MEASURING STRUCTURAL CHANGES OF THE GREEK ECONOMY DURING THE PERIOD OF ECONOMIC CRISIS

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Abstract
After a long period of growth, the Greek economy in 2008 tipped into recession, which lasted at the period 2008-2018 and still affects the economic recovery of the country, which appeared relatively slow due to the magnitude or the characteristics of the economic problem and the unsuccessful strategies adopted and implemented. This paper studies the evolution of the fundamental macroeconomic measures of the Greek economy and detects the key changes that have occurred during that period on data from the Input - Output Tables of the years 2010 and 2015. which provide a satisfactory context for describing the interconnections of productive sectors of an economy. The study aims to provide insights about the structural characteristics of the Greek economy, the profound knowledge of which contributes to the successful implementation of economic development policies and to the interconnection of its productive sectors, given that the intensification of relations between the productive sectors of an economy is a critical factor for a growth prospect and the expansion of productive activity brought about by developmental actions. The overall approach drives to conclusions and strategy proposals aiming at economic growth and development.
Keywords: Greek economic crisis, Input – Output Analysis, economic changes, structural changes

1. INTRODUCTION

The economic crisis that emerged in mid-2008 led to a dramatic increase of public debt in many advanced economies in EU (Greece, Portugal, Spain, Cyprus, etc). While the other countries managed to overcome quickly the main financial problems, in Greece this crisis had as results thousands of jobs to be lost, incomes to be slashed and taxes to be raised. Despite many similarities, key differences exist between the circumstances surrounding each crisis in these countries. The different speed of response to the economic crisis between Greece and other countries was due both to the measures taken and to the different causes of the crisis (Kouretas and Vlamis, 2010; Dudin et al., 2016).

It has been noted that during the period 2008-13, after many years of rapid economic growth, the country's real GDP contracted by 23%, while in the period 2008-2018 its GDP decreased by about 26% (ELSTAT, 2020). The fiscal constraints and economic austerity imposed had the expected effect of lowering demand and causing a deep recession, resulting in high unemployment, which amounted to 27.5% (Polyzos, 2019). The economic crisis has affected all regions of the country, to a large or small extent, depending on the structure of their economy. More generally, this crisis has led to changes in the structure of the Greek economy, its productive patterns and the way the economy operates.

On the causes of the economic crisis in Greece and the strategies that have been implemented to achieve economic growth, many analyzes have been made and various and often conflicting views have been formulated. Most of them conclude that there is a need for reversals in development and industrial policy, based

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on structural changes or reforms and modernization of productive patterns, namely the structure and the way the economy operates (Christodoulakis, 2013; Papadimitriou et al., 2013; Galenianos, 2015; Mavridis, 2018; Pagoulatos, 2018; Karamouzis and Anastasatos, 2019).

It is evident that during the economic crisis, changes were made or imposed in the processes of organizing productive activities and functional interconnections of the productive sectors of the economy. These changes reflect the evolution of the structure of the economy and the degree of interdependence of its productive sectors, while indirectly reflecting technological changes and changes in final demand. An investgaion of the changes in the way in which the productive activities of an economy are organized and interdependent can be achieved by utilizing the information contained in Input - Output Tables (Miller and Blair, 2009).

Input - Output (I-O) Analysis falls under the category of simultaneous equations models and describes the flow of goods or services between the individual sectors of an economy at a given time (eg a year). It is based on the theoretical framework developed by W. Leontief in the mid-1930s (Miller and Blair, 2009), while in its practical form the model of Leontief, like other modern models of general equilibrium, was based on the scientific work of F. Quesnay and L. Walras (Polyzos, 2019).

In its simplified form, the Input - Output model is a method of systematically quantifying the reciprocal productive relationships between the various sectors in the context of operation of an economic system. Otherwise, it is a method of systematically quantifying the interdependencies of the various sectors of an economy and product creation given production technology and describes the ability of a production system to create products endogenously, in combination with the activities that support it (added value, final demand). The analysis assumes that the output of each sector is affected by final demand and primary inputs (Polyzos 2006; Polyzos and Sofios 2008; Miller and Blair 2009).

Technological coefficients are the key element of Input - Output Analysis, while the use of a model for future changes analyzing presupposes their stability over time. Researchers report that technological coefficients remain stable for a period of 5-10 years, which requires a constant correlation between the output of each sector and the inputs used by it (Polyzos, 2019). Longer periods require adjustment of technological coefficients tables. The more developed the economy of a country and its regions are, the smaller the changes in the mix of inputs used and hence the changes in technological factors. The main factors affecting the stability of technological coefficients can be cited as the technological changes, changes in production process, price changes, changes in trade pattern, start-ups and other random factors (Miller and Blair, 2009).

Input - Output Analysis has been established as a very useful tool of economic and regional science and is used to analyse the impacts on the economy sectors at national, regional and local level, following investment actions or other economic changes (Miller and Blair, 2009; Polyzos, 2019). Given that the Input - Output Analysis interprets the functioning of an economic system by quantifying the interdependence of its sectors, this article will seek to study the changes in the Greek economy using the information included in Input - Output Tables. Specifically, by studying the changes in technological coefficients, final demand vectors, and intersectoral relationships of the Input - Output Tables for the years 2010 and 2015, the impact of the economic crisis on the productive structure of the Greek economy during this period is examined.

To overcome the economic crisis, the development of endogenous conditions for growth is considered necessary. These conditions, in combination with the necessary structural changes may improve productivity and mitigate the negative effects of external disturbances. In the context of Input - Output Analysis the effectiveness of structural change is greater, if through the interconnections of economic sectors, their diffusion will be achieved in a large number of economic activities. The development of strong intersectoral relationships between a wide array of productive sectors is a critical factor for the growth of economies (Pnevmatikos et al., 2019; Polyzos, 2019).

The remainder of the paper is organized as follows; Section examines the values of basic macroeconomic sizes that indirectly reflect the performance of the Greek economy during the economic crisis. The following will describe the key relationships and indicators that will be used to investigate the changes that have taken place in the Greek economy in 2010-15. For the indicators calculations information included in the input-output tables compiled by ELSTAT at the beginning and at the end of this period will be used. In addition, the results obtained from the implementation of the proposed indicators using the data included in the Input - Output

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Tables of 2010 and 2015 will be calculated and evaluated. Finally, conclusions regarding the changes in the Greek economy during the period under review, which emerge from the analysis that preceded it, will be formulated.

2. THE EVOLUTION OF MAIN MACROECONOMIC INDICATORS OF THE GREEK ECONOMY

In general, economic crisis is the phenomenon in which an economy is characterized by a continuous and noticeable decline in its activities (Pnevmatikos et al., 2019). Economic activities are depicted in macroeconomic sizes or indices of an economy, such as employment, GNP, investments, etc. There were a number of factors that have contributed to the appearance of economic crisis that Greece has been experienced during the decade 2009-2018. Some of these factors are endogenous related to the structure of the Greek economy, the prolonged macroeconomic imbalances that the Greek economy faced and the credibility problem of macroeconomic policy. Other factors are exogenous connected with the financial turmoil implications and the delayed Europe's reaction to the Greek economic crisis (Kouretas and Vlamis, 2010).

The economic crisis in Greece was considered more profound and lasting than in other European Union countries due to the structure and general characteristics of the Greek economy, which favored the emergence of the crisis (Dudin et al., 2016). The productive base of the Greek economy was weak as it was relied, in contrast to other European countries, on sectors such as tourism, shipping and construction, sectors affected first and foremost by the crisis. Greece suffered from deteriorating competitiveness as unit labor costs increased relative to international standards, causing exports to drop and current account deficits to worsen. In addition, Banks, were operated at an unprecedented rate of credit expansion, both domestically and internationally, that along with other large Greek companies were exposed to an international crisis with high risks (Mavridis, 2018; Pagoulatos, 2018; Karamouzis and Anastasatos, 2019).

In order the course of the economic crisis in Greece to be illustrated as well the efficiency of the measures taken, the evolution of some key macroeconomic sizes will be presented below using data from ELSTAT (2020) concerned the period 2007 to 2018. Figure 1 shows the evolution of GDP and total domestic demand during the aforementioned period. It is easy to observe that both macroeconomic sizes follow a parallel path, which includes a sharp decline until 2012, a steep rise until 2014 and a smaller rise thereafter. The parallel course of the two macroeconomic figures can be characterized as expected and justified, since the decline in total domestic demand, if not replaced by an equal increase in demand from exports, causes a decrease in firms output and therefore a corresponding change in GDP (Polyzos, 2019).

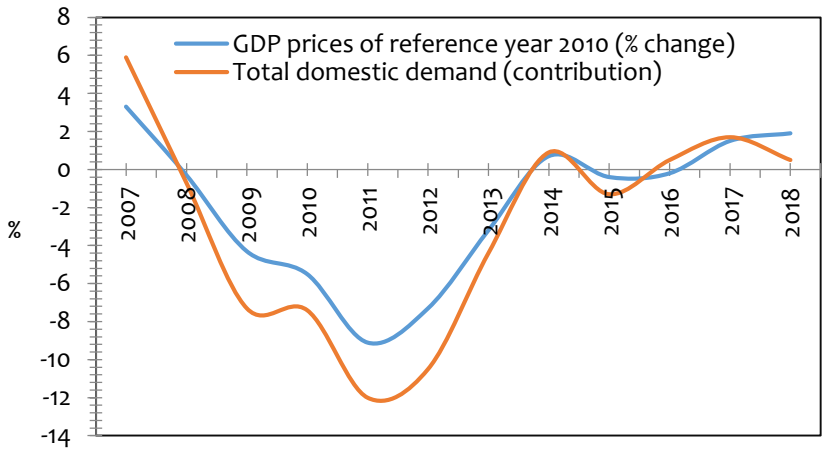

FIGURE 1 - THE EVOLUTION OF GDP (GROWTH RATE) AND DOMESTIC DEMAND (CONTRIBUTION) DURING THE PERIOD 2009-2018 (DATA SOURCE: ELSTAT, 2020).

