46	315.45	0.04	NO
Ipeiros	12018.18	4115.23	140.51	0.01	NO
Ionian Islands (d)	13336.36	2913.65	96.17	0.00	YES
Western Greece	10745.45	7852.82	299.53	0.02	NO
Sterea Ellada	16209.09	9044.76	239.28	0.05	NO
Peloponnisos	13254.55	7921.65	263.60	0.07	NO
Attika	20727.27	82276.15	1720.46	0.44	NO
North Aegean (d)	11763.64	2388.46	74.35	0.01	YES
South Aegean (d)	17109.09	5152.65	127.74	0.00	YES
Crete (d)	14609.09	8741.17	274.20	0.02	YES

Notes: Source Eurostat, Regional Year Average. (a) in euros, (b) millions of euro, (c) Land locked region, (d) island regions.

TABLE 2 - *Descriptive Statistics*

	MEAN	**St.DEV**	**MIN**	**MAX**
LEXP	12,48	1,41	9,42	15,46
LGDP	8,72	0,67	7,51	11,41
LGDPCAP	9,43	0,19	9,08	10,04
*HURBAN * ENTROPY*	1,18	0,63	0	3,7
LandLOCK	0,08	0,27	0	1
ISL	0,33	0,47	0	1
TERTSHARE	0,16	0,04	0,09	0,29
HURBAN	0,43	0,12	0,25	0,95
ENTROPY	2,63	0,95	0	3,89
HHI	0,26	0,2	0,047	1
LEM	2,09	0,69	0,05	3,55
*HURBAN*HHI*	0,1	0,68	0,026	0,35

Note: *LEXP* is the logarithm of the regional exports, *LGDP* is the logarithm of the regional GDP, *LGDPCAP* is the logarithm of the regional per capita GDP, *HURBAN * ENTROPY* is the interactive – synergetic affect between urbanization and sectoral diversity, *LandLOCK* is the dummy variable for the landlocked regions, *ISL* is the dummy variable for the island regions, *TERTSHARE* is the share of tertiary education student in total regional population, *HURBAN* is the urbanization index, the share of regional population living in urban areas, *ENTROPY* is the entropy index for regional sectoral diversity, *HHI* is the alternative index for regional sectoral diversity, *LEM* is the logarithm of the share of employment in high tech sectors over active population, and finally *HURBAN*HHI* is the interactive –synergetic effect between urbanization and regional sectoral diversity when *HHI* is used as an indicator for diversity.

TABLE 3 - *Correlations Matrix*

	LGDP	*LGDPCAP*	*HURBAN * ENTROPY*	*LandLOCK*	*ISL*	*TERTSHARE*	*HURBAN*	*ENTROPY*	*HHI*	*LEM*
LGDP										
LGDPCAP	0,33									
*HURBAN * ENTROPY*	0,83	0,19								
LandLOCK	-0,22	0,018	-0,15							
ISL	-0,46	0,21	-0,44	-0,07						
TERTSHARE	0,48	0,16	0,64	0,09	-0,32					
HURBAN	0,74	-0,083	0,85	-0,07	-0,37	0,42				
ENTROPY	0,625	0,4	0,79	-0,17	-0,38	0,5	0,36			
HHI	-0,58	-0,36	-0,71	0,07	0,41	-0,51	-0,31	-0,95		
LEM	0,66	0,24	0,51	-0,11	-0,53	0,14	0,34	0,49	-0,47	
*HURBAN *HHI*	-0,43	-0,42	-0,55	0,09	0,32	-0,13	-0,06	-0,91	0,95	-0,44

Note: *LGDP* is the logarithm of the regional GDP, *LGDPCAP* is the logarithm of the regional per capita GDP, *HURBAN*ENTROPY* is the interactive – synergetic affect between urbanization and sectoral diversity, *LandLOCK* is the dummy variable for the landlocked regions, *ISL* is the dummy variable for the island regions, *TERTSHARE* is the share of tertiary education student in total regional population, *HURBAN* is the urbanization index, the share of regional population living in urban areas, *ENTROPY* is the entropy index for regional sectoral diversity, *HHI* is the alternative index for regional sectoral diversity, *LEM* is the logarithm of the share of employment in high tech sectors over active population, and finally *HURBAN *HHI* is the interactive –synergetic effect between urbanization and regional sectoral diversity when *HHI* is used as an indicator for diversity.

