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# Dissecting the Input-Output Structure of the Greek Economy\*

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## ABSTRACT

Using input-output table data and a system of basic and derivative indices, the analysis in this paper provides a dissection of the Greek economy for the years 2005 and 2010. The findings suggest that: (i) the structural features of the economy have been shaped well before the emergence of the so-called Greek (or PIIGS) crisis; (ii) a well-targeted effective demand management policy could be mainly based on the service and primary production sectors; and (iii) industrial policy would be necessary and could primarily focus on nine highly import-dependent commodities of the industry sector. Therefore, it seems that a change in the intersectoral structure of the Greek economy is necessary.

*Key words:* Domestic and foreign value added; Greek economy; Industrial policy; Interindustry linkages and leakages; Management of effective demand; Structural transformation

*JEL classification:* C67, D57, E61, F14, O25

## 1. Introduction

During the period 2008-2010, the Greek economy faced serious external and fiscal imbalances. In 2010, the unemployment rate was at 12.7%, the government budget and current account deficits, amounted to 11.1 % and 10.1% of GDP, respectively, while the trade balance deficit was 6.8% (according to Bank of Greece data). The public debt reached 146% of GDP, the ‘net international investment position’ was at minus 97.9% and, finally, the net national savings were minus 24 billion euro or 13%

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of the net national disposable income (according to Hellenic Statistical Authority data).<sup>1</sup>

The Greek governments attempted to correct those imbalances by the application of contractionary fiscal and internal devaluation policies, such as *indiscriminate* reductions in government expenditures, increases in taxes and cuts in unit labour costs. These policies resulted to a significant improvement of the state budget primary deficit but with a GDP contraction (for the period 2010-2013) of about 22.2% (in constant prices of 2010) and a rate of unemployment of about 27.5%. In the same period, the exports were reduced by 3.3% and the imports by 15.5% (in constant prices of 2010), while the export market share of world's total was reduced by 9.4% (according to Hellenic Statistical Authority and World Bank data).

The objective of this paper is to analyze the intersectoral structure of the Greek economy and thus to provide a context for formulating possible alternative economic policy programmes. For this purpose, we use:

- (i). Data from the Symmetric Input-Output Tables (SIOTs) of the Greek economy for the years 2005 and 2010;<sup>2</sup> and
- (ii). A system of basic and derivative indices associated with the constituent components of gross national expenditure and the external sector of the economy, respectively (Mariolis, 2018).

The remainder of the paper is structured as follows. Section 2 gives the system of indices. Section 3 presents and evaluates the main empirical results. Finally, Section 4 concludes.

## 2. The System of Indices

For each produced commodity  $i$  ( $=1, 2, \dots, n$ ) it holds true that

$$X_i = IC_i + C_i + I_i + EX_i - IM_i \quad (1)$$

where  $X_i$  denotes the gross domestic production,  $IC_i$  the intermediate consumption (domestic and imported),  $C_i$  the total final consumption expenditure (by households and government),  $I_i$  the gross capital formation (gross fixed capital formation and

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<sup>1</sup> After entering the European Monetary Union, the net annual national savings in Greece became systematically negative. During the period 2000-2010, the total net external borrowing of the country amounted to 148% of its total net investments. For a macroeconomic analysis of the falling tendency of savings in the Greek economy, see Katsimi and Moutos (2010); Mariolis (2017, ch. 2).

<sup>2</sup> For the data, see the Appendix in this paper.

changes in inventories),  $EX_i$  the exports, and  $IM_i$  the imports of commodity  $i$ . The sum  $IC_i + C_i + I_i$  denotes the gross national expenditure for commodity  $i$ , while  $X_i - IC_i$  denotes the gross value added of commodity  $i$ .

Dividing equation (1) by  $X_i$  we obtain

$$1 = \delta_{IC_i} + \delta_{C_i} + \delta_{I_i} + \delta_{EX_i} - \delta_{IM_i} \quad (2)$$

where  $\delta_{IC_i} \equiv IC_i / X_i$ ,  $\delta_{C_i} \equiv C_i / X_i$ ,  $\delta_{I_i} \equiv I_i / X_i$ ,  $\delta_{EX_i} \equiv EX_i / X_i$ , and  $\delta_{IM_i} \equiv IM_i / X_i$ .

When  $\delta_{IC_i} > 1$ , the gross value added of commodity  $i$  is negative.

Now, we can introduce the following derivative indices:

(i). Index of gross domestic savings: For each produced commodity we may write

$$S_i = I_i + EX_i - IM_i \quad (3)$$

where  $S_i$  denotes the gross domestic savings in commodity  $i$ . Dividing equation (3) by  $X_i$  we obtain

$$\delta_{S_i} = \delta_{I_i} + \delta_{EX_i} - \delta_{IM_i} \quad (4)$$

or, invoking equation (2),

$$\delta_{S_i} = 1 - (\delta_{IC_i} + \delta_{C_i})$$

where  $\delta_{S_i} \equiv S_i / X_i$  denotes the index of gross domestic savings in commodity  $i$ .

