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PROSPECTS OF CHANGES IN REGIONAL ECONOMIC STRUCTURES SINCE EU ACCESSION

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Abstract

In recent years, the European Union (EU) has expanded by including two additional "less developed" new members, Bulgaria and Romania, and in the near future several other neighboring countries are on the list. The case of the region of East Macedonia and Thrace, a remote region that neighbors Bulgaria, might offer some insights into the changes which will occur in the economy of these new EU members. Changes in the structure of the regional economy are traced by estimated various indices of structural changes using two input-output tables, the 1980 I-O, a year before Greece's accession to EU, and the 1997 I-O, one and a half decade after the implementation of several EU supported programmes. The cause of structural changes cannot be identified by applying this methodology, only the final outcome in terms of sectoral structure. Results reveal that significant transformations took place in this regional economy altering the interdependence between producing and consuming sectors. It is not clear that this change has moved the whole regional economy to a more competitive level as highly supported sectors grew substantially.

JEL Classification: R100, R150, R580.

Key words. Greece, East Macedonia and Thrace, input-output analysis, structural change, regional development

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Introduction

The 1981 accession of Greece into the EU inflated the future prospects for spectacular growth and transformation for remote and less developed regions in this country. These expectations are paralleled in today's expectations of new EU members, Bulgaria and Romania, and several other Balkan countries on the waiting list. These aspirations witnessed throughout the Balkan region provided the impulse to investigate the structural changes occurring in a Greek region, East Macedonia and Thrace, neighboring Bulgaria, fifteen years after the area's inclusion in the EU. Structural changes are viewed here under an Input-Output (IO) framework.

The terms "structural" and "technological" change overlap to some extent in the IO literature. Probably the best resolution of the ambiguity induced by this term is owed to Carter (1970), who refers to "technological" change as replacement of one production process by another and "structural" change as a change in input requirements, new products, and the relative size of sectors within an economy. Nevertheless, the identification of methods that measure sectoral interconnectedness is crucial as development planners prefer to expand sectors with extensive interindustry ties, rather than those with weak interindustry connections (Diamond 1974). The IO approach is particularly well-suited to the analysis of structural changes, given its disaggregated nature and its attention to tracing intersectoral connections (Rose and Miernyk 1989).

In this context, the objective of this paper is the intertemporal analysis of structural changes in the regional economy of East Macedonia and Thrace, a NUTS 2 less developed area in Greece. This is accomplished by a comparison of the 1980 and 1997 regional IO tables and the computation of various IO indicators which reflect structural change. A widely used hybrid technique, the so-called Generation of Regional Input-Output Tables (GRIT) procedure (Jensen, Mandeville and Karunarante 1979), is employed to generate regional IO information. The choice of the East Macedonia and Thrace study region for this analysis is justified by the fact that several of its structural and developmental characteristics in the early 1980s resemble the current situation in the adjacent Bulgaria; thus, an investigation of structural changes in this region might offer useful insights into the changes which could occur in the economy of Bulgaria after its accession to the EU. Consequently, the choice of 1980 as the base-year for this analysis is justified by the need to account for study-region structural characteristics before the country's accession into the EU (i.e. 1980); in a rather similar manner, the choice of 1997 as the "second" base-year (and not of the more recent 2000 and 2005, for which Greek national IO tables are available) is justified as follows: first, the choice of 1997 ensures that structural change investigated here is associated with a rather satisfactory (in terms of its length) period of 17 years, during which all EU institutional and policy "environment" has been fully applied in Greece; second, more recent Greek IO tables were constructed through the use

of ESA 95 and thus a comparison of tables built under different accounting systems would have given rise to an incompatibility problem; finally, unlike the 1980 Greek IO table which is expressed in Greek Drachmas, more recent ones (i.e. 2000, 2005) are expressed in Euros, something that would complicate comparisons.

The paper is organized as follows: the next section describes the GRIT technique adopted in the construction of regional tables, followed by a presentation of the several measures and indicators, employed here to investigate structural changes. Then the results of the analysis are presented, ending with the main conclusions and policy implications.

Theoretical framework

Regional input-output modelling

Isard (1951, 1953) and Leontief (1953) were the first scholars who sought regional extensions to the IO model. From the early days of these efforts, the high cost of obtaining the necessary regional data through survey methods forced researchers to develop short-cut or non-survey methods which facilitate the construction and use of regional IO tables without incurring prohibitive costs. Applications of regional IO analysis are provided among others by Miernyk *et al.* (1967), Schaffer (1976), Sawer and Miller (1983), Karunarante (1989), Midmore (1993), and Tzouvelekas and Mattas (1995). The terms "survey" and "non-survey" suggest the existence of two well-defined and mutually exclusive groups, but in practice, most of the IO tables are "hybrid" ones, constructed by semi-survey techniques, employing primary and secondary sources, to a greater or lesser extent (Round 1983). One of those techniques, extensively used, is the Generation of Regional Input-Output Tables technique (Johns and Leat 1987).

The GRIT technique, developed by Jensen, Mandeville and Karunarante (1979), was originally applied to the production of the IO tables for the regions of Queensland, Australia, from both national IO tables and other sources. It is based on a combination of non-survey methods, but allows modifications of mechanically produced tables at the discretion of the analyst, to produce more accurate regional tables. The GRIT method estimates the flows of regional intermediate demand by applying the employment-based Cross Industrial Location Quotient (CILQ) to corresponding elements of the national matrix. After deriving initial estimates of regional technical coefficients, the GRIT procedure permits the insertion of superior data, where appropriate (an issue judged by the discretion of the analyst), to replace mechanically derived estimates. The superior data may come from survey data, published statistics and other sources (Johns and Leat 1987, Psaltopoulos and Thomson 1993, Psaltopoulos 1995). As noted by Tohmo (2004) other adjustment formulas such as the FLQ (Flegg *et al.*, 1995) can also be applied for the mechanical regionalization of national

IO tables. However, as in several other studies which used GRIT (indicatively, Johns and Leat 1987; Psaltopoulos *et al.* 2004), the CILQ method was chosen here.