Figure 2 illustrates the evolution of three other macroeconomics, Private consumption, Public consumption and Gross fixed capital formation (GFCF). The private consumption declined sharply in 2011 and 2012 related to the other two sizes, which was the result of increased taxation and reduced wages. On the contrary, the decline in the other two macroeconomic sizes has been smaller and is justified by the fact that these sizes are more inert than private consumption.

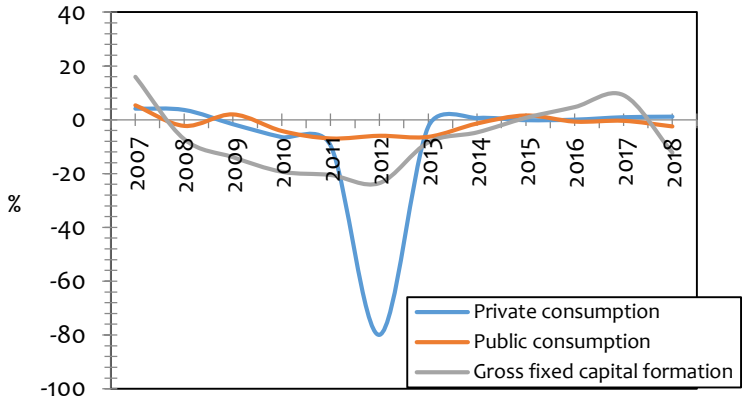

FIGURE 2 - THE EVOLUTION OF PRIVATE AND PUBLIC CONSUMPTION AND GFCF (GROWTH RATE) DURING THE PERIOD 2009-2018 (DATA SOURCE: ELSTAT, 2020).

Finally, Figure 3 shows the evolution of Exports, Imports and Unemployment during the aforementioned period. We see a sharp parallel decline in Exports, Imports in 2009, as the economic crisis was in its first stage. In the following years, both Exports and Imports have seen an increase, with both sizes taking a parallel course. Many of the structural changes adopted in the Greek economy, if examined in the context of Input - Output Analysis, were aimed at lowering the costs of producing enterprises and improving their productivity (Miller and Blair ,2009). Achieving these goals would lead to increased exports and the substitution of domestic demand, which was reduced by taxation and wage reduction (Polyzos, 2019).

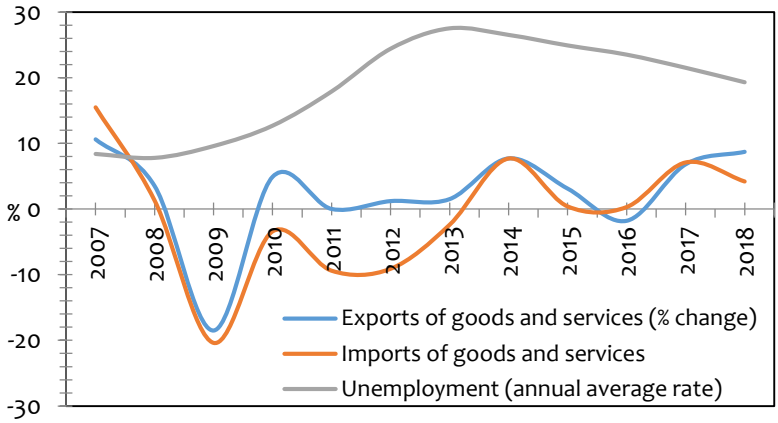

FIGURE 3 - THE EVOLUTION OF EXPORTS, IMPORTS AND UNEMPLOYMENT DURING THE PERIOD 2009-2018 (DATA SOURCE: ELSTAT, 2020).

However, exports did not increase during the period of economic crisis, while Figure 3 shows that part of domestic demand continued to be met by imports. It is also likely that the excessive increase in corporate taxation has led to increased production costs and reduced competitiveness with negative effects on their exports. These developments have resulted in a fall in GDP and an increase in unemployment. As we can see in Figure 3, unemployment has been steadily rising since the start of the economic crisis until 2013, and is gradually declining in the coming years. Otherwise, unemployment is moving in parallel with the GDP, while both GDP and unemployment up to 2018 failing to reach their 2007 levels.

The overall picture from these accounts is that the Greek economy felled in deep recession in the period 2008-2014 and then it recovered but very slowly. Slow recovery has not allowed a sharp drop in unemployment and improved macroeconomic indicators. The slow recovery has not allowed the sharp decline in unemployment and the improvement of macroeconomic indicators, which may be due to the lack of substantial reforms and structural changes.

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3. INDICATORS FOR THE ANALYSIS OF STRUCTURAL CHANGES AND THEIR APPLICATION TO THE GREEK ECONOMY FOR THE PERIOD 2010-2015.

The basic equation of the Input - Output methodology in the form of tables is the following (Miller and Blair, 2009):

$$X=(I-A)^{-1}\cdot Y \quad (1)$$

where X is the n×1 vector of final product, I is the n×n Identity matrix, A is the n×n matrix of technological coefficients or direct requirements, and Y is the n×1 vector of final demand.

The matrix A includes technological coefficients (aij), which show the number of units of one sector's output that are required to produce one unit of another sector's output and they are estimated BY the formula aij=xij/XJ, where xij is the flow from sector i to sector j, Xj is the total output of sector j. Technological coefficients, therefore, represent the structure of production cost, that is, the production technology used (Polyzos and Sofios, 2008; Miller and Blair, 2009).

The change in productivity of one sector causes two different effects on the production of the other sectors of the system (Miller and Blair, 2009; Polyzos, 2019). The first regards when an increase in output of sector j simultaneously causes increase in the demand of this sector for inputs from other sectors (named "backward linkage" of sector j), whereas the second when an increase in output of sector j increases the supply of this sector to other sectors by using the sector's j product as a productivity input (named "forward linkage" of sector j).

If the inverse matrix satisfies the expression B=(I-A)-1, which is also known as the Leontief inverse matrix and bij the elements of matrix B, then a unit change in the demand of sector i (s.t. the condition that the demand for the other sectors is zero) will cause an output per sector according to equation (2) (Polyzos and Sofios, 2008; Miller and Blair, 2009).

$$X=\begin{bmatrix} b_{11} & . & b_{1i} & . & b_{1n} \\ . & . & . & . & . \\ b_{i1} & . & b_{ii} & . & b_{in} \\ . & . & . & . & . \\ b_{n1} & . & b_{ni} & . & b_{nn} \end{bmatrix}\begin{bmatrix} 0 \\ . \\ 1 \\ . \\ 0 \end{bmatrix}=\begin{bmatrix} b_{1i} \\ . \\ b_{ii} \\ . \\ b_{ni} \end{bmatrix} \quad (2)$$

where the i-th column of the inverse matrix B indicates the unit production increase at each sector when one unit of final demand is generated in the sectors. In other words, the sum of the elements in column (sector) i expresses the total output after a unit increase in demand in this sector. This formula facilitates calculate some indicators that are useful in assessing the structural changes of an economy. It is worth noting that the Input – Output Analysis 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).

3.1. Output Multipliers

Multipliers derived from Input - Output Tables are particularly important to assess the effects of changes in final demand on the output of each industry, on income, employment, etc. An output multiplier for sector j is defined as the total value of production in all sectors of the economy that is necessary in order to satisfy a dollar's worth of final demand for sector j's output (Miller and Blair, 2009). The output multiplier for each sector is calculated from the sum of the bij elements of the corresponding Leontief inverse matrix column (Polyzos, 2019). By using formula (2), the output multiplier equals to:

$$PM_j=\sum_{i=1}^{n} b_{ij} \quad (3)$$

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where PMj is The output multiplier of sector j and bij are the elements of the Leontief's inverse matrix B.

An employment multiplier of a sector j expresses the total employment change caused in the economy after a change in the final demand of each sector. The calculation of the employment multiplier presupposes that the number of Ej employers and the total output Xj of each sector j are known. For the calculation of employment multipliers firstly the vector of direct employment rates DEj from the equation (4) are estimated (Miller and Blair, 2009):

$$DE_j = \frac{E_j}{X_j} \tag{4}$$

Then, total employment multipliers EMj are from the equation (5):

$$EM_j = DE_j B \tag{5}$$

These indicators along with the following will be estimated on data of the national Input - Output Tables of 2010 and 2015 (ELSTAT. The tables are of size 65×65, namely they include 65 sectors of the Greek economy. The productive content of each sector and its code are displayed in the Appendix.

