Evaluating the Differences in the Greek Regional Productivity by Applying Shift-Share Analysis

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Abstract
The productivity level of a regional economy is associated with regional competitiveness reflecting indirectly the prosperity level of the region's inhabitants. Under this context, this paper studies the differences in regional productivity in Greece, by using a version of the Shift-Share analysis. The analysis is conducted on data on regional productivity, added value and labor employment, in different economic sectors, concerning records of the period 2005-2010. The further purpose of this paper is to examine the decomposition of regional productivity among the economic sectors and thus to illustrate the contribution of regional productivity by sector to the welfare map of the country. The Shift-Share analysis allows evaluating the differences of the regional labor productivity from the respective national by decomposing it into structural components and produces some interesting conclusions.

Keywords: Regional Development, Greek Regions, productivity, Shift-Share analysis

JEL classification: R11, R12, R15, R58

Introduction

The prosperity level in a region is closely and positively connected with some other regional economic sizes such as are, suggestively, the development, the competitiveness, the employment and the per capita income. Regional competitiveness suggests a regional economic variable that is strongly influenced by the average regional productivity and this allows considering regional productivity as an indirect measure of the effectiveness of the enterprises and further utilizing it for the assessment of regional competitiveness (Polyzos et al., 2007). Since regional productivity is influenced by structural changes in regional economy, the dynamics of the productive sector shares are related to economic growth, which, according to many scientists, is influenced by the changes in economy's sector composition. In addition, productivity is the most important factor determining the regional or national prosperity (Baumol et al., 1989).

Consequently, the productivity level might be seen as a measure of economic performance in many countries or regions, which is closely associated with economic growth and it is therefore important for regional economic analysis. Differences in productivity's performance across the regions of a country constitute an indirect measure of regional inequalities. A fundamental task of a regional policy is to reduce the "gap" of productivity either among regions or between regional and national terms (Polyzos et al., 2007). The increase in the level of regional productivity can guarantee a regional economic progress, since higher levels of productivity render more possible for regional firms to enjoy good prospects for higher profits and so to invest in new technologies, to create jobs opportunities and thus to pay more in wages and dividends (Alam et al., 2008).

Under economic terms, the productivity level shows the degree of the factors of production exploitation and therefore it indicates the level of the production capacity, of the organization and of the infrastructure of an enterprise, a sector or a region. Productivity can be defined as the rate of manufacture, of creation, or of delivery of a desired output or commodity, in relation to the inputs used to create the above outputs. In general, the productivity may be defined as the volumes ratio of the output to input use. In order to measure productivity at the regional level, we can use Added Value (AV) as a measure of regional economic activity or output and the corresponding working hours or the labor cost as a measure of the labor input, which is used to produce this output (Polyzos and Sofios, 2008; Polyzos et al., 2007). A positive change in productivity is achieved when a greater quantity of output is produced using the same level of inputs, or when the same output is produced using reduced quantities of the factors of production.

Productivity contributes considerably to the development of the wider issue of competitive advantage of each enterprise and region, because enterprises' viability in a competitive economic environment is tightly connected to the level of productivity and, vice versa, productivity is connected to the level of enterprise earnings. In their study, Polyzos et al. (2007) described the basic determinant factors of productivity per industrial sector in Greece and analyzed the relationship among them and the size of productivity. Their study elected an expected diachronic increase in productivity of economic sectors in Greece. Moreover, productivity changes were found not to be the same in all prefectures and, consequently, this fact seems to influence the size of regional development.

This paper studies the level of productivity's divergence per region in comparison with the corresponding national in Greece. The research hypothesis in this study is oriented to Fagerberg's (2000) work, under the difference that the application field refers to the Greek case. Consequently, the purpose of this paper is to measure the effect of differences among the Greek regions in both the sector-based structure and the structural change on productivity's growth. Dollar and Wolff (1993) support that the total convergence in the productivity can result from the convergence of productivity in sector-based level, due to the convergence in the sector-based shares of employment, which express the convergence in the sector-based structure of regional economies.

Further, this article examines the differences in the aggregate sectorial productivity, by using a version of Shift-Share analysis (Polyzos and Minetos, 2008) that decomposes aggregate productivity into a first component that expresses changes within the regions, a

second that expresses changes among regions and a third that expresses the covariance of change in shares and productivity growth. The mean divergence of labor productivity of each region in Greece is analyzed in accordance with the respective national productivity as also with their diachronic change for the period 2005-2010.

The remainder of this article is organised as follows: Section 2 describes the methodological framework of the Shift-Share model and the available data used for this analysis for the period 2005-2010. Section 3 presents and discuses the results of the analysis per component (expressing the share, the differential and the mix parameters) and evaluates the contribution of each component to the total model. Finally, Section 4 draws the conclusions, under the regional economic perspective and policy.