(ii). Index of normalized trade balance:

$$\delta_{TB_i} \equiv (EX_i - IM_i) / (EX_i + IM_i) = (\delta_{EX_i} - \delta_{IM_i}) / (\delta_{EX_i} + \delta_{IM_i})$$

(iii). Index of ‘revealed comparative advantage’ (see, e.g. Laursen, 1998):

$$\delta_{RCA_i} \equiv \alpha_i (\delta_{TB_i} - \delta_{TB})$$

where

$$\alpha_i \equiv 2[(EX_i + IM_i) / (EX + IM)], \quad EX \equiv \sum_{i=1}^n EX_i, \quad IM \equiv \sum_{i=1}^n IM_i$$

is a coefficient of normalization, and

$$\delta_{TB} \equiv (EX - IM) / (EX + IM)$$

Positive (negative) values for  $\delta_{RCA_i}$  imply comparative advantage (disadvantage), while all values sum up to zero.

(iv). Index of intra-commodity trade (Grubel-Lloyd index):

$$\delta_{ICT_i} \equiv 1 - [ |EX_i - IM_i| / (EX_i + IM_i) ] = 1 - [ | \delta_{EX_i} - \delta_{IM_i} | / (\delta_{EX_i} + \delta_{IM_i}) ]$$

(v). Index of self-sufficiency:

$$\delta_{SSi} \equiv X_i / (X_i + IM_i - EX_i) = 1 / (1 + \delta_{IMi} - \delta_{EXi}) \quad (5)$$

From equations (1) and (5) it follows that

$$X_i = \delta_{SSi} (IC_i + C_i + I_i)$$

which implies that  $\delta_{SSi}$  could be conceived of as a (partial) multiplier of gross national expenditure.

(vi). Index of total import dependency:

$$\delta_{IDEi} \equiv IM_i / (X_i + IM_i - EX_i) = \delta_{IMi} / (1 + \delta_{IMi} - \delta_{EXi}) \quad (6)$$

From equations (1) and (6) it follows that

$$X_i = (1 - \delta_{IDEi})(IC_i + C_i + I_i) + EX_i$$

which implies that, for a given value of the exports,  $1 - \delta_{IDEi}$  could be conceived of as a multiplier of gross national expenditure.

(vii). Index of import dependency of capital goods:

$$\delta_{IDKi} \equiv IM_i / (X_i + IM_i - EX_i - C_i) = \delta_{IMi} / [1 + \delta_{IMi} - (\delta_{EXi} + \delta_{Ci})] \quad (7)$$

From equations (1) and (7) it follows that

$$X_i = (1 - \delta_{IDKi})(IC_i + I_i) + C_i + EX_i$$

which implies that, for given values of both the total final consumption and the exports,  $1 - \delta_{IDKi}$  could be conceived of as a multiplier of the sum of intermediate consumption and gross capital formation.

As is easily checked, when  $\delta_{EXi} < 1$ : (i)  $\delta_{SSi}$  is positive and, when  $\delta_{TBi} > (<) 0$ , greater than (less than) 1; (ii)  $\delta_{IDEi} < 1$ ; and (iii)  $\delta_{IDKi} \geq \delta_{IDEi}$ .

### 3. Main Empirical Results and Evaluation

The application of this system of indices to the SIOTs of the Greek economy for the years 2005 and 2010 produced the following main results:

(i). Using the indices (%) of revealed comparative advantage and normalized trade balance, the exported or/and imported commodities of the Greek economy can be categorized into three groups ('product mapping scheme'; Widodo, 2008). Table 1 refers to the year 2005, and shows that there are twenty-seven commodities with comparative disadvantage ('Group C'): twenty of them (or 74%) are industrial commodities. By contrast, there are twenty-four commodities with comparative

advantage ('Groups A and B'): two of them (or 8%) are industrial commodities (the symbol ' $\bar{\delta}$ ' indicates the arithmetic mean of an index). Table 2 refers to the year 2010, and shows that there are twenty-nine commodities with comparative disadvantage: nineteen of them (or 66%) are industrial commodities. By contrast, there are twenty-three commodities with comparative advantage: three of them (or 13%) are industrial commodities. Finally, Figure 1 shows the linear regression between the  $\delta_{RCAi}$  values of commodity  $i$  at time  $t_2 = 2010$  and those at time  $t_1 = 2005$ , i.e.

