ASSESSING THE STRUCTURAL CHANGES IN THE GREEK ECONOMY FOR THE PERIOD PRIOR TO ECONOMIC CRISIS

Triantafyllos PNEVMATIKOS
PhD in Planning and Regional Development, University of Thessaly
trpnevmatikos@gmail.com

Serafeim POLYZOS
Professor, University of Thessaly, Department of Planning and Regional Development
spolyzos@uth.gr

Dimitrios TSIOTAS
Adjunct Lecturer, University of Thessaly, Department of Planning and Regional Development
tsiotas@uth.gr

Abstract

The process of economic growth is directly related to structural changes, the study of which has been the subject of research for many decades and it allowed detecting the dynamics affecting national and regional economies over time. Especially for the policy makers, the in-depth understanding of inter-sectorial linkages and of the structural changes existing in national or regional economics is increasingly important for the planning of effective economic policies leading to economic development and to the improvement of competitiveness and productivity. Within this context, this paper studies the inter-sectorial linkages in the Greek economy by using a combined approach based on input-output modeling and on causative matrix analysis. The purpose of the analysis is to detect the structural changes in Greece at the period prior to economic crisis (2000-2010), which is an important period because, at that time, the economic structure of the country have been proven deficient to successfully deal with the crisis that followed. The analysis shows that the majority of the productivity sectors (impressively) witnessed an increase in their gross output at that time, that the most significant changes induced in the tertiary sector, where technical changes were fewer than those captured due to change in final demand, and that the effects of final demand are increasingly individually internalized. The overall approach aspires to learn from a crucial period leading to an economic crisis, under a structural perspective of the Greek economy.

Keywords: structural changes, input-output analysis, multipliers, Greek economy.

JEL classification: Q33, Q40, Q41

1. Introduction

The ex-ante identification of the potentially high growth sectors, which might be suitable for economic development reinforcing in a country, is a continuous task of every economic planner. In the relevant literature this discussion is timeless but it's recent concern focuses on the definition and estimation of the key sectors. Traditionally, a key-sector is the one generating above-average input requirements than the other sectors and of whose the output is widely used by other sectors. The utility of input-output sectorial linkages has been the subject of many studies (Miller and Blair, 2009; Garcia-Muñiz and Ramos-Carvajal, 2015; Cassar, 2017).

Structural changes are changes in the structure and in the functionality of an economy, which have a significant impact on the development of a country, region, or generally place (Miller and Blair, 2009; Korres, 1996). The process of economic development in an economy results in distinct structural changes. As the gross domestic product (GDP) of a country increases (or decreases), a shift in economic activity arises among productive sectors. The process in turn leads to structural shifts, and consequent diminishing significance of some activities and growing dominance of others (Kaur et al., 2009). Investigation of structural relationships among the sectors becomes important from the policy perspective, since it helps at understanding the evolution of such relationships as well as the inter-sectoral adjustments over time.

Structural decomposition analysis can be used for historical analysis, but some recent work indicates how it might be used as a forecasting tool. Also, structural decomposition analysis enables the analyst to examine responses to price changes, which are only implicit in even value-based input-output tables (Bekhet, 2009). The Input-Output Analysis has been widely applied to study structural change in an economy over a particular period of time (Magtibay-Ramos et al., 2010; Trinh et al., 2012). Structural change, in the framework of Input - Output, refers to changes in input requirements, new products, and changes in the relative size of sectors within an economy.

In Greece, the recent economic crisis (Polyzos et al., 2013) seemed to have significantly affected the productive-web of the country. One of the key-methodologies for assessing and evaluating structural changes in an economy over time is the so-called Input-Output Analysis, which models interactions among the sectors of the economy concerned (Polyzos and Sofios, 2008; Polyzos, 2009; Pnevmatikos, 2017; Polyzos, 2019). Input-Output Analysis describes the operability of an economic system and explores the relationships among the productive sectors of an economy. It provides tools to assess structural changes in the economy, in terms of linkages among these sectors (Miller and Blair, 2009). Input–Output Tables give insights on the status-quo of a particular economy, on an annual basis, through an analysis of inter-sectorial transactions in goods and services.

The Input-Output analysis is used in this paper to study the structural changes in the sectors of the Greek economy at the period 2000-2010, focusing on the corresponding Input-Output Tables. The analysis focuses on structural changes that have taken place in the Greek economy using input-output data. The purpose of the analysis is to detect the structural changes in Greece at the period prior to economic crisis (2000-2010), which is an important period that marked the economic performance of the country the years that followed the crisis (Polyzos et al., 2013).

The remainder of this paper is organized as follows: Section 2 discusses the methods used to detect structural changes. Section 3 shows the results of the analysis and discusses them in order to identify the structural changes and the leading sectors of the Greek economy at the period 2000-2010. Finally, in section 4, the main conclusions that are drawn from the above research and analysis, as well as proposals are formulated for the growth of the Greek economy.

2. Methods of analyzing structural changes

In this section, key-methods, which are used to examine structural changes in an economy, are described and evaluated.

2.1. Structural Decomposition Analysis (SDA)

The Structural Decomposition Analysis (SDA) enables the main sources of change to be examined and distinguished in an economy. This is done by identifying changes to basic parameters in the framework of input-output analysis (Rose and Casler, 1996; Rose and Chen, 1991; Pnevmatikos, 2017). Specifically, in the Input-Output system, the gross production value (X), for two successive years (t-1, t), is defined as follows:

$$X^{t-1} = (I - A^{t-1})Y^{t-1} \text{ and } X^{t} = (I - A)^{t} Y^{t} \quad (1),$$

where Y is the vector of final demand and $(I\text{-}A)^{-1}$ is the Leontief's inverse matrix. According to Skolka (1989), the differences in gross output between two years can be determined by two general categories of structural changes in final demand (Y) and the changes in the input coefficients of matrix A. Particularly:

$$\Delta X = X^{t} - X^{t-1} = (I - A^{t})^{-1}Y^{t} - (I - A^{t-1})^{-1}Y^{t-1} \quad (2),$$

$$\Delta X = \left[(I - A^{t})^{-1} - (I - A^{t-1})^{-1}\right]Y^{t-1} + (I - A^{t})^{-1}(Y^{t} - Y^{t-1}) \quad (3),$$

$$\Delta X = \left[(I - A^{t})^{-1} - (I - A^{t-1})^{-1}\right]Y^{t} + (I - A^{t-1})^{-1}(Y^{t} - Y^{t-1}) \quad (4).$$