Methodology and Data

The Shift-Share Model

The differences between regional and national labor productivity are analyzed by using a version of the Shift-Share analysis. The Shift-Share analysis is based on the concept of decomposing a measure (resultant) into a set of components that further allows attaining structural information, through the examination of these components (Polyzos, 2011). Labor productivity, in a region *r* and at the time *t*, can be estimated by using the formula of relation (1), where $P_{r,t}$ expresses the Productivity in region *r*, at time *t*, *AV* expresses the Added Value and *E* the Employment, where *i* stands for the indicator of the Economic Sector in the summation operator.

$$p_{r,t} = \frac{AV_{r,t}}{E_{r,t}} = \sum_i \frac{AV_{ri.t}}{E_{r,t}} \quad (1)$$

Relation (1) may be further edited, by using a multiplication treatment, providing the equivalent relation (2).

$$p_{r,t} = \frac{AV_{r,t}}{E_{r,t}} = \sum_i \frac{AV_{ri.t}}{E_{r,t}} = \sum_i \frac{AV_{ri.t}}{E_{r,t}} \cdot \frac{E_{ri,t}}{E_{ri,t}} \quad (2)$$

For the measures *AV* and *E* the expressions of relation (3) stand.

$$AV_{r,t} = \sum_r AV_{ri.t}, \quad E_{r,t} = \sum_r E_{ri.t} \quad \text{and} \quad E = \sum_i \sum_r E_{ri.t} \quad (3)$$

Further, relation (2) may provide the equivalent relation (4), after introducing the zero terms $\pm \frac{E_{i,t}}{E_t}$ and $\pm \frac{AV_{i.t}}{E_{i,t}}$ into its right side.

$$\begin{aligned} P_{r.t} &= \sum_i \left(\frac{E_{ri,t}}{E_{r,t}}\right) \cdot \left(\frac{AV_{ri.t}}{E_{ri,t}}\right) = \\ &= \sum_i \left[\frac{E_{ri,t}}{E_{r,t}} + \left(\frac{E_{i,t}}{E_t} - \frac{E_{i,t}}{E_t}\right)\right] \cdot \left[\frac{AV_{ri.t}}{E_{ri,t}} + \left(\frac{AV_{i.t}}{E_{i,t}} - \frac{AV_{i.t}}{E_{i,t}}\right)\right] = \\ &= \sum_i \left[\left(\frac{E_{ri,t}}{E_{r,t}} - \frac{E_{i,t}}{E_t}\right) + \frac{E_{i,t}}{E_t}\right] \cdot \left[\left(\frac{AV_{ri.t}}{E_{ri,t}} - \frac{AV_{i.t}}{E_{i,t}}\right) + \frac{AV_{i.t}}{E_{i,t}}\right] \end{aligned} \quad (4)$$

Assuming that:

- the ratio $\frac{AV_{ri,t}}{E_{ri,t}} = p_{ri,t}$ expresses the labor productivity in region *r*, for the sector *i*, at time *t*,
- $\frac{AV_{r,t}}{E_{r,t}} = p_{r,t} = p_r$ stands for the labor productivity in region *r* for the total of sectors, at the time *t*,
- $\frac{E_{ri,t}}{E_{r,t}} = s_{ri,t}$ expresses the share of employment of sector *i*, in region *r*, at the time *t*, and
- $\frac{E_{i,t}}{E_t} = s_{i,t}$ stands for the share of employment of sector *i* in the total employment of the country, at the time *t*,

then the labor productivity p_r, for the region *r*, can be written as shown in relation (5).

$$p_r = \sum_i s_{ri}p_{ri} = \sum_i \left[(s_{ri} - s_i) + s_i\right].\left[(p_{ri} - p_i) + p_i\right] \quad (5)$$

Equation (5) is equivalent to relation (6), given that $\sum_i s_i p_i = p$.

$$(5) \Leftrightarrow p_r = \sum_i (s_{ri} - s_i)\cdot p_i + \sum_i (p_{ri} - p_i)\cdot s_i + \sum_i (s_{ri} - s_i)\cdot (p_{ri} - p_r) + p$$

$$\Leftrightarrow p_r - p = A + B + C \quad (6)$$

where $A = \sum_i (s_{ri} - s_i)\cdot p_i$, $B = \sum_i (p_{ri} - p_i)\cdot s_i$ and $C = \sum_i (s_{ri} - s_i)\cdot (p_{ri} - p_r)$.

Relation (6) stands for an expression of the Shift-Share model (Polyzos, 2011; Polyzos and Pnevmatikos, 2011), decomposing the divergence of the regional productivity into three components. Further, if diving both sides by *p*, relation (6) expresses percentage growth rates (Vijselaar and Albers, 2004).

The mathematical formula of the first component $A = \sum_i (s_{ri} - s_i)\cdot p_i$ calculates the sum of differences between regional and national shares in employment times the national productivity of each sector, for the total of the sector cases (i=1,2,…,n) and for a certain region *r*. As a result, this component of **productivity share** captures the effect of changes that is ought to the sector structure of each region. This term can be allocated in the effect of sector-based regroupings that exhaust the total of sectors.

The second component $B = \sum_i (p_{ri} - p_i)\cdot s_i$ calculates the sum of differences between regional and national productivity times the national shares of employment of each sector, for the total of the sector cases (i=1,2,…,n) and for a certain region *r*. In particular, the factor (p_{ri}-p_i) expresses the divergence of labor productivity for the certain sector in the region *r* in comparison with the national labor productivity for same examined sector.

The second component (*B*) expresses the effect in productivity caused by the peculiarities of each region and so it is called **differential** or **regional** or **local-factor effect**. According to Fagerberg (2000) the differential component measures the contribution of a regions'

productivity within the individual sector to the overall productivity's growth and, according to Vijselar and Albers (2004), this component can interpret the counterfactual productivity growth that is free of productive structural changes.