$$\delta_{RCAi}^{t_2} = \beta + \gamma \delta_{RCAi}^{t_1} + \varepsilon$$

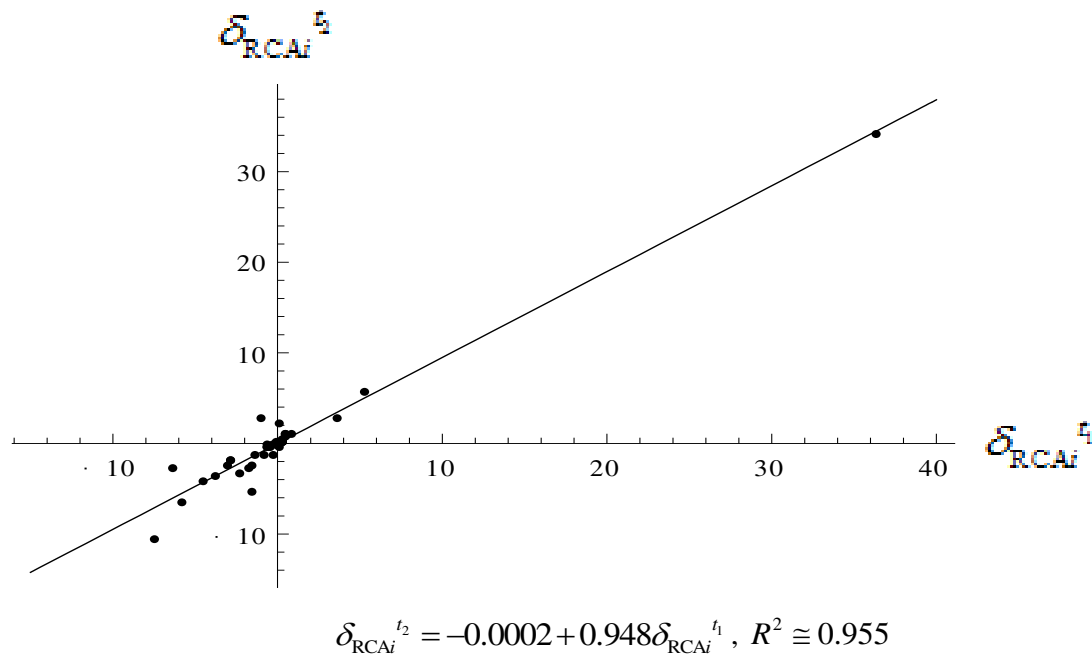
where  $\beta$  and  $\gamma$  denote standard linear regression parameters, and  $\varepsilon$  a residual term. Since both the values of  $\gamma$  ( $\cong 0.948$ ) and  $\gamma/R$  ( $\cong 0.970$ ) are not notably less than 1, it follows that there are *no* significant changes in the pattern and degree, respectively, of international specialization of the Greek economy (see Dalum et al., 1998).

**Table 1.** Product mapping scheme for the Greek economy; year 2005

<b>Group A</b> $\delta_{RCAi} > 0, \delta_{TBi} > 0$	<b>Group B</b> $\delta_{RCAi} > 0, \delta_{TBi} < 0$
$i = 3, 27, 28, 29, 30, 31, 32, 35, 39, 46, 48, 49, 53, 55, 56.$	$i = 1, 15, 33, 40, 42, 45, 47, 59, 61.$
Total Number = 15 $\bar{\delta}_{RCAi} = 3.2\%, \bar{\delta}_{TBi} = 44.3\%, \bar{\delta}_{ICTi} = 55.7\%$	Total Number = 9 $\bar{\delta}_{RCAi} = 0.2\%, \bar{\delta}_{TBi} = -12.9\%, \bar{\delta}_{ICTi} = 87.9\%$
	<b>Group C</b> $\delta_{RCAi} < 0, \delta_{TBi} < 0$
	$i = 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 24, 26, 34, 37, 38, 41, 50, 58.$
	Total Number = 27 $\bar{\delta}_{RCAi} = -1.9\%, \bar{\delta}_{TBi} = -64.1\%, \bar{\delta}_{ICTi} = 35.9\%$

**Table 2.** Product mapping scheme for the Greek economy; year 2010

<b>Group A</b> $\delta_{RCAi} > 0, \delta_{TBi} > 0$	<b>Group B</b> $\delta_{RCAi} > 0, \delta_{TBi} < 0$
$i = 3, 15, 27, 28, 29, 30, 31, 32, 33, 48, 55, 56.$	$i = 1, 10, 35, 39, 40, 45, 46, 47, 49, 53, 61.$
Total Number = 12 $\bar{\delta}_{RCAi} = 4.1\%, \bar{\delta}_{TBi} = 49.5\%, \bar{\delta}_{ICTi} = 50.6\%$	Total Number = 11 $\bar{\delta}_{RCAi} = 0.4\%, \bar{\delta}_{TBi} = -12.0\%, \bar{\delta}_{ICTi} = 88.0\%$
	<b>Group C</b> $\delta_{RCAi} < 0, \delta_{TBi} < 0$
	$i = 2, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 24, 26, 34, 37, 38, 41, 42, 50, 58, 59, 62.$
	Total Number = 29 $\bar{\delta}_{RCAi} = -2.0\%, \bar{\delta}_{TBi} = -63.7\%, \bar{\delta}_{ICTi} = 36.3\%$



**Figure 1.** Linear regression between the values of the revealed comparative advantage indices; years 2010 and 2005

(ii). There appears to be an underlying pattern in our empirical results: bad index values are concentrated in industrial commodities, whereas good index values are concentrated in service commodities. Moreover, the findings for the year 2010 do not differ much from those for the year 2005, which probably suggests that the structural features of the economy have been shaped well *before* the emergence of the so-called Greek (or PIIGS) crisis. These views are further supported by the figures in Tables 3

to 8, which report the arithmetic means of the basic and derivative indices for the primary production, industrial and service commodities in both the Greek and Eurozone economies. Thus, it can be stated that the *industry* sector is the ‘weak link’ in the Greek economy and, at the same time, diverges considerably from the industry sector in the Eurozone economy. On the other hand, the service sectors in these economies exhibit rather similar performance, whereas the primary production sector in the Eurozone economy is characterized by relatively unfavourable index values.