In equation (3), the changes in the inverse matrices (technical changes) are multiplied by final demand of base year t-1, while the changes in final demand are multiplied by the inverse matrix of current year t (Chenery et al., 1962; Syrquin, 1976; Kubo and Robinson, 1984). In equation (4), changes in the inverse matrices are multiplied by final demand of this year, while the changes of final demand with the inverse matrix of the base year (Nijhowne et al., 1984; Rose and Chen, 1991).

Generally, equations (3) and (4) are equivalent, in mathematical terms. However, their results are different because changes in technology and in final demand are different in these two cases. These approaches have been discussed by several researchers (Skolka, 1989; Rose and Chen, 1991; Vaccara and Simon, 1968; Feldman et al., 1987; Miller and Shao, 1994; Dietzenbacher and Los, 1998). According to Dietzenbacher and Los (1998), summing equations (3) and (4) and averaging their results, gives the following alternative approach:

$$\Delta x = (1/2)(\Delta L)(f^{t-1} + f^{t}) + (1/2)(L^{t-1} + L^{t})(\Delta f) \quad (5),$$

where $(\Delta L)(f^{t-1}+f^{t})$ expresses the technological changes, while $(L^{t-1}+L^{t})(\Delta f)$ depicts the changes in final demand. This approach is considered satisfactory as mid-point weights are used.

2.2. The causative matrix method

The causative matrix method is used to detect changes in an economy at two different time points and it is based on the rationale of the Markov-chain analysis. A set of random variables $\{X_n\}$ is a Markov chain when the probability of the future value x_{n+1} depends only on the present x_n value and not on previous past value. In general, for two matrices A_t and A_{t+1} defined at two different times, the causative matrix formula is defined by the relation $A^{t+1}=CA^{t}$, where C is the causative matrix and models the changes between matrices A^{t} and A^{t+1} (Lipstein, 1968; Rogerson and Plane, 1984; Plane and Rogerson, 1986; Jackson et al., 1990). In the context of Input-Output analysis, by assuming that A is the matrix of technical coefficients and S is the output matrix, causative matrix (C) is easier be explained when the sums of the columns or rows are equal to 1. However, since $\sum_i \alpha_{ij} < 1$ and $\sum_j s_{ij} < 1$, this can be achieved in two ways. The first is by the introduction of the added value, etc., and the elements of final demand into matrices A and S, respectively. With respect to the second way, elements of matrix A should be expressed as a proportion of inputs that come from sector i and end up in sector j, while the elements of matrix S should reflect the proportion of the product sold by sector i to the rest sectors.

The causative matrix can be distinguished in two categories: (a) In the Right causative matrix (C_R) used to determine horizontal linkages, and (b) in the Left Causative Matrix (C_L) used to examine vertical linkages. According to Jackson et al. (1990), one of the limitations associated with the causative matrix relates to the fact that the interpretation of its elements becomes difficult when the original matrices do not have the dominant diagonals. When the elements of the diagonal are smaller than the sum of the elements in a column or a raw, then the matrix does not have a dominant diagonal. This difficulty is due to the fact that both the determinant of the normalized matrix (A or S) and the relative co-factors may have different indications with respect to the case of a dominant diagonal matrix. In addition, in matrices with non-dominant diagonals, indirect sectorial impacts contribute to a larger extent to sectorial changes as compared to direct effects. Consequently, a small (positive) direct change in an input or output coefficient can cause a large (negative) indirect effect, leading to a misinterpretation of the content (elements) of columns and rows of a matrix.

For a better interpretation of the causative matrix, Jackson et al. (1990) used the Leontief's inverse matrix to investigate changes in output multipliers. In particular, the elements of each column of the inverse matrix are normalized with respect to the sum of the elements of the corresponding column, as the sums of the columns of normalized matrices must be equal to 1. Therefore, every element of the normalized inverse matrix (r_{ij}) expresses the ratio of the output multiplier of sector j transferred to sector i. The normalized Leontief inverse matrix is more likely to have a dominant diagonal than matrix of technical coefficients. In particular, if $B=(I-A)-1$ is the Leontief's inverse matrix and M is a diagonal matrix for which each element (m_{jj}) is equal to the sum of the elements of column j of matrix B, then the normalized Leontief's inverse matrix can be written as $R=BM^{-1}$.

Within this context, the causative matrix is estimated from the formula $C = R_{t+1}R_t^{-1}$, while a typical element of matrix R_{t+1} is determined by the equation:

$$r_{ij(t+1)} = c_{i1}r_{1j} + c_{i2}r_{2j} + c_{i3}r_{3j} + \ldots \quad (6).$$

A negative value of c_{ik} indicates a decrease in the ability of sector i to affect the output multiplier of sector j due to the presence of sector k. Sectors can be considered competing with each other in terms of their impact on the output multiplier of sector j as well as other sectors.