The third component $C = \sum_i (s_{ri} - s_i) \cdot (p_{ri} - p_r)$ calculates the sum of differences among pairs of regional and national shares in employment times the sum of differences between regional and national productivity. This component measures the effect of interactions between the previous two components *A* and *B*, that stands for the **productivity share** and the **differential effect** and it suggests the covariance of changes in shares and in productivity and concerning the sign of growth in share (positive or negative), which is associated with the productivity growth (dynamic shift effect).

The third component is so called **proportionality** or **mix effect**. Fagerberg (2000) observes that this component turns positive when the rapidly developing (in terms of productivity) sectors also increase their share in the total employment and thus it reflects the capability of a region to redistribute its resources into sectors having greater growth rates.

In relation (6), the two last terms in the right side provide the sum $\sum_i (p_{ri} - p_i) s_{ri}$. Therefore, the divergence of regional to national labor productivity is further decomposed into a pair of components, due to the mathematic expression of relation (7). As it can be seen in relation (7), the first component *A´*is equal to the corresponding first *A* of relation (6), *A=A´*, whereas relation's (7) second component *B´* embodies the respective two last components *B´=B+C* of relation (6).

$$p_r - p = A' + B' = \sum_i (s_{ri} - s_i) p_i + \sum_i (p_{ri} - p_i) s_{ri} \qquad (7)$$

Component *B´* in relation (7) calculates the sum of differences between regional and national productivity times the regional shares of employment of each sector, for the total of the sector cases (*i*=1,2,…,n) and for a certain region *r* and thus it expresses the contribution of a regions' productivity within the individual sector to, this time, the regional productivity's growth. In other words, this component expresses the **differentiation in the employment shares of one region that it is caused by this region's productivity specialization**.

Data

The available data in this study concern the variables of regional *Employment* (*E*), measured in number of thousand working people, and of the *Gross Added Value* (*AV*), measured in million Euros, in Greece. The data refer to records per Greek region and productivity sector for the six-year period 2005-2010. All Greek regions and productivity sectors considered in this study are presented in table 1.

Table 1: Regions and Productivity Sectors that are considered in the analysis

CODE	REGION	CODE	PRODUCTIVE SECTOR
R_1	East Macedonia and Thrace	i=1	Agriculture, forestry and fishing
R_2	Central Macedonia	i=2	Mining and quarrying, manufacturing, electricity, gas, steam, air conditioning and water supply, sewerage, waste management and remediation activities
R_3	West Macedonia		
R_5	Epirus		
R_6	Ionian Islands	i=3	Construction
R_7	West Greece	i=4	Wholesale and retail trade, repair of motor vehicles and motorcycles, transportation and storage, accommodation and food service activities
R_8	Central Greece		
R_9	Peloponnese		
R_{10}	Attica		
R_{11}	North Aegean	i=5	Information and communication
R_{12}	South Aegean	i=6	Financial and insurance activities
R_{13}	Crete	i=7	Real estate activities
		i=8	Professional, scientific and technical activities, administrative and support service activities
		i=9	Public administration and defense, compulsory social security, education, human health and social work activities
		i=10	Arts, entertainment, recreation, other service activities, activities of households as employers, undifferentiated goods and services producing activities of households for own use, activities of extraterritorial organizations and bodies

Results and Discussion

The Shift-Share analysis applied in this paper is based on the 3-component model described by relation (6) and on the 2-component model of relation (7). The changes in the regional productivity p_r-p are decomposed into three components, the **productivity share**, the **differential effect** and the **mix effects** component. The results of the analysis are shown in table 2 and they are further illustrated at the maps of figure 1, where each map represents the annual state of the Shift-Share components per Greek region, for the six-year period 2005-2010.

Table 2: Results of the Shift-Share analysis

RESULTANT (PRODUCTIVITY DIFFERENCES)

	Year					
Region	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
R1	-4621	-4709	-4775	-4833	-4803	-4679
R2	-4619	-4707	-4773	-4831	-4801	-4678
R3	-4609	-4698	-4764	-4822	-4793	-4669
R4	-4620	-4707	-4775	-4833	-4803	-4681
R5	-4620	-4709	-4776	-4835	-4806	-4682
R6	-4615	-4700	-4766	-4827	-4798	-4675
R7	-4620	-4707	-4775	-4833	-4805	-4682
R8	-4613	-4702	-4768	-4826	-4796	-4673
R9	-4620	-4707	-4774	-4834	-4804	-4679
R10	-4605	-4691	-4756	-4814	-4783	-4659
R11	-4616	-4703	-4770	-4825	-4796	-4674
R12	-4605	-4690	-4757	-4814	-4783	-4660
R13	-4618	-4705	-4772	-4829	-4799	-4675

COMPONENT A (PRODUCTIVITY SHARE)

Reg.	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
R1	-4618	-4706	-4772	-4830	-4800	-4676
R2	-4612	-4699	-4765	-4823	-4793	-4669
R3	-4616	-4703	-4770	-4828	-4799	-4673
R4	-4615	-4702	-4768	-4827	-4796	-4674
R5	-4617	-4705	-4772	-4830	-4801	-4677