**Table 3.** *The arithmetic means of the basic indices for the primary production, industrial and service commodities; Greek economy, year 2005*

	$\bar{\delta}_{ICi}$	$\bar{\delta}_{ICi}^m$	$\bar{\delta}_{ICi}^m / \bar{\delta}_{ICi}$	$\bar{\delta}_{Ci}$	$\bar{\delta}_{Ii}$	$\bar{\delta}_{EXi}$	$\bar{\delta}_{IMI}$
Primary Production	37.2	7.4	19.9	70.8	-4.1	12.4	16.2
Industry	108.3	62.3	57.5	91.6	77.2	27.2	204.3
Services	54.2	9.8	18.1	47.6	2.6	7.3	11.7
Total Economy (AM)	74.0	29.7	40.1	65.4	30.7	15.1	85.3

**Table 4.** *The arithmetic means of the derivative indices for the primary production, industrial and service commodities; Greek economy, year 2005*

	$\bar{\delta}_{Si}$	$\bar{\delta}_{TBi}$	$\bar{\delta}_{RCAi}$	$\bar{\delta}_{ICTi}$	$\bar{\delta}_{SSi}$	$\bar{\delta}_{IDEi}$	$\bar{\delta}_{IDKi}$
Primary Production	-8.0	-13.5	0.3	55.4	98.5	14.9	102.2
Industry	-99.9	-58.6	-1.9	37.0	63.1	48.3	348.5 [70.9] <sup>(iii)</sup>
Services	-1.8 [4.7] <sup>(i)</sup>	5.7	1.6	61.8	162.0 [97.5] <sup>(ii)</sup>	6.5	9.8
Total Economy (AM)	-39.5 [-36.4] <sup>(i)</sup>	-23.2	0	50.8	121.3 [84.2] <sup>(ii)</sup>	22.8	143.2 [36.9] <sup>(iii)</sup>

**Notes:** (i) excluding the commodity 34 ( $\delta_{Si} = -229.1\%$ ); (ii) excluding the commodity 32 ( $\delta_{SSi} = 2418.6\%$ ); and (iii) excluding the commodity 6 ( $\delta_{IDKi} = 6733.7\%$ ).



**Table 5.** The arithmetic means of the basic indices for the primary production, industrial and service commodities; Greek economy, year 2010

	$\bar{\delta}_{ICi}$	$\bar{\delta}_{ICi}^m$	$\bar{\delta}_{ICi}^m / \bar{\delta}_{ICi}$	$\bar{\delta}_{Ci}$	$\bar{\delta}_{li}$	$\bar{\delta}_{EXi}$	$\bar{\delta}_{IMi}$
Primary Production	39.9	7.2	18.0	57.2	1.4	15.4	14.0
Industry	116.6	72.3	62.0	74.5	126.2	29.3	246.7
Services	53.2	9.5	17.9	48.0	2.9	7.3	11.4
Total Economy (AM)	76.7	33.3	43.4	58.6	49.8	16.1	101.2

**Table 6.** The arithmetic means of the derivative indices for the primary production, industrial and service commodities; Greek economy, year 2010

	$\bar{\delta}_{Si}$	$\bar{\delta}_{TBi}$	$\bar{\delta}_{RCAi}$	$\bar{\delta}_{ICTi}$	$\bar{\delta}_{SSi}$	$\bar{\delta}_{IDEi}$	$\bar{\delta}_{IDKi}$
Primary Production	2.8	-4.3	0.5	57.5	104.0	13.7	35.7
Industry	-91.2	-55.0	-1.8	41.2	64.4	47.3	369.7 [73.9] <sup>(iii)</sup>
Services	-1.2 [4.3] <sup>(i)</sup>	-6.0	1.4	57.4	157.7 [97.1] <sup>(ii)</sup>	7.2	11.6
Total Economy (AM)	-35.3 [-32.7] <sup>(i)</sup>	-26.6	0	50.5	119.6 [84.8] <sup>(ii)</sup>	22.8	149.2 [34.2] <sup>(iii)</sup>

**Notes:** (i) excluding the commodity 34 ( $\delta_{Si} = -194.2\%$ ); (ii) excluding the commodity 32 ( $\delta_{SSi} = 2280.0\%$ ); and (iii) excluding the commodity 6 ( $\delta_{IDKi} = 7174.0\%$ ).