2.3. Indices of inter-sectorial linkages

The indices of inter-sectorial linkages are a particularly useful for economic analysis because they contribute to the evaluation of the structure of an economy, to explore the importance of each sector in terms of the intensity of its inter-exchanges, and to point out the leading sectors of the economy. A number of studies, such as of Chenery and Watanabe (1958), Hirschman (1958), Rasmussen (1956) and Augustinovics (1970), suggested various vertical and horizontal inter-sectorial linkages indicators. However, these indicators do not reflect the intensity of the dispersion of indirect effect between the sectors of an economy. That is, any sector with a high horizontal or vertical linkages index does not necessarily lead to an increase in the gross product of all sectors of the economy under consideration. This implies the weakness of these indicators to serve the description of the structure of the economy and the dispersion that exists between the sectors. In an attempt to solve this problem, Rasmussen (1956) and Hirschman (1958) suggested the estimation of indices of power dispersion and sensitivity of dispersion through a normalization process. In particular, these indices are estimated as follows:

$$U_j = \frac{\sum_{i=1}^{n} b_{ij}}{n} \Bigg/ \frac{\sum_{j=1}^{n}\sum_{i=1}^{n} b_{ij}}{n^2} \quad \text{και} \quad U_i = \frac{\sum_{j=1}^{n} b_{ij}}{n} \Bigg/ \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} b_{ij}}{n^2} \quad (7),$$

where U_j is the index of power dispersion, U_i is the index of sensitivity of dispersion, b_i express cases, and n is the number of productive sectors. In case when U_j> 1, an increase in final demand of sector j will cause an increase in the productive activity of economy above the average. In addition, if U_i> 1, then an increase in the final demand of the sectors by one unit, will cause an increase in sector i production above the average.

Unlike the indices of Rasmussen (1956) and Hirschman (1958), those of Allaudin (1986) are not sensitive to marginal values. Improving the methodological background, Allaudin (1986) suggested the variability index that can be used in addition to the dispersion index. The variability indicators are defined as follows:

$$V_j = \sqrt{\frac{\frac{1}{n-1}\left[\sum_{i=1}^{n}\left(b_{ij} - \frac{\sum_{i=1}^{n} b_{ij}}{n}\right)^2\right]}{\frac{\sum_{i=1}^{n} b_{ij}}{n}}} \quad \text{and} \quad V_i = \sqrt{\frac{\frac{1}{n-1}\left[\sum_{j=1}^{n}\left(b_{ij} - \frac{\sum_{j=1}^{n} b_{ij}}{n}\right)^2\right]}{\frac{\sum_{j=1}^{n} b_{ij}}{n}}} \quad (8),$$

where b_i are cases and n is the number of productive sectors. Low values of these indicators for a sector show that the indirect results of this sector are evenly distributed to other sectors, while the opposite is the case if the values of these indices are high. According to Allaudin (1986), a sector is considered to have a leading role in the economy when (a) the U_i and U_j indices have values greater than the unit, and (b) the indices V_i and V_j have relatively low values.

2.4. Output and employment multipliers

The multipliers of Input - Output Analysis are particularly important indicators used to estimate the impact of changes in final demand on output of an economy, income, employment, etc. (Polyzos, 2006, Polyzos and Sofios, 2008; Polyzos, 2009; Miller and Blair, 2009). The output multiplier of sector *j* is defined as the total value of production in all sectors of the economy that satisfy the final demand of a unit for the output of sector *j*. The output multiplier for each sector is estimated by the sum of the corresponding column of the Leontief's inverse matrix. Specifically it is defined by the equation (Polyzos, 2006; Pnevmatikos et al., 2013; Pnevmatikos, 2017):

$$OM_j = \sum_{i=1}^{n} b_{ij} \qquad (9),$$

where OM_j is the output multiplier of sector j and b_{ij} is the element of the Leontief's inverse matrix.

Next, the employment multiplier of sector *j* illustrates the overall change in employment that is induced in the economy by a change in final demand of each sector separately. In particular, for the estimation of employment multiplier, the direct employment coefficients vector is first estimated as follows (Miller and Blair, 2009):

$$DE_j = E_j / X_j \qquad (10),$$

where E_j is the number of employees in each sector and X_j is the total output of each sector. Then, total employment multipliers are estimated from the following formula:

$$EM_j = DE_j (I - A)^{-1} \qquad (11).$$

3. Assessing structural changes in the Greek Economy

In this section, structural changes of the productive sectors of the Greek economy (for the period 2000-2010) are estimated and evaluated by using the methods of Structural Decomposition Analysis and Causative Matrix. Moreover, indices of Power Dispersion (U_j), Sensitivity of Dispersion (U_i), Vertical Variability (V_j) and Horizontal Variability (V_i) are estimated, as well as the Output and Employment Multipliers, in order to highlight the sectors that play an important role in the operation of the economic system. For this purpose, the Input-Output tables of the Greek economy, for the years 2000 and 2010, which have an initial dimension of 65×65 (sectors) and are extracted from the Greek Statistical Service (ELSTAT), are used. In order to match the Input-Output Tables of two periods, further editing took place in some sectors and the final tables concluded having 49 sectors (49×49). Table 1 shows the sectors included in the Input - Output tables.

Table 1. Codes and descriptions of productive sectors of the Greek economy

Sector No.	Sector code	Sector description
1	R01	Products of agriculture, hunting and related services
2	R02	Products of forestry, logging and related services
3	R03	Fish and other fishing products; aquaculture products; support services to fishing
4	RB	Mining and quarrying
5	R10_12	Food products, beverages and tobacco products
6	R13_15	Textiles, wearing apparel and leather products
7	R16	Wood and products of wood and cork, except furniture; articles of straw and plaiting materials
8	R17	Paper and paper products
9	R18-R58	Printing, recording and publishing services
10	R19	Coke and refined petroleum products
11	R20-R21	Chemicals and chemical products (includes pharmaceutical products
12	R22	Rubber and plastics products
13	R23	Other non-metallic mineral products
14	R24	Basic metals
15	R25	Fabricated metal products, except machinery and equipment
16	R26	Computer, electronic and optical products