R6	-4611	-4697	-4763	-4822	-4793	-4671
R7	-4618	-4705	-4771	-4829	-4800	-4677
R8	-4611	-4698	-4765	-4823	-4792	-4669
R9	-4619	-4707	-4774	-4833	-4803	-4679
R10	-4610	-4696	-4762	-4820	-4789	-4666
R11	-4616	-4703	-4769	-4825	-4794	-4672
R12	-4614	-4701	-4768	-4825	-4796	-4672
R13	-4615	-4702	-4767	-4823	-4795	-4674

COMPONENT B (DIFFERENTIAL EFFECT)

Reg.	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
R1	-282	-415	-385	-455	-417	-409
R2	-427	-545	-439	-435	-441	-530
R3	638	292	399	306	-33	-196
R4	-260	-221	-288	-346	-389	-519
R5	-483	-744	-673	-854	-853	-842
R6	443	574	534	241	25	-103
R7	-381	-445	-570	-643	-806	-818
R8	252	-24	-54	63	83	4
R9	-208	-218	-365	-402	-361	-409
R10	968	1059	1366	785	763	1015
R11	-55	57	-138	7	40	-111
R12	1105	1549	1225	1313	1552	1527
R13	-214	-146	-249	-115	30	169

COMPONENT C (MIX EFFECT)

Reg.	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
R1	279	412	383	452	414	407
R2	420	537	432	427	433	521
R3	-631	-287	-393	-299	38	200
R4	255	216	281	340	382	512
R5	481	740	669	849	848	837
R6	-447	-578	-538	-246	-31	100
R7	379	443	567	640	801	813
R8	-254	21	50	-66	-87	-7
R9	207	218	364	401	361	409
R10	-963	-1054	-1360	-778	-756	-1008
R11	55	-57	137	-8	-42	108
R12	-1097	-1539	-1215	-1302	-1539	-1515
R13	210	143	244	110	-34	-170

As it can be observed from table 1 and figure 1, all values of the productivity's changes (p_{ri}-p_i) in Greece are negative, indicating that in the total of cases the national productivity in Greece outperforms the corresponding regional. This observation may imply that none of the Greek regions posses a core role so as to determine the total productivity of the country or, alternatively, that the national level of productivity in Greece is being generated through an additive process, where all the Greek regions contribute somehow in order to produce a higher national result. It is probably noteworthy that, even in the case of Attica, which is the region having almost the half population of the country (Polyzos and Tsiotas, 2012), the regional productivity is not sufficient to overcome the corresponding national value.

Figure 1 also indicates that the contribution of the productivity share (component *A*) seems to be the most determinative component to the divergence of the regional productivity (p_{ri}-p_i). The contribution of the rest components (*B* and *C*) in the Shift-Share model seems to be negligible to the model, since their performance appears anti-symmetric and thus it is almost neutralized.