Using the data of intersectoral exchanges (ELSTAT, 2020), for the years 2010 and 2015, the technological coefficients aij are calculated by equation aij=xij/Xj, as well as the inverse tables (I-A)1. The output multipliers PMj are then calculated from equation (3) and the final PMj results and the multipliers differences (PMj,2015 – PMj,2010) by sector are shown in Table 1.

TABLE 1 - OUTPUT MULTIPLIERS PER PRODUCTIVE SECTOR OF THE GREEK ECONOMY

No.	Sector	PM_j[a] (2010)	PM_j[a] (2015)	Diff[b]	No.	Sector	PM_j (2010)	PM_j (2015)	PM_j (2010)
1	A01	1.639297	1.635094	-0.0042	33	H51	1.726069	1.783834	0.057765
2	A02	1.384283	1.412265	0.027982	34	H52	1.298728	1.415784	**0.117056**
3	A03	1.426859	1.448416	0.021557	35	H53	1.564412	1.659418	0.095006
4	B	1.085902	1.076613	-0.00929	36	I	1.789266	1.755326	-0.03394
5	C10-C12	1.856865	1.780482	-0.07638	37	J58	1.670051	1.656073	-0.01398
6	C13-C15	1.343407	1.258085	-0.08532	38	J59_J60	1.688178	1.527041	-0.16114
7	C16	1.78686	1.87055	0.08369	39	J61	1.501498	1.579053	0.077555
8	C17	1.56173	1.735876	**0.174146**[b]	40	J62_J63	1.554126	1.541923	-0.0122
9	C18	1.821334	1.875196	0.053862	41	K64	1.314397	1.368489	0.054092
10	C19	1.837387	1.812071	-0.02532	42	K65	1.618373	1.556074	-0.0623
11	C20	1.348933	1.247999	-0.10093	43	K66	1.844964	1.490814	-0.35415
12	C21	1.228343	1.251549	0.023206	44	L68B	**1.13344**	**1.146722**	0.013282
13	C22	1.635757	1.697022	0.061265	45	L68A	**1.126521**	**1.138744**	0.012223
14	C23	1.854967	1.685731	-0.16924	46	M69_M70	1.372871	1.358088	-0.01478
15	C24	**2.007487**	1.719498	**-0.28799**	47	M71	1.613188	1.745134	**0.131946**
16	C25	1.888508	1.743052	-0.14546	48	M72	1.496887	1.399554	-0.09733
17	C26	1.041718	1.092231	0.050513	49	M73	**1.984481**	1.784962	-0.19952
18	C27	1.537353	1.546739	0.009386	50	M74_M75	1.688029	1.677381	-0.01065
19	C28	1.312712	1.294808	-0.0179	51	N77	1.640774	1.669585	0.028811
20	C29	1.123534	1.112245	-0.01129	52	N78	1.228467	1.181843	-0.04662
21	C30	**1.029917**	**1.034288**	0.004372	53	N79	**2.139624**	**2.232805**	0.093181
22	C31_C32	1.402572	1.385933	-0.01664	54	N80-N82	1.475904	1.598857	0.122954
23	C33	1.677542	1.578465	-0.09908	55	O84	1.373444	1.331176	-0.04227
24	D35	1.706533	1.537082	-0.16945	56	P85	1.113756	1.094545	-0.01921
25	E36	1.677042	1.737891	0.060848	57	Q86	1.378155	1.419371	0.041217
26	E37-E39	1.459218	1.432634	-0.02658	58	Q87_Q88	1.789631	1.505782	**-0.28385**
27	F	1.933263	1.976139	0.042875	59	R90-R92	1.463103	1.462587	-0.00052
28	G45	1.463915	1.565239	0.101324	60	R93	1.830111	1.884053	0.053942
29	G46	1.686406	1.695077	0.008671	61	S94	1.924406	1.705705	**-0.2187**
30	G47	1.500135	1.635734	**0.135599**	62	S95	1.19342	1.265902	0.072481
31	H49	1.670084	1.735091	0.065006	63	S96	1.291346	1.330445	0.039099
32	H50	1.802676	1.848651	0.045975	64	T	1	1	0

a. Multiplier
b. Difference PM_j(2015) – PM_j(2010)
c. Cases with highest and lowest values are shown in **bold**.

According to Table 1, the values of output multipliers range from 1.029917 to 2.139624 for 2010, corresponding to C30 and N79. For the year 2015 the lowest value is 1.034288, which corresponds to sector C30 and the highest value is 2,232805, which corresponds to sector N79. Next, some sectors show positive and some

negative values for their respective output multipliers for the two time periods. The largest positive changes were observed in sector C17 with a change of +0.1174146, sector G47 with a change of +0.135599 and sector M71 with a change of +0.1131946. The largest negative changes are observed in sector K66 with change –0.35415, sector C24 with change –0.228799 and sector Q87_Q88 with change –0.28385. Also, the sum of the total changes in the multipliers of all sectors is –0.83534. This shows that the multiplier capacity of the Greek economy contracted in 2015 compared to 2010, as 2015 produced less aggregate output for an equal change in the final demand of all sectors compared to 2010. It is noted that the equal change in the final demand of all sectors is a theoretical assumption, because in fact the final demand is never equal between the sectors, but shows significant differences. This does not limit the value of the conclusion to unfavorable evolution of the productive characteristics and productivity of the Greek economy due to the negative change in the total multipliers. The sectors with the highest values in multipliers represent key sectors of the Greek economy. These are the sectors that generate the greatest multiplier effects on the economy through their interconnections with other sectors.

TABLE 2 - RESULTS OF THE OUTPUT MULTIPLIERS PER PRODUCTIVE SECTOR, FOR THE GREEK ECONOMY

		Year 2010		Year 2015				Year 2010		Year 2015	
No.	Sector	HC[a]	GCF[b]	HC	GCF	No.	Sector	HC	GCF	HC	GCF
1	A01	4.12908	0.21337	4.93194	0.3761	34	H52	1.89337	1.56066	1.26036	0,90239
2	A02	0.0617	0.0084	0.09834	0.01816	35	H53	0.2999	0.20341	0.25375	0,25310
3	A03	0.40622	0.00286	0.35790	0.00276	36	I	8.29381	0.11805	**10.2366**	0,13153
4	B	1.87628	1.25851	2.25718	1.11269	37	J58	0.88594	0.81312	0.46566	0,86141
5	C10-C12	**8.8055**[c]	0.07566	**10.1301**[c]	0.10617	38	J59_J60	0.51368	0.27647	0.20171	0,32553
6	C13-C15	2.5611	0.2089	2.16433	0.23827	39	J61	3.25465	0.48512	**3.09380**	0,48419
7	C16	0.24981	0.55396	0.20318	0.44753	40	J62_J63	0.20029	2.39619	0.1807	3,67062
8	C17	0.73824	0.24353	0.84553	0.23643	41	K64	3.15448	1.18653	2.92098	1,22675
9	C18	0.23905	0.12831	0.17573	0.06158	42	K65	0.96432	0.2395	0.93279	0,23916
10	C19	**3.23906**	0.96248	**3.87164**	1.04382	43	K66	0.43774	0.3052	0.37876	0,24592
11	C20	1.64289	0.4728	1.78085	0.5712	44	L68B	5.95403	**3.68892**	**6.1679**	**3,97989**
12	C21	0.1474	0.00465	0.8113	0.0278	45	L68A	8.67000	**0**	**8.79033**	**0**
13	C22	0.67762	0.78271	0.82772	0.96222	46	M69_M70	1.45214	2.96375	1.39356	1,93865
14	C23	0.42453	**4.02154**	0.38610	2.74009	47	M71	0.23939	1.68273	0.24956	1,04747
15	C24	0.61659	**3.41773**	0.5867	**3.56489**	48	M72	0.02921	2.62711	0.03667	5,54494
16	C25	0.7889	**3.96261**	0.74416	**3.93201**	49	M73	0.65136	0.379	0.38936	0,2118
17	C26	0.32004	**3.51897**	0.36579	**6.19049**	50	M74_M75	0.28995	0.14514	0.28503	0,15452
18	C27	0.68347	1.34116	0.54585	1.86230	51	N77	0.30169	0.18390	0.28428	0,13969
19	C28	0.11436	**4.76241**	0.16010	**6.82120**	52	N78	0.02763	0.0456	0.04986	0,02916
20	C29	0.87509	0.86049	0.75211	0.9467	53	N79	0.8251	0.01340	0.97969	0,01653
21	C30	0.2639	**8.46066**	0.16175	**6.99505**	54	N80-N82	0.79797	0.18576	0.90711	0,29601
22	C31_C32	0.97848	0.93204	0.75386	1.87153	55	O84	1.18554	**2.4E-08**	1.12016	**3,16E-0**
23	C33	0.29641	0.59489	0.34373	0.5629	56	P85	1.58644	0.03751	1.41098	0,06405
24	D35	2.10749	0.93922	2.33712	1.02658	57	Q86	2.59859	0.01217	2.0581	0,01117
25	E36	0.34196	0.05850	0.4291	0.07703	58	Q87_Q88	0.21289	0.0038	0.10751	0,0052
26	E37-E39	0.65617	0.20737	0.81257	0.24036	59	R90-R92	1.26763	0.077	1.26876	0,08787
27	F	0.8937	**33.8788**	0.86396	**24.6768**	60	R93	0.13889	0.01464	0.13614	0,0134
28	G45	1.60244	0.98062	1.09167	0.72500	61	S94	0.12108	0.0969	0.07770	0,0793
29	G46	**6.92807**	**6.69182**	**6.09006**	**6.69395**	62	S95	0.19336	0.22224	0.19076	0,21731
30	G47	**3.97200**	**3.82308**	**3.13247**	**3.42970**	63	S96	0.66445	0.00158	0.53290	0,00188
31	H49	2.20364	0.39634	2.10781	0.5060	64	T	0.56778	**1.7E-05**	**0.27395**	**0,00178**
32	H50	0.22249	0.07045	0.22884	0.07970		**Total**	**97.35**	**103.88**	**98.2312**	**100.417**
33	H51	0.61379	0.08053	1.24567	0.08845						

a. Households Consumption
b. Gross Capital Formation
c. Cases with highest and lowest values are shown in **bold**.