Sector No.	Sector code	Sector description
17	R27	Electrical equipment
18	R28	Machinery and equipment n.e.c.
19	R29	Motor vehicles, trailers and semi-trailers
20	R30-R33	Other transport equipment - Repair and installation services of machinery and equipment
21	R31_32	Furniture; other manufactured goods
22	RD	Electricity, gas, steam and air-conditioning
23	R36	Natural water; water treatment and supply services
24	R37_39	Sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services
25	RF	Constructions and construction works
26	R45	Wholesale and retail trade and repair services of motor vehicles and motorcycles
27	R46	Wholesale trade services, except of motor vehicles and motorcycles
28	R47-R95	Retail trade services, except of motor vehicles and motorcycles - Repair services of computers and personal and household goods
29	R49	Land transport services and transport services via pipelines
30	R50	Water transport services
31	R51	Air transport services
32	R52-R79	Warehousing and support services for transportation- Travel agency, tour operator and other reservation services
33	R53-R61	Postal and telecommunication services
34	RI	Accommodation and food services
35	R59_60-R90_92-R93	Cultural, sport, entertainment services
36	R62_63	Computer programming, consultancy and related services; information services
37	R64	Financial services, except insurance and pension funding
38	R65	Insurance, reinsurance and pension funding services, except compulsory social security
39	R66	Services auxiliary to financial services and insurance services
40	RL	Real estate services
41	R69_70-R71-R73-R74_75-R78-RR80_82	Professional, scientific and technical services;
42	R72	Scientific research and development services
43	R77	Rental and leasing services
44	R84	Public administration and defence services; compulsory social security services
45	RP	Education services
46	R86-R87_88	Health and Social work services
47	R94	Services furnished by membership organisations
48	R96	Other personal services
49	RT	Services of households as employers

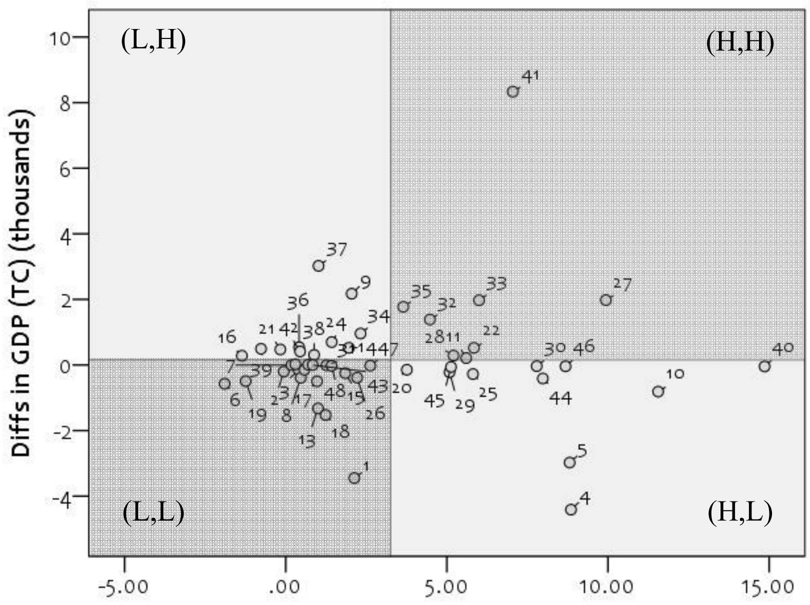
Next, Table 2 shows the results of the structural decomposition analysis (SDA) and of the left causative matrix method, computed for each sector. In particular, based on Structural Decomposition Analysis, the factors being responsible for the change in Gross Product between the years 2000 and 2010 are determined. The results show that most of the productive sectors of the economy show an increase in their Total Gross Production, with the effect of final demand generally affecting to a greater extent than the technical coefficients.

The change in the technical coefficients leads to an increase in the product for the 44.89% of the sectors. The greatest positive effect on Gross Product by the change in technical coefficients is observed for the "Professional, scientific and technical services" (RR80_82) and "Services auxiliary to financial services and insurance services" (R66) sectors. On the contrary, the most significant reductions in Gross Product due to the change in technical coefficients are observed in the "Mining and quarrying" (RB), "Agriculture, hunting and related services" (R01), and "Food products, beverages and tobacco products" (R10_12) sectors.

According to the change of Gross Product due to the change in final demand, in most (43) sectors, the change in the final demand leads to a positive change in output. The biggest positive effect on Gross Product is observed in the "Real estate services" (RL), "Coke and refined petroleum products" (R19) and "Wholesale trade services" (R46) sectors, while the most negative effect takes place in the sectors "Textiles, wearing apparel and leather products" (R13_15), "Motor vehicles, trailers and semi-trailers" (R29) and "Computer, electronic and optical products" (R26).

To illustrate the results of the SDA, we create the scatter plot of Figure 1, where the plan is divided into four quadrants defined by the mean values of the differences in GDP due to technical coefficients (TC) and due to final demand (FD). This classification produces four performance groups of sectors, namely (H,H), (H,L), (L,H), and (L,L), which include sectors with scores higher than (H=high | > mean value) or lower than (L=low | < mean value) the mean value, for the paired variables (*X*,*Y*).

Figure 1. Scatter plot based on the Structural Decomposition Analysis of Table 2. The plan is divided into four quadrants defined by the mean values of the differences (diffs) in GDP due to technical coefficients (TC) and due to final demand (FD). Each sector belongs to a quadrant according to its scores in variables *X*="diffs in GDP due FD" and *Y*="diffs in GDP due TC", where H=high (>mean value), L=low (<mean value). Case labels are sector numbers shown in Table



According to Figure 1, 8 out of 49 sectors (~16% of the total) shown in Table 1, with reference numbers (codes shown in brackets) 11 (R20-R21), 22 (RD), 27 (R46), 28 (R47-R95), 32 (R52-R79), 33 (R53-R61), 35 (R59_60-R90_92-R93), and 41 (R69_70-R71-R73-R74_75-R78-RR80_82) have a dominance "High-High" (H,H) performance, according to the SDA. The density of the other groups in Figure 1 are almost 22% (11/49) for the intermediate performance (H,L) and (L,H) groups, and almost 39% (19/49) for the lowest performance (L,L) group.

At next, according to the left Causative Matrix method (Table 2), it is observed that in 36.73% of the sectors, the diagonal elements are greater than 1. This shows that the effects of final demand on each of these sectors, in relation to the other sectors, are increasingly internalized within the sector. The sectors with the greater diagonal elements are "Natural water; water treatment and supply services" (R36), "Accommodation and food services" (RI), "Rental and leasing services" (R77), "Wood and products of wood and cork" (R16).