Measures of structural changes

IO analysis has been extensively employed to compare the structure of production over time and across countries. Rasmussen (1956) used an IO model in measuring changes in the structure of production in Denmark between 1947-1949. In this seminal study he proposed a method for the measurement of sectoral linkages using the open static IO model. Chenery and Watanabe (1958) used IO tables for Finland, Italy, Japan and the USA, to compare the structure of production in these countries, and revealed the existence of similar structural patterns. Simpson and Tsukui (1965) used the US 1947 and Japanese 1955 IO tables in comparing production structures. Yan and Ames (1965) developed a new method of measuring structural change in the US economy between 1919-1929. Carter (1970) studied structural changes in the US economy between 1939-1961 by measuring changes in the input coefficients and Staglin and Wessels (1972) examined intertemporal structural changes in the German economy.

After a short lull in research interest in this area during the 1970s, interest in the study of structural change re-emerged in the 1980s. Several researchers focused their attention on the comparative analysis of the structure of production on a disaggregated sectoral level (Kubo 1985, Kubo *et al.* 1986a, 1986b). Relevant individual country studies include those of Skountzos (1980), who examined structural changes in the Greek economy between 1958-1970, Forsell (1988) who measured the structural changes in the Finish economy between the 1960s and the 1970s, and Urata (1988) who investigated intertemporal variations in the Soviet economy for the period 1959-1972. Also, Skolka (1989) examined structural variations in the Austrian economy and Lee (1990) studied structural changes in the US agricultural sectors during 1972-1982.

More recently, Sonis *et al.* (1996), Sonis and Hewings (1998), Cho, Sohn and Hewings (1999), Guo and Planting (2000) used new decomposition approaches (such as field of influence) to visually display structural changes, and thus provide a more comprehensive view of changes in economy over time. Finally, several structural change indices have been used by Skountzos *et al.* (2007) in the context of a study on the Greek economy. Among a wide range of indices employed in the above-mentioned studies, we here briefly described those applied in this study.

Linkage indices. A measure of structural change can be found by considering changes in the elements of the Leontief inverse matrix.[1] Thus, two indices, which can be used to describe an inverse matrix and in turn the changes in its elements, are defined as follows (Rasmussen, 1956):

$$U_{.j} = \frac{\frac{1}{n}\sum_{i=1}^{n} Z_{ij}}{\frac{1}{n^2}\sum_{j=1}^{n}\sum_{i=1}^{n} Z_{ij}} \quad (\mathrm{j} = 1, 2, \ldots, \mathrm{n}) \tag{1}$$

and

$$U_{i.} = \frac{\frac{1}{n}\sum_{j=1}^{n} Z_{ij}}{\frac{1}{n^2}\sum_{i=1}^{n}\sum_{j=1}^{n} Z_{ij}} \quad (\mathrm{i} = 1, 2, \ldots, \mathrm{n}) \tag{2}$$

where $U_{.j}$ is the index of power of dispersion and $U_{i.}$ is the index of sensitivity of dispersion. $U_{.j}$ and $U_{i.}$ are also measures of backward linkages and forward linkages, respectively.[2]

The index of power of dispersion describes the relative extent to which an increase in final demand of industry j is dispersed through the system of sectors. The meaning of $U_{.j}$ may also be explained by mentioning that the index shows the magni-

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1. Throughout this study the following notation is used. $A = \{\alpha_{ij}\} = \frac{X_{ij}}{X_j}$ is the direct requirements coefficient matrix which is also called the technical coefficients matrix, where X_{ij} is sector j's direct input from sector i, and X_j is total output of sector j; $Z = \{z_{ij}\} = (I - A)^{-1}$ is the total requirements matrix which is often referred to as Leontief inverse matrix.

2. The backward linkage of sector j would be given by the sum of the elements in the jth column of the total requirements matrix. Hence, $b_{.j} = \sum_{i=1}^{n} z_{ij}$, j = 1, 2, …, n, where $b_{.j}$ is the backward linkage of sector j and z_{ij} is the element of total requirements matrix. Similarly with the backward linkages the forward linkage for sector i is given by the sum of the elements in the ith row of the total requirements matrix. Hence, $b_{i.} = \sum_{j=1}^{n} z_{ij}$, i = 1, 2, …, n, where $b_{i.}$ is the forward linkage of sector i and z_{ij} was defined above.

tude of changes in the system of sectors, caused by a change in industry j. If $U_{.j} > 1$, then the impact of a unitary increase in the final demand of sector j draws heavily on the system of sectors. If $U_{.j} < 1$, then a unitary increase in the final demand of sector j will have relatively small impact on the system of sectors.

The index of sensitivity of dispersion indicates the extent to which a change in the system of sectors will affect sector i. If $U_{i.} > 1$, then a unitary increase in the final demand of the system of sectors will have bigger impact on sector i than on the other sectors (and vice versa in case of $U_{i.} < 1$).

There has been an extensive literature on the use of linkage indices to examine the structure and functioning of an economy; some authors have attempted to modify these indices, while others have been very critical of the whole approach (Cella 1984, Hewings *et al.* 1989, Soofi 1992).