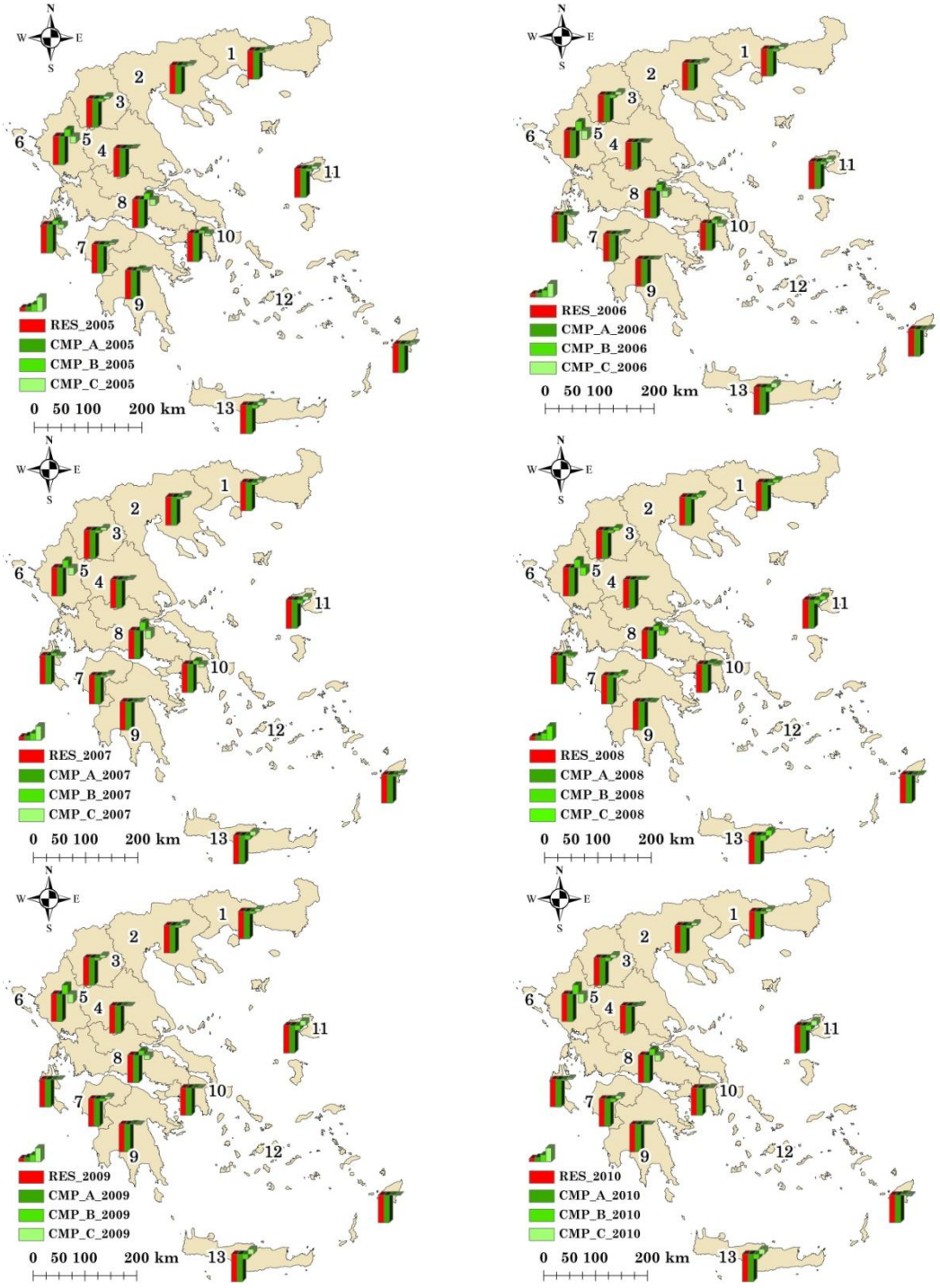

Figure 1: Annual results of the Shift-Share components per Greek region, for the period 2005-2010

For evaluating the contribution of each Shift-Share component to the model, the confidence intervals for the annual mean values of the Greek regional productivity differences ($\hat{\mu}_{t,p-p_r}$) are constructed, assuming that these differences (p_r-p) are homoscedastic (s_r=s, $\forall r \in \mathbf{X} \subset \square$) and that they can be described by the Student's distribution (Damianou, 2003; Burruss and Bray, 2005). These confidence intervals indicate the statistical range, where the respective theoretical mean values $\hat{\mu}_{t,p-p_r}$ can be detected, under a 5%

uncertainty. The formula used for constructing these confidence intervals is shown at relation (8), where $t_n(a)$ stands for the t-score of Student's distribution, $\hat{\mu}$ stands for the estimator of the mean value, m for the sample's mean value, n(=13) for the sample's size and LL,UL symbolize the Lower and Upper Limit values of the estimation in correspondence.

$$\hat{\mu}_{t,p-p_r} = [LL, UL] = \left[m_{t,p-p_r} - t_n(a/2) \cdot \frac{s_{t,p-p_r}}{\sqrt{n}} , m_{t,p-p_r} + t_n(a/2) \cdot \frac{s_{t,p-p_r}}{\sqrt{n}} \right] \quad (8)$$

The confidence level 1-a (Damianou, 2003; Burruss and Bray, 2005) in the analysis is chosen 1-a=0.95 (or 95%). For this confidence level, the t-distribution values, having degrees of freedom equal to the number of regions (n=13) and to the number of years for the period 2005-2010 (n=6), are in correspondence $t_{13}(0.025) = 2.160$ and $t_6(0.025) = 2.447$ (Damianou, 2003). The process of constructing an 95% confidence interval for the annual mean values of the regional productivity differences ($\hat{\mu}_{t,p-p_r}$) allows further estimating the contribution of each Shift-Share component to the model, by computing the distances among the values of each Shift-Share components and the $\hat{\mu}_{t,p-p_r}$ limits [LL,UL], as they were expressed in relation (8).

This procedure produces a table with the diachronic values of the annual contribution of each Shift-Share component, for the period 2005-2010, where a confidence interval can be constructed for the whole period 2005-2010 per component, indicating the total diachronic contribution of each Shift-Share component to the changes in productivity (p_r-p). Due to this process, it is resulted that the contribution of component *A* (productivity share) to the Shift-Share model ranges within the interval **99.86-99.93%**, of component *B* (differential effect) within **0.72-1.89%** and of component *C* (mix effect) within **0.73-1.88%**. These results verify the previous observation of the maps of figure 1, indicating that the productivity share (component A) appears to have the most determinative contribution to the changes of regional productivity (p_r-p).

Additionally, whether considering the expression of relation (7), the contribution of the two-component Shift-Share model terms can be similarly estimated, given that the components *A´* and *B´* can be equivalently expressed by the relations *A´=A* and *B´=B+C* in correspondence. Whether assuming that the components B and C are anti-symmetric (*B* □ *–C*), it results that the contribution of component *A´* to the Shift-Share model ranges within the interval **99.86-99.93%** and of the component *B´* within the interval **0-0.01%**.

The previous inferential statistical analysis, with the use of confidence intervals, allows applying a structural assessment to the decomposition of the regional productivity changes (p_r-p), for the period 2005-2010. The almost absolute contribution of the productivity share component (*A*) to the model implies that the shift in one region's total productivity from the respective national is ought to the pair of differences between regional and national employment (s_{ri} - s_i), considered for the total of the sector cases. This remark seems rational if comparing the summation products of all the Shift-Share components, where it is observed that only in component *A* the productivity factor appears in its entire form ($\cdot p_i$), since in all the other cases it concerns differences (p_{ri}-p_i or p_{ri}-p_r). In economic terms, this almost absolute contribution interprets that the effect of changes that is ought to the sector structure of each region determine

the amount of deviation in one region's productivity from the respective national.