Table 2. Results of Structural Decomposition Analysis and of Left Causative Matrix Method

	Structural Decomposition Analysis – SDA			Causative Matrix Method		
Sector code	Change in Gross Product due to change in technical coefficients (in € million)	Change in Gross Product due to change in final demand (in € million)	Total change in Gross Product (in € million)	Diagonal data	Total line sums	Line sums except the data of main diagonal
R01	-3446.97	2126.17	-1320.81	0.90	0.83	-0.07
R02	-199.00	-61.27	-260.27	0.79	0.70	-0.08
R03	-156.02	402.28	246.25	0.93	0.92	-0.01
RB	-4411.34	8851.75	4440.41	0.99	0.52	-0.47
R10_12	-2974.00	8808.42	5834.42	1.03	0.94	-0.08
R13_15	-573.31	-1897.32	-2470.63	1.07	1.07	0.01
R16	-2.85	179.12	176.27	1.15	1.14	-0.01
R17	-393.10	464.33	71.23	0.94	0.89	-0.05
R18-R58	2175.62	2047.45	4223.07	1.12	1.34	0.22
R19	-810.67	11556.56	10745.89	1.03	0.77	-0.26
R20-R21	210.00	5599.68	5809.68	0.98	1.11	0.13
R22	-144.49	580.34	435.85	0.93	0.95	0.02
R23	-1324.69	1000.19	-324.51	1.01	0.93	-0.08
R24	521.46	1960.05	2481.51	0.96	1.03	0.08
R25	-249.25	1843.96	1594.71	0.73	0.74	0.01
R26	281.34	-1361.97	-1080.63	1.06	1.10	0.04
R27	-495.62	970.59	474.97	0.97	0.94	-0.03
R28	-1526.90	1238.43	-288.48	0.86	0.77	-0.09
R29	-490.64	-1241.41	-1732.05	0.99	0.94	-0.05
R30-R33	-145.51	3759.95	3614.44	1.06	1.05	-0.01
R31_32	471.31	-166.03	305.28	1.07	1.10	0.03
RD	521.16	5837.64	6358.80	1.01	0.94	-0.07
R36	20.24	294.94	315.18	1.18	1.17	-0.01
R37_39	698.11	1424.71	2122.82	1.04	1.08	0.04
RF	-277.38	5809.19	5531.81	0.94	0.83	-0.11
R45	-385.04	2214.28	1829.24	0.96	0.89	-0.07
R46	1976.98	9934.71	11911.69	0.85	1.21	0.35
R47-R95	286.89	5203.13	5490.01	0.93	0.96	0.04
R49	-220.76	5084.36	4863.60	0.94	0.93	0.00
R50	-35.70	7789.34	7753.65	0.95	0.96	0.01
R51	-9.78	1263.16	1253.39	0.78	0.80	0.02
R52-R79	1388.02	4474.56	5862.58	0.93	1.04	0.11
R53-R61	1973.32	5997.16	7970.48	0.88	1.15	0.27
RI	960.97	2320.51	3281.48	1.16	1.27	0.11
R59_60-R90_92-R93	1770.46	3647.95	5418.41	0.99	1.15	0.16
R62_63	543.86	414.60	958.46	0.99	1.06	0.07
R64	3023.77	1018.64	4042.41	0.90	1.35	0.45
R65	307.37	881.58	1188.95	1.00	1.06	0.06
R66	494.58	-766.04	-271.45	1.03	1.17	0.14
RL	-44.71	14857.46	14812.74	1.00	0.68	-0.32
R69_70-R71-R73-R74_75-R78-RR80_82	8334.08	7046.41	15380.49	0.85	1.60	0.76
R72	410.21	447.69	857.91	0.85	0.89	0.05
R77	13.11	695.00	708.12	1.14	1.05	-0.09
R84	-413.52	7978.99	7565.47	1.03	1.03	0.00
RP	-61.69	5130.11	5068.42	0.97	0.96	0.00
R86-R87_88	-39.56	8683.87	8644.31	0.96	0.98	0.01
R94	-18.05	2621.79	2603.74	0.87	0.87	0.00
R96	-24.78	1422.34	1397.56	1.11	1.10	0.00
RT	0.79	837.05	837.84	1.00	1.00	0.00

Subsequently, the off-diagonal elements reflecting the changes in the relationships between the sectors are examined. The negative (positive) elements (cik) show that sector k influences negatively (positively) the contribution of sector i to the output multipliers of the other sectors of the economy. The largest negative values are found among the sectors "Real estate services" (RL), "Services furnished by membership organisations" (R94), "Mining and quarrying" (RB) and "Coke and refined petroleum products" (R19). On the other hand, the highest positive values are observed among the sectors "Air transport services" (R51), "Accommodation and food services" (RI) and "Services furnished by membership organisations" (R94).

From the sums of the causative matrix rows (except the diagonal elements), it is observed that for 26 out of 49 sectors sum above zero, indicating the increased effects on the output of each sector caused by final demand in other sectors. Highest sums are observed in the sectors “Professional, scientific and technical services” (R69_70-R71-R73-R74_75-R78-RR80_82), “Services auxiliary to financial services and insurance services” (R66) and “ Wholesale trade” (R46). In contrast, for 23 sectors, the rows sum (excluding diagonal) is less than zero, with the lowest being observed in the sectors “Real estate services” (RL), and “Mining and quarrying” (RB). In these sectors, there is a reduced impact on their output from final demand in other sectors.

From the investigation of sectorial linkages, it is observed that, in Greece, for the year 2000, the sectors with the strongest vertical linkages, as they are estimated through the Index of power dispersion, are “Food products, beverages and tobacco products” (R10_12), “Wood and of products of wood and cork” (R16), “Basic metals” (R24), and “Constructions and construction works” (RF). The last two sectors maintain particularly strong vertical linkages in 2010, while higher index values are observed in the sectors “Services furnished by membership organisations” (R94), “Fabricated metal products, except machinery and equipment” (R25) and “Air transport services” (R51). These sectors play a key-role in the economy as growth in these sectors produces an increase in final demand for inputs from other sectors of the economic system.