The $U_{.j}$ and $U_{i.}$ indices are based on averages. Averages are sensitive to extreme values and may give misleading results. Consequently, these indices do not fully describe the structure of a particular sector. For instance, it is possible that an increase in final demand for the product of a particular sector, characterized by a high index of power of dispersion may not affect other sectors. Such a situation would arise if a particular sector draws heavily on only one or few industries.

To overcome this difficulty, the indices of coefficient of variation are used by Rasmussen (1956) as additional indices.[3] A high $V_{.j}$ can be interpreted as an index showing that a particular sector draws heavily on one or a few sectors and a low $V_{.j}$ shows that a sector draws evenly from the other sectors. The $V_{i.}$'s can be interpreted similarly.

Indices of concentration. To compare changes in the structure of production of the regional economy at two distinct points of time, the indices of concentration for sectoral transactions was proposed (Soofi 1992):

$$G_{.j}\left(b_{ij}\right) = \left[\max\left(V_{.j}\right) - V_{.j}\right]^{1/2} = \left[n\left(1 - \sum_{i=1}^{n} c_{ij^2}\right)\right]^{1/2} \text{ (j = 1, 2, …, n)}$$

3. The indices of coefficient of variation are defined as follows: $V_{.j} = \dfrac{\sqrt{\dfrac{1}{n-1}\sum_{i=1}^{n}\left(Z_{ij} - \dfrac{1}{n}\sum_{i=1}^{n} Z_{ij}\right)^2}}{\dfrac{1}{n}\sum_{i=1}^{n} Z_{ij}}$, j = 1, 2, …, n and $V_{i.} = \dfrac{\sqrt{\dfrac{1}{n-1}\sum_{j=1}^{n}\left(Z_{ij} - \dfrac{1}{n}\sum_{j=1}^{n} Z_{ij}\right)^2}}{\dfrac{1}{n}\sum_{j=1}^{n} Z_{ij}}$, i = 1, 2, …, n where V_{ij} is the backward index of variation, $V_{i.}$ is the forward index of variation and Z was defined before.

where $G_{.j}$ is the backward index of concentration, $V_{.j}$ is the backward index of variation and $c_{ij} = z_{ij}/b_{.j}$.

$$G_{.j}\left(b_{ij}\right) = \left[\max\left(V_{i.}\right) - V_{i.}\right]^{1/2} = \left[n\left(1 - \sum_{j=1}^{n} d_{ij^2}\right)\right]^{1/2} \quad (i = 1, 2, \ldots, n)$$

where $G_{i.}$ is the forward index of concentration, $V_{i.}$ the forward index of variation and $d_{ij} = z_{ij}/b_{i.}$.

Since these indices are increasing functions of the size of the inverse matrix, they can be expressed as percentages of the theoretical maximum indices. Hence, the percentage concentration indices G^* are calculated as follows:

$$G^* = \frac{G}{(n-1)^{1/2}} 100 \tag{3}$$

$G_{.j}$ and $G_{i.}$ are measures of variation in intersectoral transactions. When there is no variation in a sector's sales to (purchases from) other sectors, then the sum of sector sales (purchases) will determine the number of sector connections. Generally, given the sum of the ith sector's sales (purchases), a large value for G implies more sector connections. In contrast, a small value for G implies fewer intersectoral sales (purchases). In the extreme case where G = 0, total skewness in sectoral transactions predominates, implying maximum concentration. When G is expressed as percentage, G^* of 100 indicates complete uniformity of sectoral transactions.

In addition, Soofi (1992) constructed a general index (GI) representing the combined effects of the ranks of U and G as follows:

$$GI = \alpha(RG - RU) + RU \tag{4}$$

where RG represents the ranks of concentration indices and RU represents the ranks of linkage indices. α is the weight to be attached to the concentration index; this parameter reflects the planners' preference for the sectors with uniform sectoral sales and purchases.[4]

If RG = RU, then the ranking of G or U alone should be sufficient in decision-making. For α = 0,5 the GI index value, for a sector which is ranked number one by both U and G indices, is equal to 1. If RG > RU, the sectors with a lower measure of concentration and high linkages are ranked lower than sectors with the same linkage value but higher measure of concentration. If RG < RU, given two sectors with equal linkage index but different concentration measures, the GI will rank the sector with the larger concentration measure higher. Note that the GI modifies the ranking sectors

4. GI, G and U are used as generic terms to include all general indices, concentration indices and linkage indices, respectively, regardless the data used in their calculation.

with wide differences in values for G and U. Moreover, the GI will have a small effect in the ranking of sectors with small differences between G and U rankings.

Empirical results

The regional economy

East Macedonia and Thrace is a EU region (NUTS 2 level) that covers the north-eastern part of Greece. The geopolitical location of East Macedonia and Thrace is a factor that might have contributed to its isolation and marginalisation. However, the recent significant changes to the map of Europe, EU enhancement, have changed the region's prospects for growth (Regional innovation and technology transfer strategies 2001). The particularly favorable complex of development incentives in East Macedonia and Thrace, supported by the Community Support Framework and the Regional Development Plans, offer significant investment opportunities mainly for the establishment of new technology-based firms.