For a further assessment of the decomposition terms of the Shift-Share total (p_r-p), the diagrams of figure 2 were constructed, showing the diachronic fluctuation of each Shift-Share component per Greek region, for the period 2005-2010.

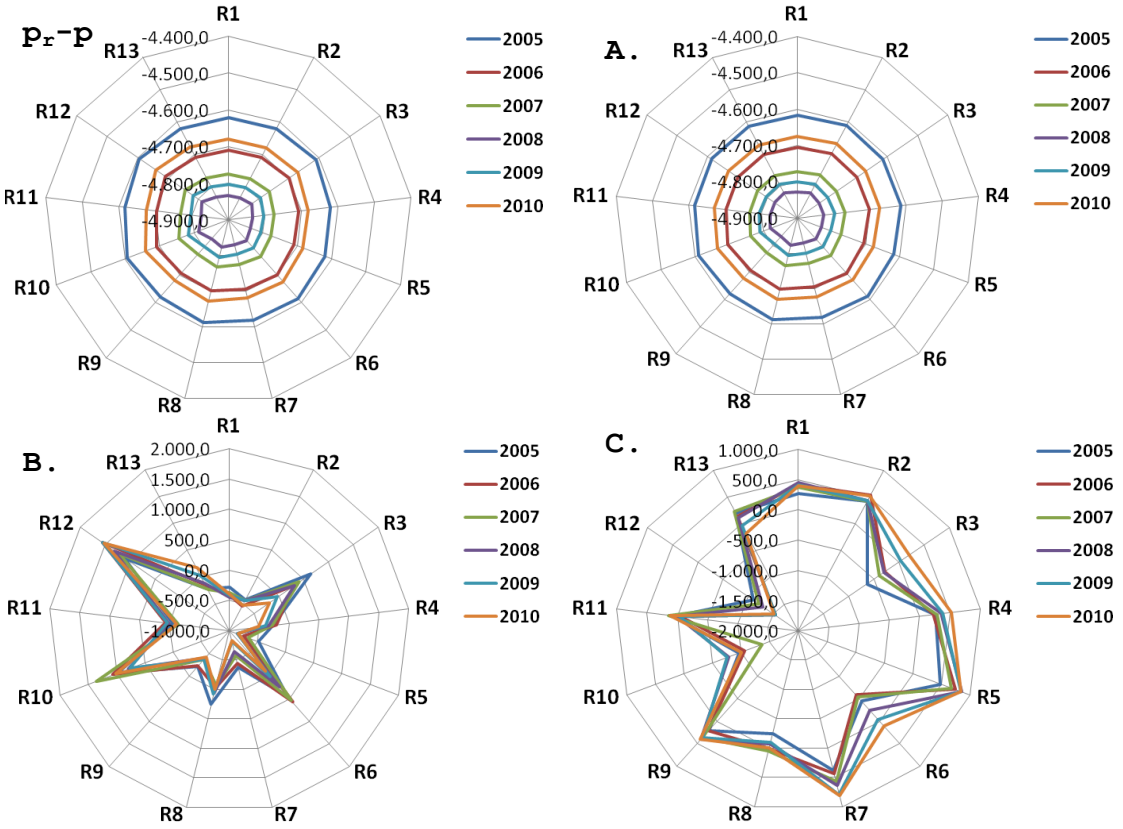

Figure 2: Arachnoids showing the diachronic fluctuation of each Shift-Share component per Greek region, for the period 2005-2010 (the cases *A,B,C* refer to the respective Shift-Share components and the term p_r-p represents the productivity changes)

The first pair of diagrams of figure 2, first of all, spot the previously detected similarity between the graph of differences in productivity (p_r-p) and the graph of the component *A* (productivity share). This pair of diagrams also indicates the existence of an inconsiderable variability in the interregional fluctuations of the differences p_r-p and of the first Shift-Share component (*A*). Both arachnoids appear an almost identical picture consisting of homocentric polygons (made of 13 vertices), where their canonical shape represents the existence of an interregional homogeneity.

On the other hand, the next pair of diagrams in figure 2, consisting of the cases of the Shift-Share components *B* and *C*, presents a considerable interregional variability. Although the contribution of these components to the model may be considered as latent, since their pair contribution is neutralized, whether regarding them as a unity component B´=B+C due to relation (7), the interpretation of their bipolar performance may provide useful evidence for the regional local dynamics and for the interregional interaction potentials. A clearer picture of the anti-symmetric performance of this pair of components (*B* and *C*) can be shaped in figure 3, where the diachronic fluctuation

of the Shift-Share components *B* and *C* is shown, per Greek region and for the period 2005-2010.

Figure 3: Diagrams showing the diachronic fluctuation of Shift-Share components *B* and *C* per Greek region, for the period 2005-2010

As a further part of the analysis, the diagrams of figure 4 were constructed, showing the diachronic fluctuation of the interregional mean values ($\mu_t = \frac{1}{n} \cdot \sum_n x_{r,t}$) of the Shift-Share total (p_r-p) and of the three components *A*, *B* and *C*, for the period 2005-2010.