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It should be noted that in this article the employment multipliers are not estimated by applying equations (4) and (5), as insufficient employment data are not available for all sectors. Employment data for all sectors is essentially derived from the National Censuses carried out every 10 years and therefore for 2015 there is no such data available from ELSTAT (2016, 2020).

The output multipliers were calculated using equation (3) by assuming that the final demand in each sector is equal to unit. In fact, there is no equilibrium of demand in each sector, as it is shown in the vector of final demand of Input - Output Tables. For this reason, the output multipliers will be calculated distributing demand by sector according to the real data of the Greek economy. Specifically, the output multipliers for 2010 and 2015 and for the final demand corresponding to Consumption expenditure by households and Gross fixed capital formation will be calculated. The calculation will be for aggregate demand equal to 64 units, which is the number of Input - Output Tables sectors.

The results of the calculations are shown in Table 2, where the sectors with high values and very low values of output multipliers are shown in bold. It is noted that total output multipliers are approximately 100, indicating that a total increase of 64 units in the Consumption expenditure by households or Gross fixed capital formation by enterprises will result in output of approximately 100 units. Therefore the total multiplier output is equal to 100/64 = 1.6. Also, the values in Table 2 show that there were no significant changes in total output multipliers from 2010 to 2015.

3.2. Power of Dispersion and Sensitivity of Dispersion indices

The indicators of intersectoral exchanges are a particularly useful tool that can help assess the productive structure of an economy. It also helps in exploring the importance of each sector in terms of the intensity of intersectoral exchanges and in highlighting the leading sectors of the economy. Chenery and Watanabe (1958) noted that the indices of backward and forward linkages of each sector should be calculated on the basis of their direct input requirements or their sales in the intermediate demand of the system. Therefore, the indicators should be based on the matrix of direct requirements. In particular, the vector of backward linkages indicators is estimated by the equation: $\mathrm{BL_j} = \sum_{i=1}^{n} a_{ij}$,while the vector of forward linkages indicators is estimated by the equation: $\mathrm{FL_i} = \sum_{j=1}^{n} a_{ij}$,, where a_{ij} denotes the elements of direct requirements matrix.

The above indicators take into account the direct effects arising from the interdependence of the sectors, while ignoring the indirect effects arising in the economy from external changes in the system. For this reason, these indicators are also called direct backward or forward linkages. As stated above, the sum of the elements of column i of the inverse matrix coefficients gives the total output required directly and indirectly in each sector when the final demand on the corresponding row of the final demand vector increases by one unit (Mattas et al., 2010).

The vertical sum of every column sector of the Leontief inverse matrix coefficients is divided by the mean value of the entire sum of column to produce a ratio, which indicates the relative magnitudes of production repercussions; that is, which sector's final demand can exert the greatest production repercussions on entire industries. This is called the "Index of the Power of Dispersion" Uj and can be calculated as follows:

$$U_j = \frac{\sum_{i=1}^{n} b_{ij}}{n} \Bigg/ \frac{\sum_{j=1}^{n}\sum_{i=1}^{n} b_{ij}}{n^2}, \text{ for } j=1, 2, \ldots, n \qquad (6)$$

Also, in the same way, the ratio produced by dividing the total (horizontal sum) by the mean value of the entire sum of row will indicate the relative influences of one unit of final demand for a row sector, which can exert the greatest production repercussions on entire industries. This is called Sensitivity of Dispersion indicator Ui, which can be calculated as follows:

$$U_i = \frac{\sum_{j=1}^{n} b_{ij}}{n} \Bigg/ \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} b_{ij}}{n^2}, \; i=1, 2, \ldots,n \tag{7}$$

In other words, Index of Power of Dispersion Uj gives the relative degree of diffusion in the economic system of a change in the final demand of sector j. If Uj> 1, then an increase in the final demand of sector j will cause an increase in the productive activity of the economy above the average. If Uj<1, then an change in the final demand of sector j will cause small changes in the economic system (Mattas et al., 2010; Pnevmatikos et al. 2019). The sensitivity of dispersion Index Ui shows the degree of impact of a change in the economic system on sector i. If Ui>1, then an increase in the final demand in the whole system of sectors has a large impact on sector i and will cause a large change in its production activity, above average. Conversely, if Ui<1, the effect that a change in the economic system will have on sector i activity, is less than average. Subsequently, the Power of Dispersion (Uj) and the Sensitivity of Dispersion (Ui) indices will be estimated by applying the equations (6) and (7). The results of estimations are shown in Table 3, where a positive relationship between the competitiveness of an industry and the competitiveness of the corresponding sectors is observed. With regard to the overall competitiveness of an economy, this does not appear as the sum of the performances of the sectors as a whole, but is the result of a more complex process and concerns the relationships of each sector with rest ones. For this reason, strengthening sectoral interconnections is embedded in the structural policies that seek to grow an economy (Hu and McAleer, 2004).

TABLE 3 - RESULTS OF THE POWER OF DISPERSION UJ AND SENSITIVITY OF DISPERSION UI INDICES.

		Year 2010		Year 2015				Year 2010		Year 2015	
No.	Sector	U_j	U_i	U_j	U_i	No.	Sector	U_j	U_i	U_j	U_i
1	A01	1.07025	1.094351	1.07653	1.09944	33	H51	1.126901	0.7355	1.17446	0.740177
2	A02	0.903759	**0.707236**	0.92982	**0.72059**	34	H52	0.847902	**1.67625**	0.93214	**1.31926**
3	A03	0.931555	**0.702545**	0.95363	**0.71306**	35	H53	1.02136	0.87431	1.09255	0.841706
4	B	**0.708954**	1.72375	**0.70883**	1.83948	36	I	1.168161	0.92676	1.15569	0.942173
5	C10-C12	1.212294	1.024001	1.17226	1.01512	37	J58	1.090328	0.80780	1.09035	0.785251
6	C13-C15	0.877072	0.874821	0.82831	0.87614	38	J59_J60	1.102163	0.79282	1.00539	0.718194
7	C16	1.16659	1.033081	1.23156	1.05177	39	J61	0.980285	1.10038	1.03964	1.095305
8	C17	1.019608	1.201613	1.14289	1.29135	40	J62_J63	1.014644	0.85463	1.01519	0.864072
9	C18	1.189097	0.795819	**1.23462**	0.74356	41	K64	0.858132	**1.87540**	0.90100	**1.856223**
10	C19	1.199577	**1.626874**	1.19306	**1.77170**	42	K65	1.056589	0.81149	1.02451	0.824325
11	C20	0.880679	1.149074	0.82167	1.24897	43	K66	1.204524	1.16443	0.98154	1.005954
12	C21	0.80195	0.67535	0.82401	0.73875	44	L68B	0.73999	**3.25396**	0.75499	3.480319
13	C22	1.067939	0.98843	1.11731	1.09868	45	L68A	0.735473	0.65287	0.74974	0.658396
14	C23	1.211055	0.941133	1.10987	0.90216	46	M69_M70	0.896308	**1.76570**	0.89416	**1.725326**
15	C24	**1.310631**	**1.679754**	1.13211	1.64565	47	M71	1.053204	0.89370	1.14898	0.882913
16	C25	1.232952	1.085198	1.14761	1.14102	48	M72	0.977275	0.69814	0.92146	0.709455
17	C26	**0.680108**	0.799847	**0.71912**	0.84832	49	M73	**1.295611**	1.03380	1.17521	0.874014
18	C27	1.003694	0.863701	1.01836	0.85269	50	M74_M75	1.102066	0.87885	1.10438	0.852986
19	C28	0.857032	0.717737	0.85249	0.75477	51	N77	1.071214	0.91269	1.09924	0.844355
20	C29	0.733523	0.68177	0.73229	0.68926	52	N78	0.802031	0.69811	0.77812	0.711783
21	C30	**0.672403**	0.697031	**0.68097**	0.69181	53	N79	**1.396899**	0.70238	**1.47006**	0.74826
22	C31_C32	0.915699	**0.723335**	0.91249	**0.71283**	54	N80-N82	0.963575	1.19945	1.05268	1.214289
23	C33	1.095219	0.871729	1.03925	0.89498	55	O84	0.896682	**0.65287**	0.87644	0.658399
24	D35	1.114147	**1.409355**	1.01200	**1.65973**	56	P85	0.72714	0.72533	0.72064	0.738251
25	E36	1.094893	0.73014	1.14422	0.754273	57	Q86	0.899758	0.71023	0.93450	0.683486
26	E37-E39	0.952682	0.817131	0.94324	0.866563	58	Q87_Q88	1.168399	**0.66151**	0.9914	**0.667312**
27	F	**1.262172**	0.980707	**1.30108**	1.028263	59	R90-R92	0.955218	0.95577	0.96296	0.897496
28	G45	0.955748	0.957463	1.03054	0.885609	60	R93	1.194827	0.77929	**1.24045**	0.735995
29	G46	**1.101006**	**2.05716**	1.11603	1.865427	61	S94	1.256389	0.74818	1.12302	0.728111
30	G47	0.979395	**1.446059**	1.07696	**1.28982**	62	S95	0.77915	0.74362	0.83346	0.753252
31	H49	1.09035	0.963063	1.14237	1.026343	63	S96	0.843083	0.65884	0.87595	0.666301
32	H50	1.176915	0.72971	1.21714	0.739257	64	T	**0.652871**	0.65293	**0.65839**	0.660748

a. Power of Dispersion indicator
b. Sensitivity of Dispersion indicator
c. Cases with highest and lowest values are shown in **bold**