Briefly, the regional economy is dominated by relatively few sectors, agriculture, trade and construction being the most important. These sectors account for 74% of output and 82% of employment in 1980 and 62% of output and 72% of employment in 1997. In 1997, agriculture contributed 12% to the regional output and 39% to the regional employment, relative to 1980 figures, 21% and 51%, respectively. On the other hand, the contribution of services sector to the regional output and employment was increased. Construction contributed approximately 9% to the regional output in 1997 and accounted for 5% in employment. The corresponding numbers for 1980 were 13% and 10%, respectively. The main manufacturing sector, food and beverages, which is considered a traditional sector in the region, contributed 8% to the regional output in 1980 and 1% to the local employment (the corresponding figures for 1997 were 6% and 2%).

Indices of structural changes

The indices of structural changes are estimated on the base of two 34 sector (Appendix 1) IO tables, the 1980 I-O, a year before Greece's accession to EU, and the 1997 I-O, and sixteen years of interventions to change the structure of the regional economy. The GRIT technique was used to generate both tables (Jensen *et al.*, 1979), involving the mechanical regionalization of the national IO tables as well as the insertion of superior data obtained from secondary sources and selected interviews with local policy makers and stakeholders. Table 1 presents two indices of structural changes: the index of power of dispersion (backward linkage index) and the index of sensitivity of dispersion (forward linkage index). These two indices provide a quantitative description of the structure of the economy for the period 1980-1997, concerning the 34 local production sectors.

From the backward linkage indices for 1980, it is obvious that trade, food and beverages, hotels and restaurants and livestock are the sectors with the most backward connections with the other sectors. For 1997 the backward linkage indices, column (2) of Table 1, identify food and beverages, leather industry, metal products and tobacco products as sectors having the largest number of backward transactions with the rest of the economy. Regarding the rate of change between the two time points, column (3) of Table 1, the agricultural sectors (cereals, vegetables and fruits) show an important increase in backward linkages. In other words these sectors, not only together but separately too, affected more heavily the whole economy in 1997 than in 1980. By contrast, for the livestock sector the changes are reversed.

Comparing 1980 and 1997, it seems that a substantial increase (over 10%) has occurred in the backward linkages of sectors such as clothing, leather industry and chemicals. The other manufacturing sectors seem to influence the system of industries to a relatively small extent, recording a smaller increase in their backward linkages.

A substantial decrease (over 10%) has occurred in the backward linkages of the transport equipment sector. Among the non-manufacturing industrial sectors, only construction showed a considerable increase in backward linkages during the time span. Looking at the service sectors, substantial increases have occurred in financial intermediation and the other service sectors.

The indices of sensitivity of dispersion, column (4) of Table 1, for 1980 show as sectors with highest forward linkages trade, real estate, renting and business activities, financial intermediation, transport and communication and cereals. For 1997 the forward linkages, column (5) of Table 1, identify trade, real estate, renting and business activities, metal products, chemicals and livestock as sectors having the most forward connections with the other sectors. In other words these sectors appeared to be more strongly influenced by a general increase in final demand than other sectors.

Regarding the indices of sensitivity of dispersion and their changes between 1980 and 1997, column (6) of Table 1, it can be seen that sectors with increases of over 10% in forward linkages include fruits, extraction of crude oil and natural gas, textiles, leather, wood, rubber and plastic products, chemicals, metal products and real estate, and renting and business activities. This means that the impact of a unit increase in the final demand in the whole system of sectors on each of the above sectors was bigger in 1997 than in 1980. Sectors with a decrease of over 10% in their forward linkages are forestry, mining and quarrying, transport equipment, construction, trade, financial intermediation, public administration and defense, and health.

Furthermore, Table 2 presents the indices of concentration and the general indices for 1980 and 1997. For 1980, the measures of concentration identify trade, food and beverages, hotels and restaurants, livestock and health sectors as having the most backward connections with other industries. Trade, financial intermediation, real es-