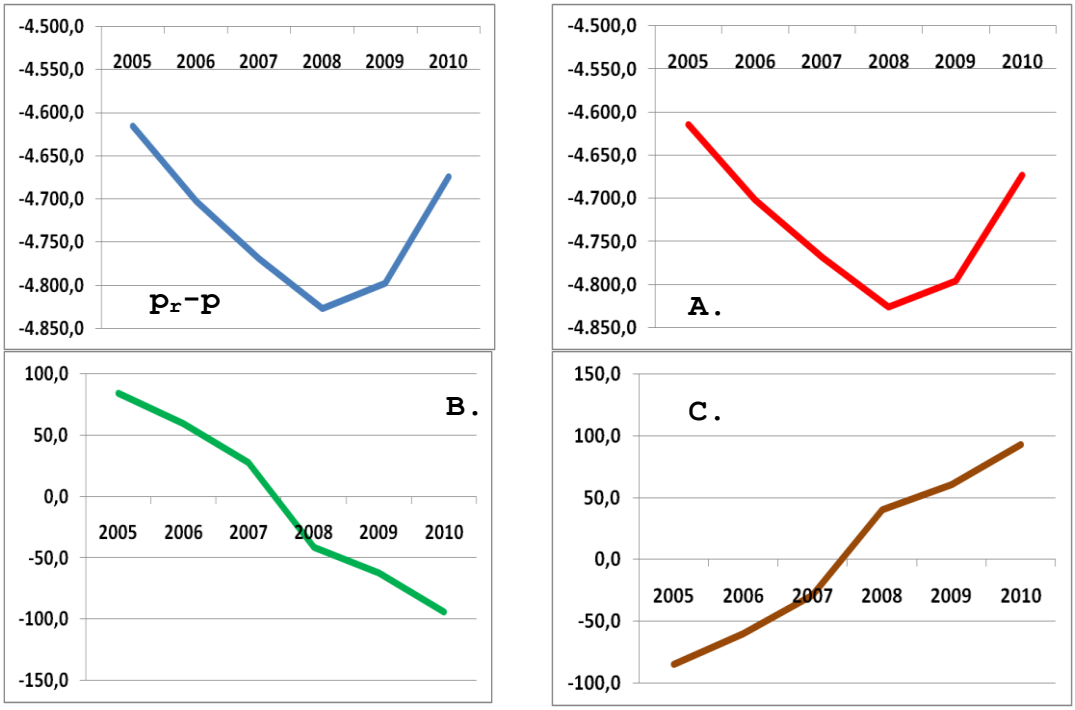

Figure 4: Diachronic fluctuations of the interregional mean values of the Shift-Share terms p_r-p, component *A*, component *B* and component *C*, for the period 2005-2010

The first pair of diagrams (p_r-p and component *A*), first of all, verifies the almost identical performance of these Shift-Share terms that was also previously detected. Further, this pair of diagrams illustrates that the respective Shift-Share terms (p_r-p and component *A*) appear to follow a U-shaped curve into their diachronic process. As it is shown in figure 4, at the period 2005-2008 both these Shift-Share terms have presented a decreasing diachronic process, which was overruled at the next period 2008-2010 and turned increasing. In

Algebraic terms, the diachronic curves of this pair of Shift-Share terms presented a local minimum at the year 2008, for the period 2005-2010, following a decreasing process the period before and increasing one the period after.

Moreover, whether interpreting this observation in conjunction with the fact that Greece started to be influenced by the world economic crisis at the year 2008, then the increasing overturn in both the productivity differences (p_r-p) and the regional productivity share (component *A*) comes to an agreement with the theoretical background saying that **regional inequalities** (Tsiotas and Polyzos, 2012) **converge during the periods of economic crisis** (Petrakos and Psicharis, 2004; Polyzos, 2011).

The second pair of diagrams (components *B* and *C*) in figure 4 verifies the anti-symmetric performance of the Shift-Share local (*B*) and proportionality effect (*C*) components. The diachronic process of component B is presented to be decreasing at the period 2005-2010 and the respective of component C increasing. The decreasing curve of component *B* indicates that the local specialization of the Greek regions weakens through time.

This observation may attain an interpretation in terms of the Greek economic crisis, which for many academics and politicians is considered as a systemic crisis of the European bank system, under the consideration of the previous statement that regional inequalities converge during the periods of economic crisis. This convergence in the regional inequalities may operate as a compression mechanism to the endogenous trends, which tries to differentiate the productivity dynamics of a region resulting to the weakening of its local specialization performance.

Additionally, the decreasing diachronic process in the diagram of the second Shift-Share component (*B*), in figure 4, does not seem to present a considerable variability in the year 2008, where Greece started to be influenced by the previous worldwide, probably due to the existence of a pre-crisis period that may cover the diachronic range of 2005-2008. Such an assertion may be rational, whether considering that Greece faced a considerable deflation in the economic sector of constructions at the meta-Olympic Games (Athens 2004) period.

On the other hand, the increasing diachronic process in the diagram of the third Shift-Share component (*C*), in figure 4, implies according to Fagerberg (2000) the existence of rapidly developing (in terms of productivity) sectors that increase their share in the total employment and thus reflecting the capability of some regions to redistribute their resources into sectors that have greater growth rates. This assertion may imply that the meta-Olympic period in Greece favored the redistribution of the regional productivity into these sectors having high national growth rates and thus not to these electing the local specialization dynamics.