**Table 7.** The arithmetic means of the basic indices for the primary production, industrial and service commodities; Eurozone economy, year 2010

	$\bar{\delta}_{ICi}$	$\bar{\delta}_{ICi}^m$	$\bar{\delta}_{ICi}^m / \bar{\delta}_{ICi}$	$\bar{\delta}_{Ci}$	$\bar{\delta}_{li}$	$\bar{\delta}_{EXi}$	$\bar{\delta}_{IMi}$
Primary Production	67.8	9.9	14.6	40.1	5.6	5.9	19.4
Industry	83.3	29.1	34.9	22.3	11.9	25.0	42.5
Services	51.9	4.0	7.6	41.9	3.5	7.7	5.0
Total Economy (AM)	64.6	13.8	21.4	34.3	6.8	14.2	20.0

**Table 8.** *The arithmetic means of the derivative indices for the primary production, industrial and service commodities; Eurozone economy, year 2010*

	$\bar{\delta}_{Si}$	$\bar{\delta}_{TBi}$	$\bar{\delta}_{RCAi}$	$\bar{\delta}_{ICTi}$	$\bar{\delta}_{SSi}$	$\bar{\delta}_{IDEi}$	$\bar{\delta}_{IDKi}$
Primary Production	-7.8	-50.1	-0.5	49.9	88.6	16.6	31.7
Industry	-5.6 [11.8] <sup>(i)</sup>	10.0	-0.4	74.7	98.7	25.9	37.2
Services	6.2	23.6	0.3	64.3	104.6	5.2	8.2
Total Economy (AM)	1.0 [7.6] <sup>(i)</sup>	14.9	0	67.6	101.6	13.7	20.4

**Notes:** (i) excluding the commodity 4 ( $\delta_{Si} = -400.5\%$ ).

(iii). In the year 2010, there are fourteen industrial and two service commodities in the Greek economy that are simultaneously characterized by a ‘low’ self-sufficiency index and ‘high’ import dependency indices.<sup>3</sup> These ‘highly import-dependent commodities’ are reported in Table 9: it is observed that they all belong to Group C of Table 2, and it should also be noted that, in value terms, their imports correspond to about 566% of their exports and 76% of the economy’s total imports, while their exports correspond to 22% of the economy’s total exports. At least nine of these commodities, i.e. those with  $\delta_{IDKi} > 1$ , could be the immediate objective of a well-designed industrial policy programme.<sup>4</sup> By contrast, there are two primary production, one industrial and sixteen service commodities that are simultaneously characterized by a high self-sufficiency index and low import dependency indices. These ‘lowly import-dependent commodities’ are reported in Table 10: it is observed that they all belong to Groups A and B of Table 2, and it should also be noted that, in value terms, their imports correspond to about 17% of their exports and 6% of the economy’s total imports, while their exports correspond to 57% of the economy’s total exports.

<sup>3</sup> Hereafter, the term ‘low’ (‘high’) shall mean ‘lower (higher) than the arithmetic mean of the total economy’, i.e., in the present case, lower than 84.8%, and higher than 22.8% and 34.2% (see the last row and the notes in Table 6).

<sup>4</sup> For basic dilemmas that such a policy would inevitably face, see Mariolis (2018, Section 2).

**Table 9.** *The highly import-dependent commodities in the Greek economy; year 2010*

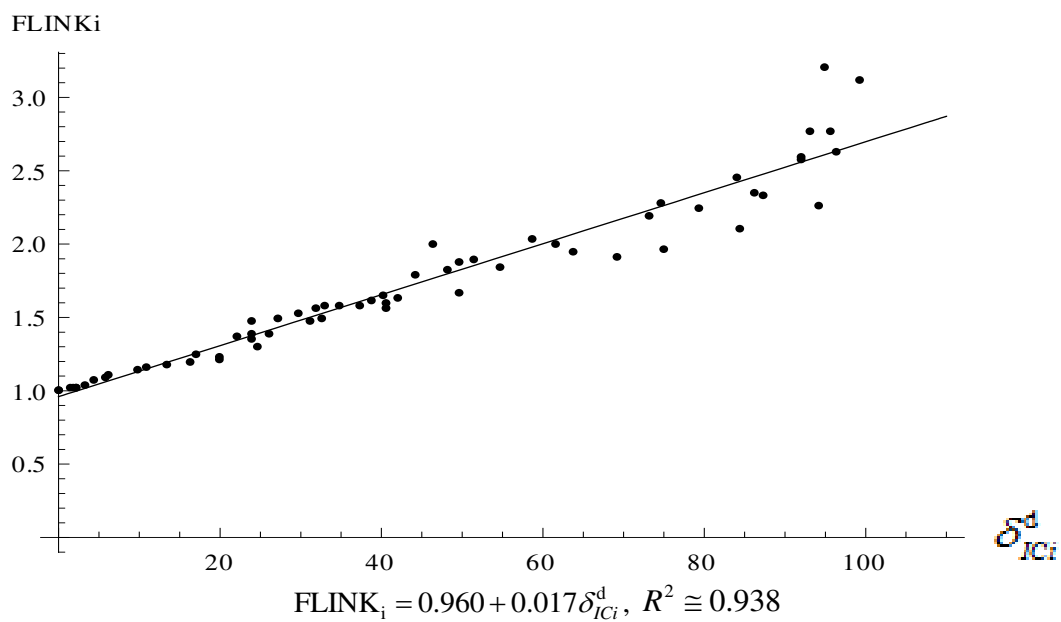
$i$	$\delta_{ICi}$	$\delta_{ICi}^m$	$\delta_{Si}$	$\delta_{TBi}$	$\delta_{RCAi}$	$\delta_{ICTi}$	$\delta_{SSi}$	$\delta_{IDEi}$	$\delta_{IDKi}$
4	717.8	630.5	-617.8	-96.1	-10.48	3.9	14.1	87.7	87.7
5	23.1	6.8	-18.1	-44.3	-2.43	55.7	84.3	25.5	128.7
6	40.8	17.0	-153.2	-56.0	-2.78	44.0	46.6	74.4	7174.0
8	100.8	73.6	-55.9	-79.1	-1.18	20.9	54.5	51.5	73.6
11	165.7	125.7	-167.9	-65.4	-3.60	34.6	36.9	79.8	128.1
12	102.9	83.2	-197.4	-66.5	-3.36	33.5	35.6	80.7	262.1
13	117.2	53.5	-40.3	-44.7	-0.48	55.3	71.4	46.3	55.5
16	98.3	23.3	-16.7	-74.6	-1.84	25.4	73.4	31.1	36.0
17	371.7	347.9	-495.4	-100	-4.12	0.0	5.6	94.4	108.0
18	77.3	60.5	-26.0	-29.5	-0.15	70.5	63.7	79.8	115.6
19	24.9	19.2	72.1	-64.1	-1.99	35.9	39.4	77.5	78.4
20	76.2	66.3	-317.0	-94.7	-2.59	5.3	15.2	87.2	181.0
21	61.9	58.5	-120.5	-72.1	-5.28	27.9	6.9	111.1	124.8
22	71.3	51.3	-68.9	-83.1	-2.33	16.9	46.7	58.7	107.9
34	280.6	211.6	-194.2	-77.9	-6.42	22.1	34.0	75.4	79.0
42	59.1	20.5	-24.1	-39.9	-0.27	60.1	80.6	34.1	71.6
AM	149.4	115.6	-152.6	-68.0	-3.1	32.0	44.3	68.5	550.8