Table 1. Linkage indices for 1980 and 1997

	Indices of power of dispersion (U_j) 1980 1997 (2):(1)			Indices of sensitivity of dispersion (U_i) 1980 1997 (5):(4)		
	1980	1997	(2):(1)	1980	1997	(5):(4)
Sectors	(1)	(2)	(3)	(4)	(5)	(6)
1[a]	0.830 (28) **	0.931 (22)	1.122	1.326 (5)	1.265 (6)	0.954
2	0.843 (27)	1.010 (12)	1.199	0.935 (14)	1.008 (14)	1.078
3	0.824 (30)	0.980 (14)	1.189	0.857 (19)	1.176 (8)	1.372
4	1.236 (4)	0.966 (16)	0.782	1.171 (6)	1.267 (5)	1.082
5	0.797 (31)	0.750 (33)	0.941	0.887 (18)	0.787 (27)	0.887
6	0.950 (17)	0.914 (25)	0.963	0.817 (30)	0.742 (30)	0.909
7	0.795 (34)	0.726 (34)	0.914	0.795 (34)	0.955 (16)	1.201
8	0.826 (29)	0.791 (30)	0.957	0.937 (13)	0.797 (26)	0.850
9	1.546 (2)	1.421 (1)	0.919	1.093 (8)	1.156 (9)	1.058
10	1.079 (9)	1.150 (4)	1.065	0.843 (23)	0.840 (23)	0.995
11	1.029 (12)	1.081 (9)	1.051	0.857 (20)	1.028 (12)	1.200
12	0.850 (26)	0.988 (13)	1.163	0.838 (25)	0.767 (29)	0.916
13	0.987 (15)	1.175 (2)	1.190	0.799 (32)	0.880 (20)	1.101
14	1.109 (6)	1.052 (11)	0.949	0.893 (16)	1.015 (13)	1.136
15	1.111 (5)	1.053 (10)	0.948	1.164 (7)	1.065 (10)	0.915
16	0.796 (32)	1.088 (8)	1.367	0.818 (29)	1.299 (4)	1.588
17	1.032 (11)	0.941 (21)	0.911	0.854 (21)	0.942 (17)	1.103
18	0.948 (18)	0.963 (17)	1.016	0.916 (15)	0.896 (19)	0.978
19	1.101 (7)	1.171 (3)	1.063	0.948 (12)	1.372 (3)	1.448
20	0.910 (20)	0.950 (20)	1.044	0.821 (28)	0.846 (22)	1.031
21	1.023 (13)	0.807 (28)	0.789	1.010 (10)	0.834 (24)	0.825
22	0.904 (22)	0.961 (18)	1.063	0.846 (22)	0.828 (25)	0.979
23	1.016 (14)	0.852 (27)	0.839	1.040 (9)	1.036 (11)	0.997
24	1.051 (10)	1.102 (7)	1.048	1.007 (11)	0.874 (21)	0.868
25	1.837 (1)	0.957 (19)	0.521	2.277 (1)	1.780 (1)	0.782
26	1.285 (3)	1.121 (6)	0.873	0.835 (26)	0.785 (28)	0.939
27	0.945 (19)	0.926 (23)	0.979	1.328 (4)	1.232 (7)	0.928
28	0.850 (25)	0.973 (15)	1.144	1.453 (3)	0.933 (18)	0.642
29	0.909 (21)	0.870 (26)	0.957	1.480 (2)	1.689 (2)	1.141
30	0.867 (23)	0.920 (24)	1.061	0.843 (24)	0.726 (34)	0.861
31	0.865 (24)	0.788 (31)	0.911	0.801 (31)	0.739 (31)	0.922
32	1.080 (8)	0.777 (32)	0.719	0.827 (27)	0.737 (32)	0.891
33	0.976 (16)	1.141 (5)	1.169	0.888 (17)	0.972 (15)	1.094
34	0.795 (33)	0.800 (29)	1.006	0.796 (33)	0.733 (33)	0.921

Column (1) and column (2) have been calculated according to formula (1). Column (4) and column (5) have been calculated according to formula (2). ** Figures in parentheses indicate the sectoral ranking in terms of linkage indices. [a] Sector's classification may be found in Appendix 1.

Table 2. Concentration indices and general indices for 1980 and 1997

	Backward				Forward			
	Concentration indices ($G^*_{.j}$)		General indices ($GI_{.j}$)[b]		Concentration indices ($G^*_{i.}$)		General indices ($GI_{i.}$)	
Sectors	1980	1997	1980	1997	1980	1997	1980	1997
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	15.99 (30) ***	26.69 (30)	29	26	77.03 (4)	69.96 (7)	4.5	6.5
2	18.56 (28)	46.13 (24)	27.5	18	46.49 (12)	45.65 (20)	13	17
3	26.64 (27)	39.96 (25)	28.5	19,5	37.76 (15)	64.33 (10)	17	9
4	73.90 (4)	36.71 (28)	4	22	69.08 (6)	70.06 (6)	6	5.5
5	6.42 (31)	25.23 (31)	31	32	43.95 (13)	38.6 (24)	15.5	25.5
6	53.87 (14)	60.86 (12)	15.5	18,5	19.96 (28)	19.11 (27)	29	28.5
7	0 (34)	2.85 (34)	34	34	0 (34)	64.09 (11)	34	13.5
8	27.54 (26)	39.21 (26)	27.5	28	52.82 (10)	40.43 (23)	11.5	24.5
9	79.56 (2)	80.19 (1)	2	1	57.36 (9)	68.51 (9)	8.5	9
10	61.35 (8)	67.84 (5)	8.5	4,5	1.12 (33)	0.57 (33)	28	28
11	59.33 (11)	66.53 (7)	11.5	8	26.96 (23)	61.35 (12)	21.5	12
12	35.39 (24)	64.18 (9)	25	11	31.69 (19)	15.91 (30)	22	29.5
13	58.42 (12)	66.94 (6)	13.5	4	2.22 (32)	7.28 (32)	32	26
14	62.20 (7)	59.46 (16)	6.5	13,5	24.21 (25)	54.97 (18)	20.5	15.5
15	38.42 (22)	56.00 (20)	13.5	15	47.64 (11)	57.60 (14)	9	12
16	4.08 (32)	65.94 (8)	32	8	24.06 (26)	78.60 (3)	27.5	3.5
17	60.98 (9)	60.29 (14)	10	17,5	29.39 (22)	60.69 (13)	21.5	15
18	48.63 (16)	56.85 (19)	17	18	42.45 (14)	46.13 (19)	14.5	19
19	60.01 (10)	53.64 (21)	8.5	12	36.69 (16)	69.42 (8)	14	5.5
20	47.75 (17)	58.16 (17)	18.5	18,5	22.08 (27)	40.64 (22)	27.5	22
21	16.88 (29)	25.05 (32)	21	30	5.59 (30)	35.20 (26)	20	25
22	46.15 (18)	62.68 (10)	20	14	31.50 (20)	42.27 (21)	21	23
23	55.85 (13)	51.77 (22)	13.5	24,5	59.75 (8)	71.35 (5)	8.5	8
24	65.19 (6)	74.79 (3)	8	5	61.31 (7)	55.57 (16)	9	18.5
25	82.74 (1)	60.24 (15)	1	17	90.96 (1)	90.81 (1)	1	1
26	78.52 (3)	76.05 (2)	3	4	30.72 (21)	38.17 (25)	23.5	26.5
27	37.49 (23)	57.46 (18)	21	20,5	75.21 (5)	78.34 (4)	4.5	5.5
28	35.24 (25)	60.60 (13)	25	14	82.70 (2)	56.18 (15)	2.5	16.5
29	44.91 (19)	51.24 (23)	20	24,5	79.75 (3)	88.05 (2)	2.5	2
30	40.25 (20)	62.01 (11)	21.5	17,5	33.55 (18)	0 (34)	21	34
31	39.25 (21)	38.83 (27)	22.5	29	9.93 (29)	17.63 (28)	30	29.5
32	67.61 (5)	35.77 (29)	6.5	30,5	26.18 (24)	17.05 (29)	25.5	30.5
33	52.91 (15)	70.50 (4)	15.5	4,5	35.58 (17)	55.21 (17)	17	16
34	0 (33)	10.27 (33)	33	31	4.17 (31)	13.62 (31)	32	32