The data in Table 3 show that the sectors with high values of Uj (Uj>1.25) for 2010 are N79, C24, M73 and F. Correspondingly, for 2015 the sectors with high values of Uj are N79, F, R93, C18 and C16. The sectors with

the lowest prices Uj, (Uj<0.70) for both years are the same for sectors U, C30, C26 and B. According to Table 2, the sectors with the lowest values of the Ui index (Ui<0.66) for both 2010 and 2015 (Ui<0.66) are service sectors. These sectors are: L68A, O84, T, S96 and Q87_Q88. Regarding the sectors with high values of the Ui index (Ui> 1.72), they are also the same sectors for both time periods. These sectors are: L68B, G46, K64, M69_M70 and B.

Since the estimation of Uj and Ui indices is based on the use of averages, these indices are sensitive to extreme values. For this reason, the description of the structure of a sector is not entirely satisfactory. For example, changing the final demand of a sector with a high Index of Power of Dispersion is likely to not affect the rest sectors, when this sector has limited transactions with many sectors (Mattas et al., 2010).

For the improvement of this methodological background the backward and forward indices of variability have been proposed, which take into account the dispersion of intermediate consumption and intermediate sales of the sector respectively (Boucher, 1976; Allaudin, 1986). At the same time, they are not sensitive to limit values such as normalized indices. So, it is possible the estimation of the extent to which the economic impacts associated with the individual sectors are spreading. In particular, for the size of production, variation is formulated by equations (8) and (9):

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

and

$$V_i = \sqrt{\frac{\frac{1}{n-1}\left[\sum_{j=1}^{n}\left(b_{ij} - \frac{\sum_{j=1}^{n} b_{ij}}{n}\right)^2\right]}{\frac{1}{n}\sum_{j=1}^{n} b_{ij}}} \quad (i=1, 2, \ldots,n) \tag{9}$$

where Vj is the backward variability and Vi is forward variability index.

Low values of these indices for a sector indicate that the indirect effects of this sector are distributed evenly across the rest of the sectors, while the opposite is true when the values of these indices are high. The backward index of variability Vj shows the relative dispersion of the indirect effect, due to changes in final demand in the sectors of the economy. The forward index of variability Vi shows the relative dispersion of the indirect effect due to changes in the final payments in the productive sectors. That is, high values of the variability indices show a high dispersion of intermediate exchanges of a sector to the other productive sectors, hence the relative uniformity of its results and vice versa.

The values of the backward indices of variability Vj and forward indices of variability Vi are then estimated using equations (8) and (9) and the results of the estimations are presented in Table 3. As mentioned above, low values of these indicators for one sector of the economy indicate that indirect effects are evenly distributed to other sectors, while the opposite is true for high values. Table 4 shows the high and low values of these indicators. An overview of the data in Table 4 shows that there were no significant changes in the values of these indices in the two time periods examined.

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TABLE 4 - ESTIMATIONS OF BACKWARD (VJ) AND FORWARD (VI) INDICES OF VARIABILITY

		Year 2010		Year 2015				Year 2010		Year 2015	
No.	Sector	V_j	V_i	V_j	V_i	No.	Sector	V_j	V_i	V_j	V_i
1	A01	0.90111	0.90711	0.90106	0.90610	33	H51	0.76270	0.94158	**0.75071**	0.94280
2	A02	0.90317	**1.02239**	0.89236	**1.01486**	34	H52	0.90781	**0.65704**	0.86487	0.732
3	A03	0.88411	**1.01901**	0.88775	**1.02750**	35	H53	0.80197	0.86390	0.77886	0.88444
4	B	0.96374	0.68798	0.96827	0.67199	36	I	**0.75761**	0.84716	**0.76284**	0.84126
5	C10-C12	0.80219	0.86646	0.81975	0.87522	37	J58	0.78615	0.90945	0.78732	0.92643
6	C13-C15	0.94497	0.94551	0.95242	0.92485	38	J59_J60	0.82278	0.96881	0.83902	0.99328
7	C16	0.95687	**1.01644**	**1.00986**	**1.09462**	39	J61	0.84885	0.7816	0.83709	0.79004
8	C17	**0.98266**	0.92955	**0.999**	0.9667	40	J62_J63	0.80817	0.88095	0.81227	0.88080
9	C18	0.77975	0.91124	0.77150	0.94501	41	K64	0.90501	**0.60751**	0.89136	**0.61752**
10	C19	0.86605	0.67482	0.881	**0.64861**	42	K65	0.82062	0.89797	0.82905	0.89423
11	C20	0.89733	0.79173	0.92125	0.75688	43	K66	0.93845	0.97464	0.87979	0.8910
12	C21	0.90310	0.98628	0.90281	0.9566	44	L68B	0.9638	**0.5125**	0.95993	**0.50009**
13	C22	0.80823	0.82674	0.80289	0.79057	45	L68A	0.9422	1	0.93638	1
14	C23	0.86666	0.98186	0.86557	0.96145	46	M69_M70	0.88057	**0.6160**	0.88520	**0.62482**
15	C24	**0.97889**	0.88149	**0.97979**	0.83328	47	M71	0.80007	0.85379	0.77794	0.86335
16	C25	0.79631	0.82702	0.82016	0.8053	48	M72	0.85065	**1.01096**	0.88257	**1.00959**
17	C26	**0.98340**	0.90456	0.97627	0.89649	49	M73	0.77429	0.80287	0.79119	0.86969
18	C27	0.83858	0.89057	0.83790	0.89529	50	M74_M75	0.80797	0.86204	0.81050	0.87849
19	C28	0.87817	0.95920	0.88730	0.94169	51	N77	0.82575	0.89393	0.80212	0.91492
20	C29	0.94599	0.98199	0.9500	0.97994	52	N78	0.90970	0.97623	0.92562	0.96848
21	C30	**0.98889**	0.97099	**0.98510**	0.97719	53	N79	**0.70440**	0.99247	**0.71128**	0.99378
22	C31_C32	0.84776	0.95476	0.85353	0.96417	54	N80-N82	0.84654	0.76146	0.84600	0.78982
23	C33	0.78706	0.87801	0.8131	0.87295	55	O84	0.85037	0.99999	0.8645	**0.99999**
24	D35	0.84816	0.74191	0.85924	**0.66986**	56	P85	0.94742	0.94928	0.96553	0.95424
25	E36	0.77786	0.95085	0.79261	0.96148	57	Q86	0.85450	0.96465	0.84450	0.98896
26	E37-E39	0.82782	0.89339	0.87369	0.907943	58	Q87_Q88	**0.74760**	0.99673	0.8144	0.99632
27	F	0.77404	0.87048	**0.76961**	0.85671	59	R90-R92	**0.98791**	0.99086	0.94535	0.98204
28	G45	0.83792	0.82535	0.81757	0.863	60	R93	0.81130	0.99636	0.77432	0.99702
29	G46	0.80353	**0.57904**	0.80047	**0.60816**	61	S94	**0.7304**	0.94304	0.77014	0.95712
30	G47	0.83133	0.67107	0.80482	0.71433	62	S95	0.91484	0.93590	0.8890	0.93408
31	H49	0.77711	0.82634	**0.76423**	0.8030	63	S96	0.87838	0.99537	0.86866	0.9971
32	H50	0.7626	0.95055	**0.74884**	0.95017	64	T	**1**	0.99995	**1**	**0.99816**

Cases with highest and lowest values are shown in **bold**.

3.3. Leading or key sectors

Leading or key sectors of an economy in the input-output model are the sectors that have simultaneously forward and backward linkages, as given by the normalized equations (6) and (7), greater than the average of all sectors of the economy. Identifying the leading sectors can be related to the size of production, employment, wages, or any other size investigated through input-output analysis (Allaudin, 1986; Oosterhaven, 2003; Lenzen, 2003).

Identifying the leading sectors of an economy facilitates the investigation of the magnitude of the effects of changes in supply and demand on a sector's output. Otherwise, it is easier to identify sectors with greater integration and diffusion of the endogenous dynamic feedback of the economy, as they are linked to the effects of changes in demand (backward linkages) and supply (forward linkages). Identifying the leading sectors of an economy on a national or regional scale facilitates the exercise of developmental policy. According to Allaudin (1986), a sector is considered to have a leading role in an economy when the Ui and Uj indices are higher than the unit and the Vi and Vj indices are relatively low. Conversely, a sector is considered to be non-leading if Uj<1 and Ui <1, while Vi and Vj have relatively high values (Alauddin, 1986; Lenzen, 2003; Pnevmatikos et al. 2019). These assumptions are used to identify the leading sectors of the Greek economy.