The examination of the horizontal sectorial linkages, based on Sensitivity of Dispersion index, reveals that sectors such as “Professional, Scientific and Technical Services” (R69_70-R71-R73-R74_75-R78-RR80_82), “Mining and Quarrying” (RB), “Real Estate Services” (RL), “Basic Metal” (R24) services, and “Financial services” (R64) show high values for both reference years (2000 and 2010). These sectors can be boost for the growth of the Greek economy, as an increase in the final demand of the other sectors causes an increase in the production activity of these sectors above the average.

The previously approach was adopted to identify the leading manufacturing sectors of the Greek economy. According to this, a sector is considered as dominant in the operation of an economy when the indices of sensitivity of dispersion and power dispersion (U_i and U_j) have values greater than the unit, and when the indices of horizontal and vertical variability (V_i and V_j) have relatively low values Table 3).

Table 3. Indicators of Dispersion, Variability and Product and Employment multipliers

Sector No.	Sector code	Index of power dispersion (U_j)		Index of sensitivity of dispersion (U_i)		Index of vertical variability (V_j)		Index of horizontal variability (V_i)		Product multiplier		Employment multiplier	
		2000	2010	2000	2010	2000	2010	2000	2010	2000	2010	2000	2010
1	R01	1.05	1.08	1.25	1.05	0.78	0.82	0.73	0.84	1.53	1.64	71.58	59.94
2	R02	0.75	0.97	0.81	0.72	0.98	0.89	0.95	1.04	1.09	1.47	21.14	43.09
3	R03	0.92	0.95	0.72	0.68	0.90	0.86	1.02	1.02	1.35	1.44	18.06	17.42
4	RB	0.75	0.73	1.98	1.39	0.97	0.96	0.68	0.74	1.10	1.10	4.56	2.15
5	R10_12	1.31	1.14	1.02	0.86	0.84	0.79	0.82	0.90	1.92	1.73	34.82	19.88
6	R13_15	1.00	0.83	0.87	0.80	0.94	0.94	1.01	0.96	1.46	1.27	22.10	10.30
7	R16	1.31	1.11	0.95	0.92	0.89	0.96	1.05	1.05	1.91	1.68	45.80	27.93
8	R17	1.06	1.02	1.12	0.97	0.98	0.92	0.96	0.94	1.54	1.55	9.84	7.15
9	R18-R58	1.19	0.90	0.86	1.10	0.78	0.82	0.91	0.78	1.74	1.52	30.28	10.86
10	R19	1.20	1.16	1.50	1.32	0.89	0.86	0.70	0.75	1.76	1.76	5.39	3.85
11	R20-R21	0.91	0.87	1.25	1.29	0.95	0.93	0.82	0.77	1.34	1.33	7.76	4.70
12	R22	1.02	1.06	0.84	0.83	0.84	0.82	0.93	0.92	1.49	1.62	11.95	10.49
13	R23	1.15	1.06	0.96	0.83	0.87	0.86	0.96	0.98	1.68	1.62	15.99	12.77
14	R24	1.27	1.25	1.53	1.59	0.86	0.82	0.87	0.82	1.86	1.90	8.96	7.91
15	R25	0.90	1.32	1.06	0.95	0.89	0.82	0.81	0.89	1.32	2.01	13.07	15.10
16	R26	0.77	0.68	0.79	0.82	0.97	0.99	0.95	0.89	1.12	1.04	4.02	1.50
17	R27	0.99	0.97	0.82	0.74	0.86	0.84	0.94	0.95	1.45	1.47	8.04	7.34
18	R28	0.82	0.92	0.89	0.76	0.92	0.85	0.88	0.93	1.20	1.39	7.85	8.40
19	R29	0.75	0.72	0.77	0.70	0.97	0.96	0.95	0.98	1.09	1.10	2.12	2.04
20	R30-R33	0.74	0.67	0.72	0.69	0.96	0.99	0.98	0.98	1.09	1.02	8.44	2.08
21	R31_32	0.96	0.87	0.79	0.79	0.85	0.87	0.94	0.92	1.41	1.32	22.41	16.57
22	RD	0.89	1.11	1.22	1.27	0.87	0.84	0.77	0.86	1.45	1.69	11.39	5.20
23	R36	1.10	0.91	0.73	0.72	0.79	0.86	0.97	0.97	1.61	1.38	20.84	12.55
24	R37_39	1.00	0.92	0.77	0.79	0.84	0.85	0.95	0.92	1.46	1.39	30.51	11.31
25	RF	1.22	1.31	1.18	1.03	0.76	0.76	0.76	0.84	1.78	2.00	23.01	20.49
26	R45	0.93	0.94	1.00	0.91	0.87	0.85	0.82	0.85	1.36	1.42	28.97	18.62
27	R46	1.10	1.15	1.46	1.75	0.85	0.81	0.69	0.64	1.43	1.75	16.19	12.30
28	R47-R95	1.12	1.03	1.25	1.24	0.84	0.81	0.74	0.73	1.46	1.57	53.43	40.97
29	R49	1.11	1.16	0.89	0.84	0.79	0.77	0.88	0.90	1.63	1.76	40.89	19.15
30	R50	1.13	1.14	0.72	0.70	0.81	0.79	0.98	0.97	1.65	1.73	10.15	6.79
31	R51	1.02	1.27	0.76	0.74	0.82	0.74	0.95	0.95	1.49	1.93	12.95	9.57
32	R52-R79	0.89	0.92	1.21	1.32	0.93	0.89	0.83	0.77	1.30	1.40	15.25	8.35
33	R53-R61	0.93	1.08	1.28	1.58	0.96	0.73	0.82	0.77	1.36	1.64	15.17	8.26
34	RI	1.14	0.94	0.89	1.01	0.78	0.84	0.88	0.81	1.66	1.43	27.94	21.22
35	R59_60-R90_92-R93	0.96	1.02	0.78	0.95	0.89	0.92	0.99	0.93	1.41	1.55	24.87	12.29
36	R62_63	0.99	0.95	0.80	0.84	0.86	0.86	0.96	0.91	1.44	1.45	23.08	18.10
37	R64	0.86	0.92	1.29	1.68	0.93	0.88	0.75	0.65	1.25	1.40	12.70	10.23
38	R65	1.14	1.04	0.77	0.78	0.83	0.82	1.00	0.92	1.67	1.59	29.65	12.56
39	R66	1.00	1.03	0.88	0.95	0.86	0.92	0.93	0.94	1.47	1.56	12.19	18.54
40	RL	0.84	0.81	1.70	1.46	0.91	0.91	0.64	0.67	1.23	1.23	3.09	2.31
41	R69_70-R71-R73-R74_75-R78-RR80_82	1.03	1.21	2.11	2.74	0.72	0.87	0.64	0.57	1.51	1.84	29.65	17.66
42	R72	1.00	1.17	0.73	0.78	0.87	0.82	1.03	1.01	1.46	1.78	29.04	13.95
43	R77	1.20	0.99	0.90	0.82	0.79	0.84	0.91	0.92	1.75	1.51	14.59	8.64
44	R84	1.03	0.94	0.70	0.66	0.83	0.83	1.01	1.00	1.50	1.42	24.00	19.65
45	RP	0.77	0.76	0.71	0.68	0.95	0.93	0.98	0.98	1.12	1.16	36.36	27.61
46	R86-R87_88	1.10	1.08	0.71	0.68	0.80	0.79	1.00	0.98	1.61	1.64	37.78	22.04
47	R94	1.21	1.36	0.72	0.69	0.76	0.71	0.98	0.99	1.77	2.06	20.82	15.27
48	R96	0.93	0.81	0.69	0.66	0.86	0.90	1.00	1.00	1.36	1.23	23.60	18.34
49	RT	0.68	0.66	0.68	0.66	1.00	1.00	1.00	1.00	1.00	1.00	67.71	56.81