The numbering of sectors is in accordance with table 1. Columns (1), (2), (5) and (6) have been calculated according to formula (3). Columns (3), (4), (7) and (8) have been calculated according to formula (4). *** Figures in parentheses indicate the sectoral ranking in terms of concentration indices. b $\alpha = 0,5$

tate, renting and business activities, cereals and transport and communications are the sectors with the largest number of forward connections.

The backward general index identifies trade, food and beverages, hotels and restaurants, livestock, wood industry and health sectors as having the closest value to one. The forward general index identifies trade, financial intermediation, real estate, renting and business activities, cereals, transport and communications and livestock as the leading sectors.

For 1997, the ranking of measures of concentration identifies the following sectors as having the largest number of backward transactions with the rest of the economy: food and beverages, hotels and restaurants, construction, other services and tobacco products. Trade, real estate, renting and business activities, chemicals, transport and communications, electricity and water and livestock are identified as sectors with the largest number of forward connections with other sectors.

The backward general indices list the following sectors as having the smallest values: food and beverages, leather industry, hotels and restaurants, tobacco products, other services and construction. The forward general indices identify trade, real estate, renting and business activities, chemicals, livestock, metal products and transport and communications as the leading sectors.

The concentration indices reveal that trade is the sector with the most backward and forward connections with other industries both in 1980 and 1997. Food and beverages appears to have the first and the second strongest backward connections with the rest of the economy in 1997 and 1980, respectively. Real estate, renting and business activities sector appears in 1980 and 1997 as having the third and the second, respectively, forward connections with other sectors.

Correlation coefficients representing the correspondence among the ranking of the above computed indices are reported in Table 3. Results suggest that the coefficients of rank correlation between various indices for 1980 and 1997 are either quite low or quite high.

These relationships indicate that during this period continuous transformations took place in the economic structure of the region, with several sectoral activities maintaining their position in the economy and others maximizing or minimizing their importance to the economy of the region.

Between 1980-1997 coefficients of rank correlation vary from 0.316 among linkage indices and 0.637 among general indices. Generally, it can be observed that both row and column measures show weak or negative correlation among the regional indices during the period under study. Also, a moderate correlation is observed between forward concentration index and general index, (0.650), the forward general index and linkage index, (0.641), and the forward general indices, (0.637). The correlation coefficients between the ranking of backward linkage index and forward linkage index, backward linkage index and row concentration index, backward linkage index

Table 3. Rank correlation coefficients among various indices for 1980 and 1997

	$U_{.j}^{80}$	$U_{.j}^{97}$	$U_{i.}^{80}$	$U_{i.}^{97}$	$G_{.j}^{80}$	$G_{.j}^{97}$	$G_{i.}^{80}$	$G_{i.}^{97}$	$GI_{.j}^{80}$	$GI_{.j}^{97}$	$GI_{i.}^{80}$	$GI_{i.}^{97}$
$U_{.j}^{80}$	1	0.316	0.334	0.231	0.893	0.246	0.138	0.136	0.970	0.311	0.234	0.186
$U_{.j}^{97}$		1	-0.038	0.198	0.304	0.760	-0.076	-0.018	0.334	0.927	-0.060	0.081
$U_{i.}^{80}$			1	0.635	0.160	-0.229	0.873	0.632	0.232	-0.143	0.973	0.641
$U_{i.}^{97}$				1	0.121	-0.152	0.529	0.915	0.174	0.020	0.617	0.976
$G_{.j}^{80}$					1	0.371	0.115	0.071	0.971	0.363	0.121	0.095
$G_{.j}^{97}$						1	-0.155	-0.204	0.328	0.929	-0.225	-0.191
$G_{i.}^{80}$							1	0.615	0.103	-0.140	0.954	0.568
$G_{i.}^{97}$								1	0.092	-0.133	0.650	0.975
$GI_{.j}^{80}$									1	0.362	0.158	0.134
$GI_{.j}^{97}$										1	-0.159	-0.067
$GI_{i.}^{80}$											1	0.637
$GI_{i.}^{97}$												1

and row general index are –0.038, -0.076 and –0.060, respectively, showing that a negative correlation exists between these pairs of indices.

The weak and negative correlation among most of the ranked indices for linkage and concentration is an indication that the structure of production of the regional economy during 1980-1997 recorded significant dissimilarities.

Conclusions

When Greece joined the European Community in 1981, East Macedonia and Thrace, faced threatening structural problems, and EU funding was utilized to revamp the whole structure of the region. The construction of the IO regional model and the computation of several indices of structural changes provide useful insights into the structure of the regional economy and the embodied changes between 1980 and 1997, changes that to a large extent would be attributed to initiation of an array of supporting schemes over this long period. Recommended IO indices by a large number of IO scholars have been estimated and then the changes recorded in this time stretch are compared.