**Table 10.** *The lowly import-dependent commodities in the Greek economy; year 2010*

$i$	$\delta_{ICi}$	$\delta_{ICi}^m$	$\delta_{Si}$	$\delta_{TBi}$	$\delta_{RCAi}$	$\delta_{ICTi}$	$\delta_{SSi}$	$\delta_{IDEi}$	$\delta_{IDKi}$
1	58.1	8.5	0.2	-7.1	0.94	92.9	98.0	14.7	24.8
3	27.6	2.8	22.9	57.4	0.68	42.6	126.7	9.9	26.7
27	13.6	0.2	81.7	38.3	0.97	61.7	101.4	1.1	1.2
28	32.6	0.00	13.4	100	1.05	0	107.1	0	0
29	40.4	0.00	19.1	100	5.63	0	110.5	0	0
30	40.6	0.00	19.0	100	2.91	0	110.4	0	0
31	27.2	1.1	0.8	15.5	0.27	84.5	100.8	2.2	8.1
32	2.3	0.3	95.6	99.1	34.06	0.9	2280.0	9.7	18.4
35	96.5	1.8	-0.7	-25.8	0.00025	74.2	99.3	1.8	1.9
39	46.2	2.1	-0.7	-9.5	0.20	90.5	99.3	4.2	9.2
40	62.1	12.5	36.8	-6.4	0.25	93.6	97.7	19.2	19.4
45	22.2	0.00	4.3	-14.5	0.15	85.5	98.5	5.9	6.3
46	89.5	5.4	-0.6	-11.5	0.07	88.5	99.4	2.9	3.3
48	99.3	3.9	0.6	7.8	0.16	92.2	100.7	3.9	3.9
49	86.8	7.5	-1.8	-11.3	0.08	88.7	98.3	8.6	10.1
53	93.4	1.4	-0.3	-10.1	0.05	89.9	99.7	1.5	1.6
55	1.9	0.1	0.1	27.0	0.04	73.0	100.1	0.1	5.9
56	2.2	0.01	0.1	27.0	0.06	73.0	100.1	0.2	7.7
61	39.6	2.2	-0.7	-6.4	0.04	93.6	99.3	5.5	13.9
AM	46.0	2.6	15.3	24.7	1.6	64.5	217.2	4.9	8.6