Finally, given that the contribution of the second and the third component is pairwise negligible, it may be asserted that the loss in the local specialization was resonated with the proportionality effect in a way that the productivity effects to be mutually retracted. A considerable perhaps point in the diachronic process of this pair of curves (*B* and *C*), in figure 4, is the intersection point of these curves, located in the middle of the year 2007-2008, where the interregional mean values of the components *B* and *C* are zero.

Conclusions

This paper studied the differences of regional productivity in Greece, by using a version of the Shift-Share analysis. The available data concerned records on regional productivity, on added value and labor employment, per economic sector, for the period 2005-2010. The analysis was based on the decomposition attribute of the Shift-Share model, targeting to illustrate a structural picture of the Greek regional productivity, through the examination of each Shift-Share decomposition component.

One primary outcome of the foregoing Shift-Share analysis indicated that none of the Greek regions, not even Attica, occupies a central role so as to overstep the national rates in productivity and thus to determine the evolutionary patterns of productivity, at the scale of the country. This result implies that the national level of productivity in Greece operates additively, having all the regions to contribute positively into the national total.

At the decomposition part of the Shift-Share analysis it was elected that the contribution of the first component (productivity share) seems to be the most determinative to the model, where the presence of the second and the third components is mutually neutralized, producing latent results. The almost absolute contribution of the first component to the model implies that the differences in regional productivity, from the respective national, are ought to the differences in employment ($s_{ri} - s_i$), fact that sets the labor and consequently the social capital as the most significant determinative factors in the productivity map of the country.

Additionally, the second and the third components of the Shift-Share model presented an intense interregional variability in their diachronic (2005-2010) process. The case regarding the second component implies that the interregional productivity pattern in Greece is described by a considerable heterogeneity and thus by a local specialization, which is, unfortunately, eventually sharpened. In the case of the third component, the interregional variability implies the existence of a heterogeneous pattern describing different capability rates of the regions to redistribute their resources into sectors having greater growth rates.

Finally, the diachronic range of the available dataset allowed interpreting the results of the foregoing Shift-Share analysis in terms of the most significant recent events in the Greek economic History, such as are the meta-Olympic Games (Athens 2004) period and the forerunner period of the economic crisis, which was formally announced at the pre-election period in Greece at the fall of 2009. Consequently, it is obvious that the previous modern-economic historical events have let their imprints on the productivity foundation of Greece. The regional productivity differences moved decreasing after the year 2004, implying an uneven regional allocation of the dynamics in productivity, where the sudden increasing turnover in productivity differences at the year 2008, were the economy of Greece started to be influenced by the previous worldwide economic crisis, imply a convergence in regional inequalities, fact which comes to an agreement with the Regional theory.

References

Alam, A. Casero, P. Khan, F. Udomsaph, C. (2008), "Unleashing Prosperity Productivity Growth in Eastern Europe and the Former Soviet Union", The International Bank for Reconstruction and Development/The World Bank, Washington

Baumol, W. Batey-Blackman, SA. Wolff, E. (1989), "Productivity and American Leadership: the Long View", The Cambridge Massachusetts, MIT Press

Burruss, G. Bray, T. (2005), "Confidence Intervals", *Encyclopedia of Social Measurement*, **1**, 455-462

Damianou, C. (2003), *An introduction to Statistics, Part I*, Athens, Greece, Symmetria Publications [in Greek]

Fagerberg, J. (2000), "Technological progress, structural change and productivity growth: a comparative study", *Structural Change and Economic Dynamics*, **11**(4), 393-411

Petrakos, P. Psicharis, G. (2008), *Regional Development in Greece*, Athens, Greece, Kritiki Publications [in Greek]

Polyzos S. Minetos D. (2008), "Structural Change and the Productivity Growth in Greek Regions", *Proceedings of 4th International Conference of ASECU on Development Cooperation and Competitiveness*, Bucharest Academy of Economic Studies, May 2008, Bucharest, Romania, 462-473

Polyzos, S. (2011), *Regional Development*, Athens, Greece, Kritiki Publications [in Greek]

Polyzos, S. Minetos, D. Sdrolias, L. (2007), "Productivity and spatial diffusion of technology in Greece: An empirical analysis", *Journal of International Business and Economy*, **8**(1), 105-123

Polyzos, S. Pnevmatikos, T. (2011), "Evaluation of Regional Inequalities in Greece by Using Shift-Share Analysis", *International Journal of Engineering and Management*, **3**(2), 119-131

Polyzos, S., Sofios, S., (2008) "Regional multipliers, Inequalities and Planning in Greece", *South Eastern Europe Journal of Economics*, **6(**1), 75-100

Polyzos, S. Tsiotas, D. (2012), "The Evolution and Spatial Dynamics of Coastal Cities in Greece", in Polyzos, S., (2012) (ed) *Urban Development*, Croatia, Intech Publications, 275-296 (ISBN: 978-953-51-0442-1)

Tsiotas, D. Polyzos, S. (2012), "The contribution of ANN's simple perceptron pattern to inequalities measurement in Regional Science", *Operational Research an International Journal*, DOI 10.1007/s12351-012-0123-0

Vijselaar, F. Albers, R. (2004), "New Technologies and Productivity Growth in the Euro Area", *Empirical Economics*, **29**, 621-646