Estimations based on the linkage indices have revealed that some sectors recorded an increase and others a decrease in their importance as stimulators of output changes in the economy between 1980 and 1997. The degree to which different sectors affect the whole system of sectors through the demand for intermediate inputs has changed considerably during this period (agricultural sectors, clothing, leather industry, chemicals, construction, financial intermediation and other services affected more heavily the system of sectors in 1997 than in 1980). Likewise, observations can be drawn on the degree to which the activity in the system of sectors affected the activity in a particular sector. Some sectors noticed an expansion (fruits, extraction of crude oil and natural gas, textiles, leather, wood, rubber and plastic products, chemicals, metal

products and real estate, renting and business activities) and others a contraction (forestry, mining and quarrying, transport equipment, construction, trade, financial intermediation, public administration and defense, health) in their dependence on the activity of the whole system of sectors. The measurements of concentration have shown that decision-makers should attach expansion priorities (especially) to sectors such as trade, food and beverages, real estate, and renting and business activities.

Each of the measures and indices employed in this study cumulatively provides a comprehensive view of the structure of the regional economy of East Macedonia and Thrace and the changes recorded between 1980-1997. According to these results, all of the regional sectors have experienced significant structural changes during the period under study. The analysis shows that the economy of East Macedonia and Thrace depends heavily on agricultural activities. Agriculture continues to be an important and indispensable part of the regional economy, strongly linked with the rest of the economy. Moreover, there are several service sectors as well as construction and manufacturing sectors that have fairly strong linkages within the regional economy.

A comparison of the ranking of the economic sectors based on linkage indices, concentration indices and general indices for 1980 and 1997, indicates that a weak or negative correlation exists between these measurements. This enables us to conclude that severe changes in the structural characteristics of the regional economy have occurred during the period under study, though there are no indications that the economy was radically transformed into a more competitive one, as sectors highly subsidized by the EU prevailed in the region. Agriculture is still an important sector for the regional economy, especially if the links with food processing are taken into account. However, the comparatively low competitiveness of several agricultural sub-sectors could also undermine a (rather) competitive sector such as food processing.

In terms of other sectors, it can also be noted that economic activities which have seen an expansion (such as textiles and wood products) are currently (for some years now) facing increased competition from abroad, and hence, rather uncertain prospects. On the other hand, linkages seem to have declined for sectors that have gained ground in terms of competitiveness (i.e. financial intermediation, construction). The overall picture of this analysis, though it cannot be claimed to be a complete and comprehensive one, still offers valuable insights into future prospects, but also a warning signal that beyond any EU funding schemes local policy-making remains a determinant factor for permanent and promising change in a region.

References

Carter, A. 1970. *Structural change in the American economy*. Harvard University Press, Cambridge, Massachusetts.

Cella, G. 1984. The IO measurement of interindustry linkages. Oxford Bull Econ Statist **46**:73-84.

Chenery, H.B., and T. Watanabe. 1958. International comparisons of the structure of production. *Econometrica* **26**:487-521.

Chletsos, M., Chr. Kollias, and G. Manolas. 1997. Structural changes and their impact on the relationship between wages, productivity and labor demand in Greece. *Center of Planning and Economic Research Athens* Discussion Paper No. 64.

Cho, B., J. Sohn, and J.D. Hewings. 1999. Structural change in the Korean economy between 1975 and 1995. *Regional Economics Laboratory University of Illinois* Discussion Paper 99-T-6.

Credit Bank 1999. *The Counties of Greece*. Credit Bank, Athens

Diamond, J. 1974. The analysis of structural constraints in developing economies: a case study. *Oxford Bull Econ Statist* **36:**95-108.

Flegg, A.T, C.D. Weber and M.V. Elliott. 1995. On the appropriate use of location quotients in generating regional input-output tables. *Reg Studies* **29**: 547-561.

Forsell, O. 1988, Growth and changes in the structure of the Finish economy in the 1960s and 1970s. In: Ciaschini M. (eds.) *Input-output analysis: current development*, Chapman and Hall, London.

Guo, J., and MA. Planting. 2000. Using input-output analysis to measure US economic structural change over a 24 year period. Macerata, Italy Paper presented at the 13th International conference on input-output techniques.

Hewings. GJ., DM. Fonseca, J. Guilhoto, and M. Sonis. 1989. Key sectors and structural change in the Brazilian economy: a comparison of alternative approaches and their implications. *J Pol Modeling* **11:**67-90.

Isard, W. 1951. Interregional and regional input-output analysis: a model of a space economy. *Rev Econ Statist* **33:**318-328.

Isard, W. 1953. Some empirical results and problems of regional input-output analysis. In: Leontief W (eds.) *Studies in the structure of the American economy*, Oxford University Press, London.

Jensen, R.C., T.D. Mandeville, and N.D. Karunarante. 1979. *Regional economic planning: generation of regional input-output analysis*. Croom Helm, London.

Johns, P.M., and P.M.K. Leat. 1987. The application of modified GRIT input-output procedures to rural development analysis in Grampian region. *J Agr Econ* **32:**243-256.

Karunarante, N.D. 1989. *Australian development issues: an input-output analysis*. Newcastle upon Tyne, Avebury.

Kubo, Y. 1985. A cross-country comparison of interindustry linkages and the role of imported intermediate inputs. *World Devel* **13:**1278-1298.