Based on the data in Tables 3 and 4, and considering the values of the indices Ui, Uj, Vj and Vi, it appears that during the period 2010-2015, the Greek economy has a number of productive sectors that are interconnected,

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but not strongly. Sectors that can be characterized as key-sectors are particularly important in product formation and can be determinants of economic growth and improved competitiveness. Tables 3 and 4 show that there have been no significant changes in the "hierarchy" of the leading sectors of the Greek economy over the period 2010-2015. Key sectors with strong interconnections are: F, N79, C19 and D35.

By combining the indices of the power of dispersion and those of the sensitivity of dispersion, we can create a typological presentation of the functions of each sector for the years 2010 and 2015. This can be achieved by constructing scatter plots (Figures 4 and 5) by placing the indices of the Uj dispersion power on the horizontal axis, and those of the sensitivity of Ui dispersion on the vertical axis. The position of each production sector in both Figures 4 and 5 can reveal its characteristics.

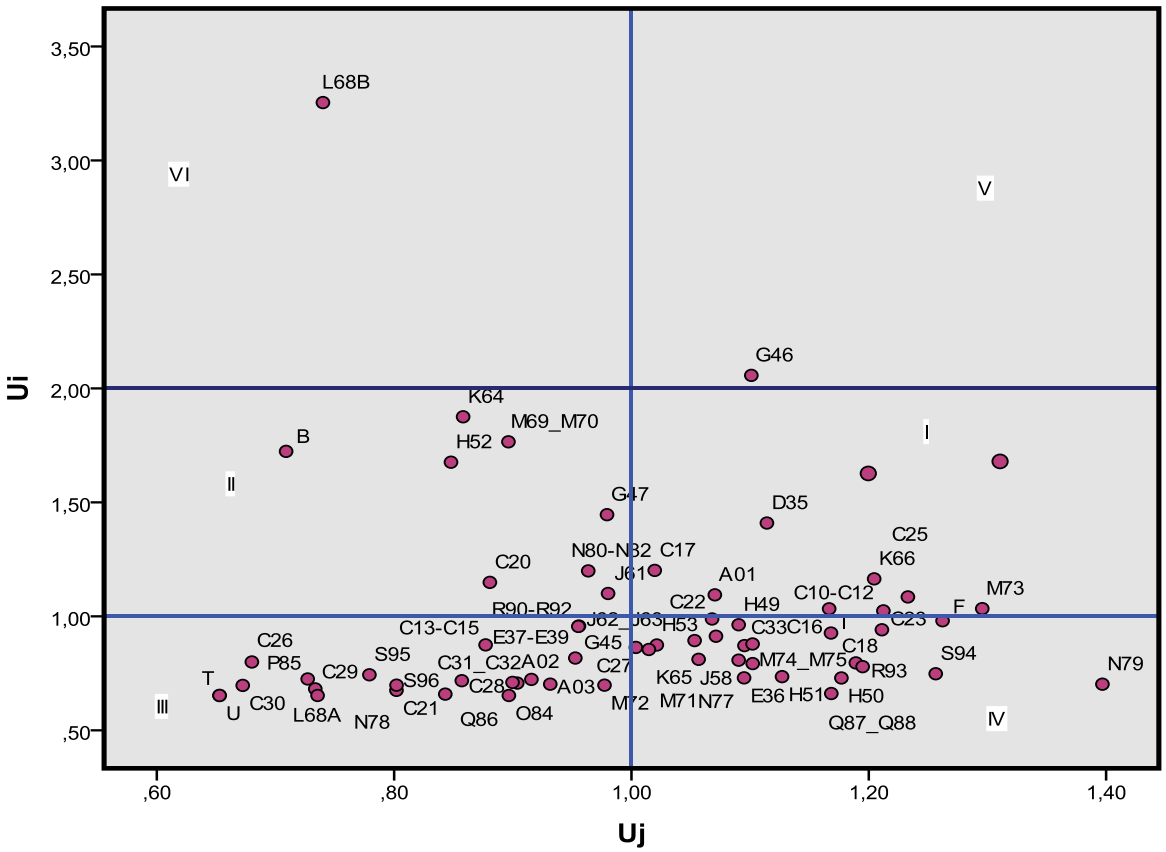

FIGURE 4 - CORRELATION SCATTER PLOT OF THE POWER OF DISPERSION (UJ) AND SENSITIVITY OF DISPERSION (UI) INDICATORS, FOR THE YEAR 2010 (DATA SOURCE: ELSTAT, 2020).

The productive sectors in the middle right part of these Figures (section I) can have a strong influence on other sectors and are more influenced by external influences. The main sectors of this section are the sectors of electricity, food, paper and paper products, tire production, etc. belonging to manufacturing and industry. The middle left section (section IIincludes sectors whose sensitivity is high, but the influence on other sectors is weak. Usually, these sectors provide services in other areas, such as business services, legal services, protection and research services, building and outdoor services, office management, secretarial services, etc. but also include manufacturing, such as minerals, quarries, chemicals, etc.

The lower left (section III) includes sectors whose influence and sensitivity are weak. This segment includes sectors of the primary sector such as forestry and fishing, as well as equipment, computers, machinery, and the ceramic or independent sectors, such as household services as domestic employers, non-differentiated goods and services. services provided by non-governmental organizations and bodies, etc.

The lower right (section IV) includes sectors with a strong impact on whole sectors, but relatively weak effects on production. Typically, these areas concern the production of gas and water treatment services, as well as transport services, cultural services, advertising services, etc. Finally, in the two upper divisions (section V and

VI), there are the Real Estate Management and Wholesale Services sectors, whose influence and sensitivity are weak.

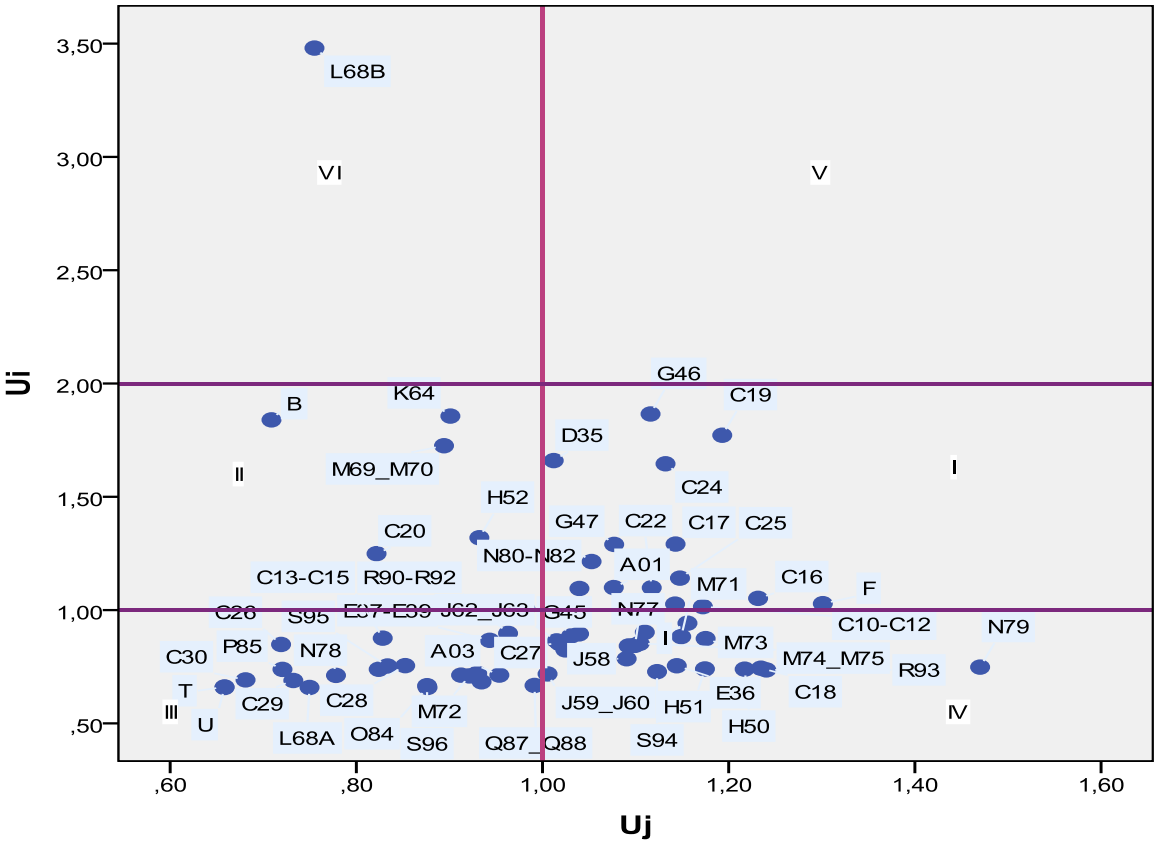

FIGURE 5 - CORRELATION SCATTER PLOT OF THE POWER OF DISPERSION (UJ) AND SENSITIVITY OF DISPERSION (UI) INDICATORS, FOR THE YEAR 2015 (DATA SOURCE: ELSTAT, 2020).