In particular, the examination of the values of the above indices shows that, during the period 2000-2010, the Greek economy has a significant number of sectors that are strongly interconnected, both on a horizontal and a vertical level. These sectors, that can be characterized as leadership, have a particular weight in product formation and can be key determinants for the growth of the economy and the improvement of its competitiveness.

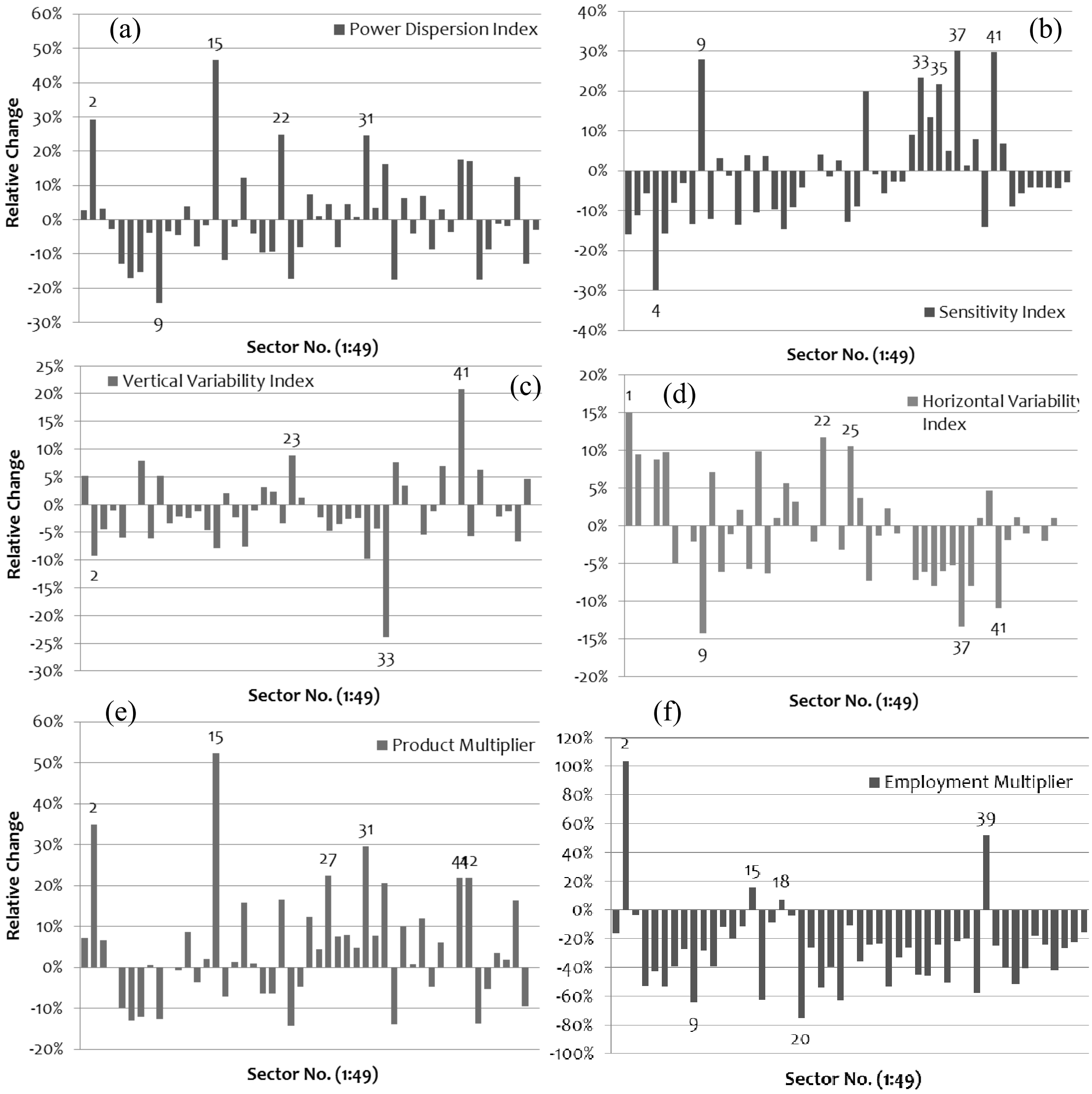
Specifically, between the years 2000 and 2010, there are 7 common sectors that have leading characteristics and are: “Products of agriculture, hunting and related services” (R01), “Coke and refined petroleum products” (R19), “Basic metals” (R24), “Wholesale and retail trade” (R45), and “Professional, scientific and technical services” (R69_70-R71-R73-R74_75-R78-RR80_82). Moreover, for the year 2000, as key-sectors is considered “Food products, beverages and tobacco products” (R10_12), while for the year 2010 the sectors “Electricity, gas, steam and air-conditioning” (RD) and “Postal and telecommunication services” (R53-R61).