Kubo, Y., J.De. Melo, S. Robinson, and M. Syrquin. 1986a. Interdependence and industrial structure. In: Chenery H., Robinson S., Syrquin M. (eds.) *Industrialization and growth: a comparative study*, Oxford University Press, New York.

Kubo, Y., S. Robinson, and M. Syrquin. 1986b. The methodology of multisector comparative analysis. In: Chenery H., Robinson S., Syrquin M. (eds.), *Industrialization and growth: a comparative study*, Oxford University Press, New York.

Lee, C. 1990. Growth and changes in the structure of the US agricultural economy, 1972-82: an input-output perspective. *Econ Systems Res* **2**:303-311.

Leontief, W. 1953. *Studies in the structure of the American economy*. Oxford University Press, London.

Mattas, K., A. Pagoulatos, and D.L. Debertin. 1984. *Building input-output models using non-survey techniques*. Southern Rural Development Center, Mississippi Series 721.

Midmore, P. 1993. Input-output forecasting of regional agricultural policy impacts. *J Agr Econ* **44:** 284-300.

Miernyk, W., E.R. Bonner, J.H.Jr. Chapman, and K. Shellhanner. 1967. *Impact of the space program on a local economy: an input-output analysis*. West Virginia University Press, Morgantown.

Mylonas, N.A., 1989. Analytical input-output tables of the Greek economy – year 1980. *Center of Planning and Economic Research*, Athens.

National Statistical Service of Greece 1998. National accounts of Greece 1988-1997. *National Statistical Service of Greece*, Athens.

Psaltopoulos, D. 1995. Input-output analysis of Scottish forestry strategies. Department of Economics, University of Aberdeen, unpublished PhD thesis.

Psaltopoulos D., and K.J. Thomson. 1993. Input-output evaluation of rural development: a forestry-centered application. *J Rural Stud* **9:**351-358.

Psaltopoulos, D., K.J. Thomson, S., Efstratoglou, J. Kola, and A. Daouli. 2004. Regional social accounting matrices for policy analysis in lagging EU rural regions, *Eur Rev of Agric Econ*, **31:**149-178

Rasmussen, P.N. 1956. *Studies in intersectoral relations*. North-Holland, Amsterdam

Regional innovation and technology transfer strategies (2001) Region of East Macedonia and Thrace. http://liaison.xan.duth.gr/ritts_emth/eng/index.htm

Rose, A., and W. Miernyk. 1989. Input-output analysis: the first fifty years. *Econ Systems Res* **1**:229-271

Round, J.I. 1983. Nonsurvey techniques: a critical review of the theory and the evidence. *Int Reg Sci Rev* **8**:189-212

Sawer C.H., and R.E. Miller. 1983. Experiments in regionalization of a national input-output table. *Environ Planning* A **15**:1501-1520

Schaffer, W.A. 1976. *On the use of input-output models for regional planning studies in applied regional science*. Martinus Nijhoff, Leiden

Simpson, D., and J. Tsukui. 1965. The fundamental structure of input-output tables: an international comparison. *Rev Econ Statist* **47**:434-446

Skolka, J. 1989. Input-output structural decomposition analysis for Austria. *J Pol Modeling* **11**:45-66

Skountzos, T. 1980. *Structural changes in the economy: intertemporal analysis in input-output framework*. Center of Planning and Economic Research, Athens

Skountzos, T., N. Stromplos, A. Vozikis, and F. Theofanides. 2007. Intersectoral relations of the Greek economy at the national and regional levels. Study no. 7, Academy of Athens, Athens.

Sonis, M., G.J.D. Hewings, and J. Guo. 1996. Sources of structural change in input-output systems: a field of influence approach. *Econ Systems Res* **8**:15-32

Sonis, M., and G.J.D. Hewings. 1998. Economic complexity as network complication: multiregional input-output structural path analysis. *Ann Reg Sci* **32**:407-436

Soofi, A. 1992. Industry linkages, indices of variation and structure of production: an international comparison. *Econ Systems Res* **4**:349-375

Staglin, R., and H. Wessels. 1972. Intertemporal analysis of structural change in the German economy. In: Carter AP, Brody A (eds.) *Input-output techniques*, North-Holland, Amsterdam

Tohmo, T. 2004. New developments in the use of location quotients to estimate regional input-output coefficients and multipliers. *Reg Studies* **38**: 43-54.

Tzouvelekas, V.M., and K. Mattas. 1995. Revealing a region's growth potential through the internal structure of the economy. *Int Advances Econ Res* **1**:304-313

Urata, S. 1988. Economic growth and structural change in the Soviet economy, 1959-72. In: Ciaschini M (eds.) *Input-output analysis: current development*, Chapman and Hall, London

Yan, C., and E. Ames. 1965. Economic interrelatedness. *Rev Econ Stud* **32**:290-310

Appendix 1

Industry (sector no.)	Description
1	Cereals
2	Vegetables
3	Fruits
4	Livestock
5	Forestry
6	Fishing
7	Extraction of crude oil and natural gas
8	Mining and quarrying
9	Food and beverages
10	Tobacco products
11	Textiles
12	Clothing
13	Leather industry
14	Wood industry
15	Paper and publishing
16	Chemicals
17	Rubber and plastic products
18	Non-metal products
19	Metal products
20	Machinery and equipment
21	Transport equipment
22	Other industries
23	Electricity and water
24	Construction
25	Trade
26	Hotels and restaurants
27	Transport and communication
28	Financial intermediation
29	Real estate, renting and business activities
30	Public administration and defense
31	Education
32	Health
33	Other services
34	Domestic services