3.4. Variability of technological coefficients

The degree of variability of the technology used in the production process of the sectors of an economy and the possible existence of structural changes in the production process appear indirectly in the technological coefficients of Input - Output Analysis. To analyze the changes in the technological coefficients of the Greek economy over the period 2005-2010, appropriate statistical indices are calculated. In particular, the similarity index (Sj), derived from the relationship, is calculated from the following equation (Le Masne, 1990):

$$S_I=100(1-0.5\sum_{i=1}^{n}\left|a_{ij0}-a_{ij1}\right|) \quad (10)$$

Where αij0 and αij1 are the normalized technological coefficients for the reference time period.

Values of Sj close to 100 show high similarity between the data examined. To obtain valid results, the Spearman's (rs) and Kendall's (τ) correlation coefficients are calculated according to the following formulas (Tsiotas, 2016; Polyzos, 2019; Tsiotas, 2019):

$$r_n=1-\frac{6\sum_{i=1}^{n}d_i^2}{N^3-N},\ \tau=\frac{S}{\frac{1}{2}N(N-1)} \quad (11)$$

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where N is the number of sectors, di is the difference between the positions of each observation in the 2 different years of examination, and S is the sum of the values (1 or -1) according to the position of each observation in the second year of examination compared to the first.

The correlation coefficients receive values from -1 (negative linear correlation) to 1 (positive linear correlation) (Tsiotas, 2016; Polyzos, 2019; Tsiotas, 2019). Then, the indices of similarity of technological coefficients will be calculated, as well as the Spearman and Kendall correlation coefficients using equations (10) and (11). The results of the calculations are shown in Table 5.

TABLE 5 - RESULTS OF SIMILARITY SJ INDICATORS AND OF SPEARMAN'S (RS) AND KENDALL'S (T) CORRELATION COEFFICIENTS

No.	Sector	S_j	τ	r_s	No.	Sector	S_j	τ	r_s
1	A01	97.29	0.893	0.96	34	H52	94.723	0.849	0.952
2	A02	98.142	0.88	0.95	35	H53	94.403	0.914	0.985
3	A03	98.765	0.951	0.991	36	I	95.890	0.804	0.894
4	B	99.046	0.949	0.989	37	J58	93.789	0.844	0.940
5	C10-C12	95.341	0.921	0.988	38	J59_J60	94.670	0.781	0.908
6	C13-C15	96.643	0.84	0.95	39	J61	95.064	0.869	0.961
7	C16	93.985	0.823	0.915	40	J62_J63	95.831	0.843	0.934
8	C17	94.533	0.833	0.954	41	K64	98.189	0.644	0.809
9	C18	94.56	0.909	0.984	42	K65	99.100	0.76	0.902
10	C19	96.006	0.888	0.977	43	K66	90.099	0.922	0.985
11	C20	96.337	0.843	0.956	44	CL68B	98.712	0.813	0.914
12	C21	97.728	0.916	0.962	45	L68A	98.333	n/a	n/a
13	C22	95.185	0.825	0.916	46	M69_M70	98.150	0.834	0.952
14	C23	91.288	0.896	0.969	47	M71	93.65	0.881	0.963
15	C24	92.478	0.934	0.983	48	M72	95.843	0.995	1.00
16	C25	94.451	0.884	0.970	49	M73	92.255	0.83	0.932
17	C26	97.934	0.759	0.897	50	M74_M75	97.981	0.889	0.965
18	C27	95.946	0.849	0.938	51	N77	95.588	0.841	0.928
19	C28	98.078	0.873	0.972	52	N78	98.376	0.791	0.934
20	C29	98.52	0.891	0.946	53	N79	89.785	0.911	0.955
21	C30	99.474	0.855	0.954	54	CN80-N82	93.442	0.828	0.95
22	C31_C32	95.751	0.889	0.966	55	O84	92.834	0.807	0.81
23	C33	94.207	0.799	0.903	56	P85	98.337	0.938	0.991
24	D35	89.234	0.823	0.941	57	Q86	95.149	0.936	0.985
25	E36	86.372	0.847	0.926	58	Q87_Q88	82.97	0.948	0.957
26	E37-E39	86.530	0.897	0.958	59	R90-R92	95.884	0.931	0.978
27	F	95.117	0.934	0.989	60	R93	87.992	0.952	0.991
28	G45	94.733	0.796	0.936	61	S94	91.455	0.839	0.936
29	G46	95.259	0.853	0.967	62	S95	97.218	0.905	0.982
30	G47	93.372	0.839	0.958	63	S96	84.605	0.901	0.906
31	H49	94.159	0.651	0.784	64	T	100	0.671	0.733
32	H50	90.117	0.859	0.949	65	U	100	n/a	n/a
33	H51	94.178	0.889	0.979					

n/a: not available

The values of the Index of similarity (Sj) shows that the majority of sectors are above 85, indicating that there is no significant change in the sector's technological coefficients between 2010 and 2015. The above is also confirmed by the values of Kendall and Spearman correlation coefficients, which are particularly high for almost all sectors, which implies that the technological coefficients of 2010 are highly correlated with the 2015 technological coefficients.

3.5. Assessment of the production techniques

In order the differences in the production structure of the Greek economy over the period considered to be compared, the estimation of a relevant index is possible using the technological coefficients of Input - Output Analysis (Bekhet, 2009). This index is a measure of the comparability of production techniques on an sector by sector basis and is estimated from the sum of absolute differences in coefficients ("absolute column measure

") divided by an "average column total" for two years, PTj. Specifically, the PTj index can be estimated from the equation:

$$PT_j = \frac{\sum_{i=1}^{n} \left| a_{ij0} - a_{ij1} \right|}{\frac{1}{2} \sum_{i=1}^{n} (a_{ij0} + a_{ij1})} \quad (12)$$

where aij0 is the technological coefficient of the reference year, and aij1 is the technological coefficient for the comparator year.

As a result, the values of the PTj index range from 0 to 2 (0<PTj<2). In particular, when the PTj index equals zero (PTj=0), the production techniques are completely identical in the two periods considered, while when the PTj index equals two (PT=2), the production techniques have the highest level of measurable difference. According to Chenery and Watanabe (1958), the value PTj=0.80 can be used as a "borderline". If PTj<0.80, the production techniques used in both cases (base year and comparator year) are approximately the same or there are not significant differences. The indices of "Comparison of production techniques" will then be calculated to identify the differences in the productive structure of the Greek economy over the period considered. These indices are calculated using equation (12), and the results are shown in Table 6.

TABLE 6 - INDICATORS OF COMPARISON OF PRODUCTION TECHNIQUES PTJ

No.	Sector	PT_j[a]	No.	Sector	PT_j	No.	Sector	PT_j
1	A01	**0.138451**	22	C31_C32	0.355705	43	K66	0.462534
2	A02	**0.145039**	23	C33	0.292222	44	CL68B	0.269552
3	A03	**0.087513**	24	D35	0.512086	45	L68A	0.381319
4	B	0.356533	25	E36	0.583242	46	M69_M70	**0.136599**
5	C10-C12	**0.187467**	26	E37-E39	**0.948378**	47	M71	0.257164
6	C13-C15	0.326867	27	F	**0.174055**	48	M72	0.285798
7	C16	0.248548	28	G45	0.277045	49	M73	0.232622
8	C17	0.273665	29	G46	0.195366	50	M74_M75	**0.076216**
9	C18	0.204258	30	G47	0.316715	51	N77	0.205461
10	C19	**0.12022**	31	H49	0.272486	52	N78	0.231691
11	C20	0.391501	32	H50	0.365323	53	N79	0.279675
12	C21	0.29489	33	H51	0.243739	54	CN80-N82	0.376655
13	C22	0.213682	34	H52	0.449654	55	O84	0.620443
14	C23	0.348186	35	H53	0.288922	56	P85	0.492514
15	C24	0.299374	36	I	**0.176139**	57	Q86	0.368508
16	C25	0.229927	37	J58	0.28222	58	Q87_Q88	0.796807
17	C26	**0.891051**	38	J59_J60	0.274811	59	R90-R92	0.269369
18	C27	0.256146	39	J61	0.238333	60	R93	0.446446
19	C28	0.2088	40	J62_J63	0.221897	61	S94	0.352225
20	C29	0.397168	41	K64	**0.153349**	62	S95	0.346984
21	C30	0.4943	42	K65	**0.049141**	63	S96	**1.518581**

a. Production techniques index

Cases with highest and lowest values are shown in **bold**.

The values in Table 5 show that there were no major changes in production techniques in most sectors, as the values of the PTj index are relatively small. The sectors with the highest index values (PTj>0.80) are: S96, E37-E39 and C26. The general conclusion, however, that can be drawn from a general overview of the values in Table 5, is that in the period 2010 to 2015 there were no significant changes in the production techniques of the Greek economy in most of the production sectors. This reinforces the aspect that during a 5-year period there are no significant changes in the production process of enterprises.