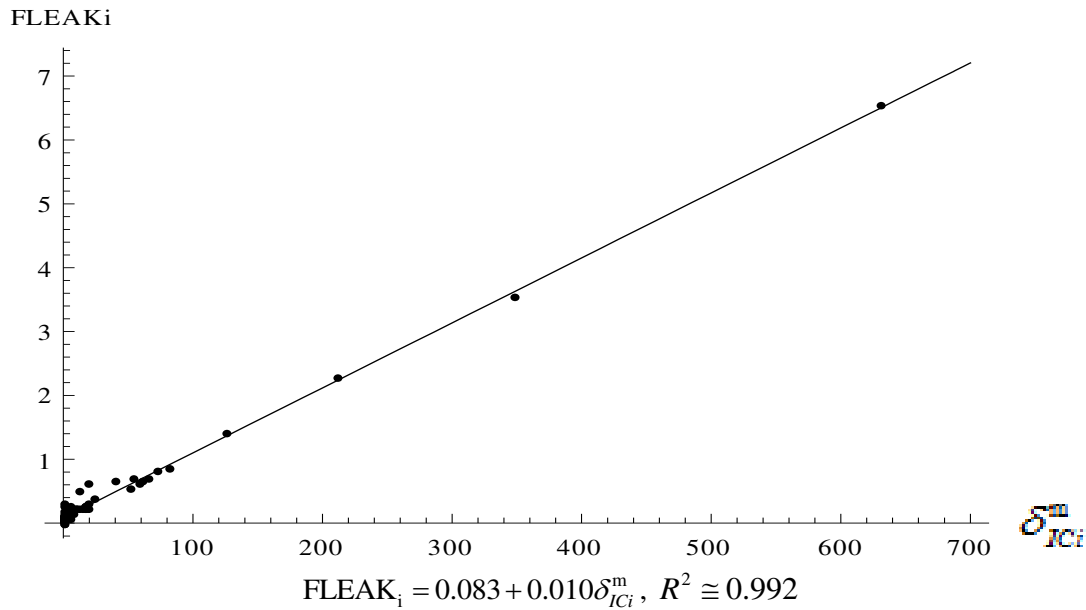
(iv). The values of the domestic intermediate consumption index,  $\delta_{ICi}^d = \delta_{ICi} - \delta_{ICi}^m$ , are equal to the row-sums of the domestic direct output coefficients (or Ghosh) matrix,  $\mathbf{D}_G$ , while the values of the imported intermediate consumption index,  $\delta_{ICi}^m$ , are equal to the row-sums of the imported direct output coefficients matrix,  $\mathbf{M}_G$ . Figures 2 and

3 refer to the Greek economy, for the year 2010, and show that there are significant linear regressions between: (a)  $\delta_{ICi}^d$  and the interindustry ‘forward linkages’,  $FLINK_i$ , i.e. the row-sums of the matrix  $[\mathbf{I} - \mathbf{D}_G]^{-1}$ ; and (b)  $\delta_{ICi}^m$  and the interindustry ‘forward leakages’,  $FLEAK_i$ , i.e. the row-sums of the matrix  $[\mathbf{I} - \mathbf{D}_G]^{-1} \mathbf{M}_G$ , respectively.<sup>5</sup> Finally, it is detected that there are fourteen commodities characterized by high forward leakages, while eleven of them are highly import-dependent commodities (see Table 9).



**Figure 2.** Interindustry forward linkages versus domestic intermediate consumption indices; Greek economy, year 2010

<sup>5</sup> For the measurement of the interindustry linkages and leakages, see Reis and Rua (2006).



**Figure 3.** Interindustry forward leakages versus imported intermediate consumption indices; Greek economy, year 2010

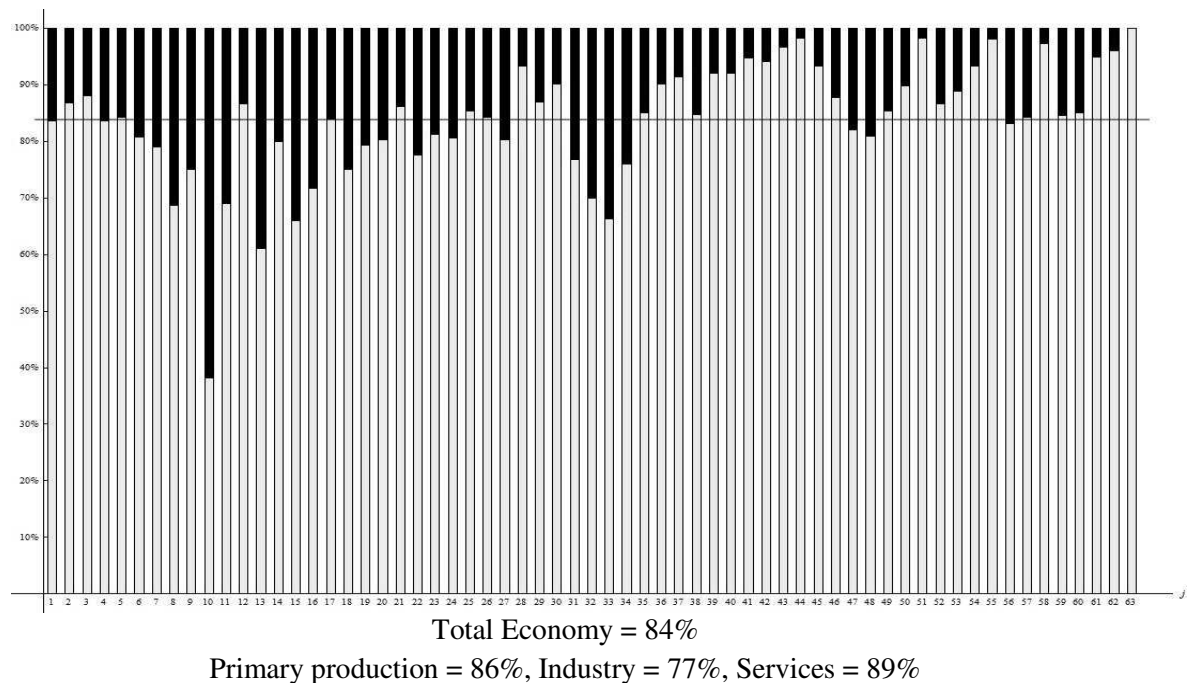
(v). Figures 4 and 5 refer to the Greek economy, for the year 2010, and show:<sup>6</sup>