TABLE 4 – *Estimation Results (Log of exports as dependent variable)*

Explanatory variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
ENTROPY	0.154*** (5.439)	0.043 (1.378)	0.028 (0.91)	0.30** (2.562)	0.304** (2.582)
HURBAN	3.282*** (4.180)	1.844*** (2.781)	1.073* (1.611)	4.244*** (3.402)	3.715*** (3.042)
LandLOCK		-0.43 (0.787)	0.0101 (0.019)	-0.451 (0.828)	-0.041 (0.078)
ISL		-1.779*** (5.272)	-1.408*** (4.367)	-1.755*** (5.224)	-1.412*** (4.349)
TERTSHARE		2.804** (2.198)	2.117** (1.907)	2.948** (2.348)	2.209** (2.018)
LGDP			0.580*** (3.606)		0.702*** (4.433)
LGDPCAP		0.398** (1.903)		-0.489** (2.334)	
LEM		0.140*** (0.884)	0.109** (2.034)	0.164*** (3.145)	0.111** (2.051)
*HURBAN*Entropy*				-0.729** (2.272)	-0.783** (2.428)
Constant	10.741*** (23.784)	6.966*** (3.775)	6.193*** (5.029)	5.051** (2.519)	4.753*** (3.375)
R2-adj.	0.61	0.81	0.87	0.81	0.86
Hausman test	$X^2(1)$= 3.26 *P-value*=0.19	$X^2(1)$= 4.89 *P-value*=0.18	$X^2(1)$= 1.95 *P-value*=0.58	$X^2(1)$= 0.008 *P-value*=0.92	$X^2(1)$= 0.06 *P-value*= 0.80

Note: Note: a) t-student in parenthesis. b) ***significant at the 0.01 level;** significant at the 0.05 level; * significant at the 0.1 level. *c) LEXP* is the logarithm of the regional exports, *ENTROPY* is the entropy index for regional sectoral diversity, *HURBAN* is the urbanization index, the share of regional population living in urban areas, *LandLOCK* is the dummy variable for the landlocked regions, *ISL* is the dummy variable for the island regions, *TERTSHARE* is the share of tertiary education student in total regional population, *LGDP* is the logarithm of the regional GDP, *LGDPCAP* is the logarithm of the regional per capita GDP, *LEM* is the logarithm of the share of employment in high tech sectors over active population, and, finally, *HURBAN*ENTROPY* is the interactive – synergetic affect between urbanization and sectoral diversity.

TABLE 5 – *Estimation Results (Log of exports as dependent variable)*

Explanatory variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
HHI	-0.641*** (4.635)	-0.173 (1.246)	-0.092*** (0.652)	-1.2 (1.513)	-1.29* (1.63)
HURBAN	3.89*** (4.869)	1.886*** (2.621)	1.22* (1.783)	1.456* (1.85)	0.674 (0.878)
*HURBAN *HHI*				3.004 (1.315)	3.506 (1.536)
LandLOCK		-0.636 (0.993)	-0.065 (0.121)	-0.661 (0.966)	-0.062 (0.115)
ISL		-1.974*** (4.803)	-1.475*** (4.469)	-1.965** (4.772)	-1.43*** (4.346)
TERTSHARE		2.906** (2.254)	2.079* (0.414)	2.991** (2.326)	2.243** (2.053)
LGDP			0.636*** (3.993)		0.671*** (4.187)
LGDPCAP		0.444** (2.122)		0.485** (2.300)	
LEM		0.092* (1.709)	0.085 (1.586)	0.114** (2.029)	0.111** (1.977)
Constant	11.034*** (24.300)	7.606*** (4.052)	6.397*** (4.98)	7.303*** (3.874)	6.179*** (4.803)
R2-adj.	0.59	0.75	0.85	0.75	0.86
Hausman test	$X^2(1)$= 0.03 *P-value*=0.86	$X^2(3)$= 2.155 *P-value*=0.54	$X^2(3)$=2.021 *P-value*=0.57	$X^2(2)$= 4.07 *P-value*=0.13	$X^2(2)$= 2.76 *P-value*=0.25

Note: a) t-student in parenthesis. b) ***significant at the 0.01 level;** significant at the 0.05 level; * significant at the 0.1 level *c) LEXP* is the logarithm of the regional exports, *HHI* is the alternative index for regional sectoral diversity, *HURBAN* is the urbanization index, the share of regional population living in urban areas, *LandLOCK* is the dummy variable for the landlocked regions, *ISL* is the dummy variable for the island regions, *TERTSHARE* is the share of tertiary education student in total regional population, *LGDP* is the logarithm of the regional GDP, *LGDPCAP* is the logarithm of the regional per capita GDP, *LEM* is the logarithm of the share of employment in high tech sectors over active population, and, finally, *HURBAN*HHI* is the interactive –synergetic effect between urbanization and regional sectoral diversity when *HHI* is used as an indicator for diversity.