3.6. Comparability in Intermediate Use

Another useful approach to the problem is the examination of the degree of similarity between two input - output tables in the intermediate use of a good. Similarity between input-output tables for two years (base year 0 and

comparator year 1) in the intermediate use of commodity i by industry j can be analyzed by comparing the intermediate use in the comparator table that would be necessary, using the input coefficients in the base table, with the actual level of use in the comparator table. The comparison could be done for an sector i by multiplying the production levels of the economy in the table of the comparator year with the input coefficients (along the row) of the reference table year, and dividing this sum by the total intermediate use of sector i of comparator year, IUi (Bekhet, 2009). This measure can be expressed as:

$$IU_i = \frac{\sum_{j=1}^{n} a_{ij0} X_{j1}}{\sum_{j=1}^{n} a_{ij1} X_{j1}} \quad (13)$$

The values of IUi are affected by the patterns of intermediate use in the base year, while in the case the value of IUi is close to 1, the similarity of the technical production between the two input-output tables will be large. Deviation of the value of IUi from 1 may be due to various factors, such as input substitution without compensating price variations, or conceptual differences in the definition of the products or sectors.

Then, the indices of comparison on intermediate use IUi for the two years (reference year 2010 and comparator year 2015) are calculated. The results are shown in Table 7, where it can be observed that indicator values are IUi<0.75 and IUi>1.25, implying a relatively large deviation from 1. The sectors with IUi<0.75 are: A02, C21, C28, E37-E39, N78 and N79. On the contrary, the branches with IUi>1.25 are: C16, C18, G45, H52, J59_J60, M73, N77, Q86, R93, and S94.

TABLE 6 - RESULTS OF THE COMPARABILITY IN INTERMEDIATE USE (IUI) INDICATOR

No.	Sector	IU_i	No.	Sector	IU_i	No.	Sector	IU_i
1	A01	1,024403	22	C31_C32	1,454588	43	K66	1,070336
2	A02	**0,601988**	23	C33	0,935343	44	CL68B	0,841317
3	A03	1,247142	24	D35	0,791731	45	L68A	x
4	B	0,959319	25	E36	0,901889	46	M69_M70	0,993678
5	C10-C12	1,011924	26	E37-E39	**0,726546**	47	M71	0,943547
6	C13-C15	1,022549	27	F	0,88371	48	M72	0,777552
7	C16	**1,332615**	28	G45	**1,42682**	49	M73	**1,760034**
8	C17	0,84793	29	G46	1,18073	50	M74_M75	1,163677
9	C18	**1,672362**	30	G47	1,118916	51	N77	**1,375572**
10	C19	0,879293	31	H49	0,865833	52	N78	**0,625578**
11	C20	0,865954	32	H50	0,950268	53	N79	**0,725794**
12	C21	**0,195792**	33	H51	1,000738	54	CN80-N82	0,91025
13	C22	0,754815	34	H52	**1,451725**	55	O84	1,10756
14	C23	1,065288	35	H53	1,15817	56	P85	0,752746
15	C24	1,026333	36	I	1,09919	57	Q86	**2,802386**
16	C25	0,857028	37	J58	1,123788	58	Q87_Q88	0,963512
17	C26	0,795401	38	J59_J60	**2,345253**	59	R90-R92	1,24436
18	C27	0,985134	39	J61	0,929633	60	R93	**1,649782**
19	C28	**0,700147**	40	J62_J63	1,03861	61	S94	**1,349845**
20	C29	0,866737	41	K64	1,154112	62	S95	0,922838
21	C30	1,068596	42	K65	0,895452	63	S96	0,863121

4. CONCLUSIONS

The implementation of structural changes and the improvement of the efficiency of the Greek economy are among the measures proposed and taken to tackle the economic crisis in Greece. But, it is certain that implementing structural reforms is not easy, as it requires significant changes in the way the sectors of the economy operate and in the production process.

Developments and changes affecting structural characteristics of an economy, as reflected indirectly in the interconnections of its productive sectors, are linked to the ability of the economy to develop new activities, produce more product and, more generally, to grow. The analysis of the Greek economy in the previous sections for the period 2010-2015 revealed some of its features and the size of the changes that occurred during that period.

The main macroeconomic indicators presented in section 2 showed the evolution of the Greek economy and indirectly the effectiveness of the measures taken to deal with the crisis. A general view of the results of the analysis shows that the measures taken did not significantly affect the production process of many sectors of the economy and there were no significant changes in their structure. It is noted that the time period studied is relatively short, so that no sharp changes in the functioning of the economy can be expected. Otherwise, the multiplier effects of the sectors of the Greek economy, as a result of their functional relations and interconnections, as a whole do not show any significant changes.

There have been no significant technological changes, as reflected in the relevant indicators calculated, with the result that the endogenous capacity of the industries to generate additional product, employment and income has not improved. However, some of the leading sectors are identified, as well as other sectors with growth prospects, which can be at the core of the planned developmental policies.

The conclusions of the preceding analysis can be summarized first that there are no significant technological changes in the productive process of the sectors, which would improve their profitability and ultimately the efficiency of the whole economy. Next, changes in output multipliers were relatively small, many positive and many negative, and the overall effect was not particularly significant. Also, the variability of technological coefficients was limited, a finding that emerges from a consideration of similarity indices and correlation coefficients. Besides, the comparison of production techniques and intermediate use indices did not show any significant changes in the structure of the Greek economy. Finally, there were no significant changes in the hierarchy of the leading sectors of the economy, while the transport and energy sectors occupied a leading position during the period considered.

The general conditions that have emerged in the last decade and given the economic crisis affecting Greece at this time, impose actions that will lead to the reconstruction of the Greek economy. These actions should aim at structural and technological transformation of the country's productive system with the aim of creating a strong, competitive and sustainable economy. Contemporary competitive economies are characterized by strong relationships that develop between their sectors.

The rise in the level of growth of an economy is linked to the increasing complexity of the functional relationships of its productive sectors, while strengthening these relationships improves the prospect of new productive activities that will expand the base of the economy. Therefore, the operational interdependence of productive sectors should be strengthened in order to increase the size of output, income and employment multipliers.

A key goal should be to further develop the leading industries and to empower the industries with the greatest multiplier results. These sectors should be at the "heart" of development actions, to lay the foundations for the creation and maintenance of a strong productive tissue that will ultimately aim for the sustainable and self-sustaining growth of the Greek economy and the exit from the crisis.

Finally, it should be noted that the analysis performed and the evaluation of the final results found are subject to certain limitations, which are related to the basic Input - Output model assumptions and the possible loss of information when preparing the relevant Tables. However, its findings are particularly useful in formulating sectoral and national development policy proposals.

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APPENDIX - *The productive sectors of the Greek economy*

Code	Economic (Productive) sector
A01	Products of agriculture, hunting and related services
A02	Products of forestry, logging and related services
A03	Fish and other fishing products; aquaculture products; support services to fishing
B	Mining and quarrying
C10-C12	Food products, beverages and tobacco products
C13-C15	Textiles, wearing apparel and leather products
C16	Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials
C17	Paper and paper products
C18	Printing and recording services
C19	Coke and refined petroleum products
C20	Chemicals and chemical products
C21	Basic pharmaceutical products and pharmaceutical preparations
C22	Rubber and plastics products
C23	Other non-metallic mineral products
C24	Basic metals
C25	Fabricated metal products, except machinery and equipment
C26	Computer, electronic and optical products
C27	Electrical equipment
C28	Machinery and equipment n.e.c.
C29	Motor vehicles, trailers and semi-trailers
C30	Other transport equipment
C31_C32	Furniture; other manufactured goods
C33	Repair and installation services of machinery and equipment
D35	Electricity, gas, steam and air-conditioning
E36	Natural water; water treatment and supply services
E37-E39	Sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services
F	Constructions and construction works
G45	Wholesale and retail trade and repair services of motor vehicles and motorcycles
G46	Wholesale trade services, except of motor vehicles and motorcycles
G47	Retail trade services, except of motor vehicles and motorcycles
H49	Land transport services and transport services via pipelines
H50	Water transport services
H51	Air transport services
H52	Warehousing and support services for transportation
H53	Postal and courier services
I	Accommodation and food services
J58	Publishing services
J59_J60	Motion picture, video and television programme production services, sound recording and music publishing; programming and broadcasting services
J61	Telecommunications services
J62_J63	Computer programming, consultancy and related services; information services
K64	Financial services, except insurance and pension funding
K65	Insurance, reinsurance and pension funding services, except compulsory social security

Code	Economic (Productive) sector
K66	Services auxiliary to financial services and insurance services
L68B	Real estate activities without imputed rents
L68A	Imputed rents
M69_M70	Legal and accounting services; services of head offices; management consulting services
M71	Architectural and engineering services; technical testing and analysis services
M72	Scientific research and development services
M73	Advertising and market research services
M74_M75	Other professional, scientific and technical services; veterinary services
N77	Rental and leasing services
N78	Employment services
N79	Travel agency, tour operator and other reservation services and related services
N80-N82	Security and investigation services; services to buildings and landscape; office administrative, office support and other business support services
O84	Public administration and defence services; compulsory social security services
P85	Education services
Q86	Human health services
Q87_Q88	Social work services
R90-R92	Creative, arts and entertainment services; library, archive, museum and other cultural services; gambling and betting services
R93	Sporting services and amusement and recreation services
S94	Services furnished by membership organisations
S95	Repair services of computers and personal and household goods
S96	Other personal services
T	Services of households as employers; undifferentiated goods and services produced by households for own use
U	Services provided by extraterritorial organisations and bodies