From the survey of output multipliers, it is noted that, for the year 2000, the sectors with the largest output multipliers are “Food and beverages and tobacco products” (R10_12), “Wood and products of wood and cork” (R16), “Basic metals” (R24) and “Construction and construction works” (RF. The last two sectors maintained high values in output multipliers in year 2010, showing an increase compared to 2000. In general, in the year 2010, 30 sectors show an increase in output multipliers, with the most significant increases being observed in the sectors “Air transport services” (R51), “Fabricated metal products” (R25), “Products of forestry, logging and related services” (R02), “Professional, scientific and technical services” (R69_70-R71-R73-R74_75-R78-RR80_82) and “Scientific research and development services” (R72). On the contrary, the largest decreases were observed in the sectors “Rental and leasing services” (R77), “Accommodation and food services” (RI), “Natural water; water treatment and supply services” (R36) and “Wood and of products of wood and cork” (R16).

Concerning employment multipliers, the highest values for 2000 are observed in the sectors “Products of agriculture, hunting and related services” (R01), “Services of households as employers” (RT), “Wholesale and retail trade” (R45) and “Wood and of products of wood and cork” (R16). These sectors maintain high values in 2010, while the top of the list is the “Products of forestry, logging and related services” (R02) sector, showing a significant increase in the period 2000-2010. It is noteworthy that in the period 2000-2010 only 4 sectors (“Products of forestry, logging and related services” (R02) , “Machinery and equipment nec” (R28), “Services auxiliary to financial services and insurance services” (R66)) show an increase in employment multiplier values.

Finally, Figure 2 shows the distribution (along the 49 examined sectors) of the relative changes, for the power dispersion index (a), the sensitivity index (b), the vertical variability index (c), the horizontal variability index (d), the product multiplier (e), and the employment multiplier (f). Relative changes were computed for the years 2000 and 2010 on data shown in Table 3. In the diagrams of figure 2, outlier values are labeled separately for positive and negative cases.

Figure 2. Relative changes [(xβ-xα)/xα] distribution of the (a) power dispersion index, (b) sensitivity index, (c) vertical variability index, (d) horizontal variability index, (e) product multiplier, and (f) employment multiplier, computed on data of Table 3 for the years α=2000 and β=2010. Case labels are sector numbers shown in Table 1.



The results of Figure 2 show that outlier values that are counted more than once in these 6 (a-f) available diagrams are sectors with numbers (codes are shown in brackets) 2 (R02), 9 (R18-R58), 15 (R25), 22 (RD), 31 (R51), 33 (R53-R61), 37 (R64), and 41 (R69_70-R71-R73-R74_75-R78-RR80_82). These sectors appear more sensitive than the others to the relative changes captured for the years 2000 and 2010, indicating possible sectors where planning of appropriate policies should focus on.

4. Conclusions

Economic development is essentially a process of activities re-organizing themselves in such a way that they will grow and lead to an increase of total output. Structural changes should be considered as a necessary condition for further growth and therefore it is a cause of economic growth and not an outcome.

This article examined the structural changes of the Greek economy at the period prior to economic crisis (2000-2010), with techniques based on input-output analysis, which is an important methodological tool interpreting, inter alia, the functionality of an economic system. According to the structural decomposition analysis (SDA), at that period, an amount of 83.67% of the Greek economy's productive sectors witnessed an increase in their gross output. The most significant increases occurred in the tertiary sector, an particularly in the "Professional, scientific and technical services" (R69_70-R71-R73-R74_75-R78-RR80_82), "Real estate services" (RL), and "Wholesale and retail trade" (R45) sectors. Based on the examination of the influence of final demand and of technical coefficients on the output, it is noted that the effect of the technical coefficients on the growth of Total Gross Product is weaker in comparison with the effect of final demand. Sectors that have a positive effect on the change in total production due to the change in technical coefficients are fewer in number than the sectors that contribute to the increase in total gross product due to the change in final demand.

The results of the Left Causative Matrix analysis showed that for a significant number of sectors (18 out of 49 sectors), the effects of final demand are increasingly individually internalized. In addition, for nearly half of the sectors, an increased impact on their product was observed, which was caused by the change of the final demand in the other sectors.

The analysis overall showed that in the last few years there have been emerging new sectors with a leading role in the tertiary sector (e.g. the "Postal and telecommunication services" (R53-R61)), whereas the secondary sector (e.g. textiles, wearing apparel and leather products) appeared to lose the momentum developed in the past years.

Overall, the analysis revealed that, at the period 2000-2010, some of the productive sectors of the Greek economy have (to some extent) undergone changes in their structure. Based on the current circumstances and on the economic crisis recently affected Greece, the ultimate goal of policymakers should focus on the productive reconstruction of the Greek economy through the structural and technological transformation of the productive system of the country, in order to create a strong, competitive, and sustainable economy. The resources allocation should focus on the development of the leading sectors and on the sectors producing the highest multiplier effects. These sectors should formulate the decision variables in the planning of appropriate policies. By strengthening the interdependencies of the dominant sectors, in the first instance lay the foundations for creating and maintaining a strong productive web with the ultimate goal of development of the Greek economy and exit from the crisis.

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