- (a). The share of domestic content (or domestic value added) in final demand, measured by the elements of the vector  $\mathbf{v}^{dT} \equiv \mathbf{v}^T [\mathbf{I} - \mathbf{D}_L]^{-1}$ , and the share of foreign content (or foreign value added) in final demand, measured by the elements of  $\mathbf{v}^{mT} \equiv \mathbf{e}^T \mathbf{M}_L [\mathbf{I} - \mathbf{D}_L]^{-1}$ , where  $\mathbf{v}^T$  denotes the  $1 \times 63$  vector of (direct) gross value added per unit activity level,  $\mathbf{D}_L$  the domestic direct input coefficients (or Leontief) matrix,  $\mathbf{M}_L$  the imported direct input coefficients matrix,  $\mathbf{e}^T \equiv [1, 1, \dots, 1]^T$  the  $1 \times 63$  summation vector, and  $\mathbf{e}^T = \mathbf{v}^{mT} + \mathbf{v}^{dT}$  (see Hummels, Ishii, and Yi, 2001).<sup>7</sup> In Figure 4, the horizontal line gives the arithmetic mean of the shares of domestic content in final demand. It is detected that there are twenty-six industries with low shares of domestic content (one primary production and eighteen industrial industries), while eleven of them correspond to highly import-dependent commodities (see Table 9).
- (b). The domestic value added of industry  $i$  ‘embodied’ in the economy’s exports, measured by  $DV_i \equiv [DV_i] \equiv \hat{\mathbf{v}} [\mathbf{I} - \mathbf{D}_L]^{-1} \mathbf{E} \mathbf{x}$ , where  $\hat{\mathbf{v}}$  denotes the diagonal matrix formed from the elements of  $\mathbf{v}^T$ , and  $\mathbf{E} \mathbf{x}$  the  $63 \times 1$  vector of exports. In Figure 5, the horizontal line gives the arithmetic mean of  $DV_i$ . It is detected that there are eighteen

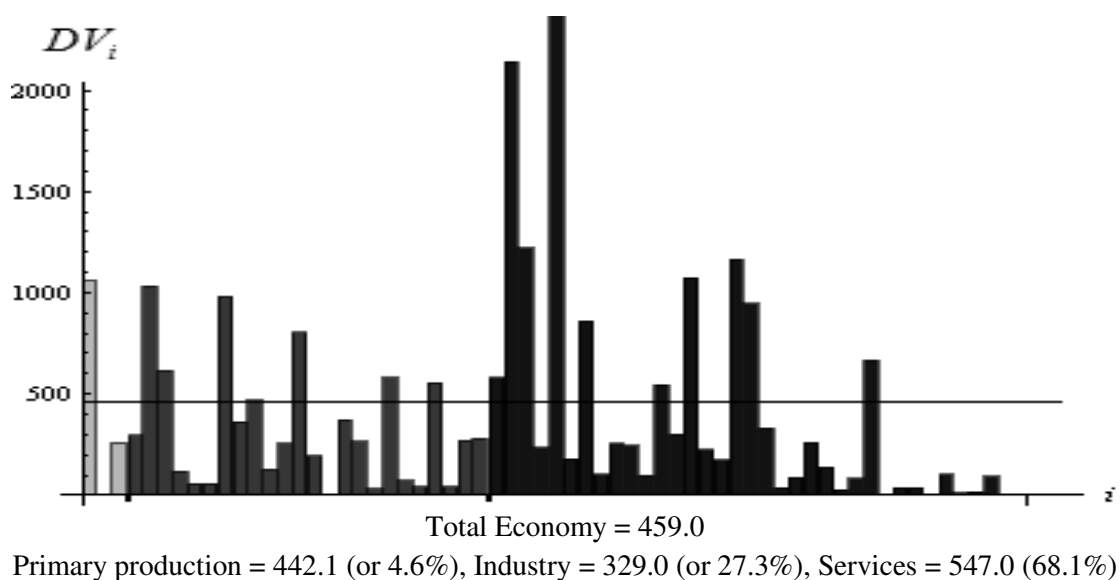
<sup>6</sup> For the numerical results, see Mariolis, Moutos and Soklis (2017).

<sup>7</sup> The elements of  $\mathbf{v}^{mT}$  also give the interindustry ‘backward leakages’.

industries with high  $DV_i$  (one primary production and seven industrial industries; see Table 11). Finally, Table 12 reports the sectoral domestic content shares of exports,  $DVS \equiv (\mathbf{v}^T [\mathbf{I} - \mathbf{D}_L]^{-1} \mathbf{E} \mathbf{x}) / (\mathbf{e}^T \mathbf{E} \mathbf{x})$ .



**Figure 4.** The shares (%) of domestic content (grey colour) and foreign content (black colour) in final demand; Greek economy, year 2010



**Figure 5.** The domestic value added (in million euros) of industry  $i$  'embodied' in the economy's exports; Greek economy, year 2010

**Table 11.** *The industries with high domestic value added (in million euros) ‘embodied’ in the economy’s exports*

<i>i</i>	$DV_i$
1	1057.2
5	1032.7
6	618.1
10	984.2
12	469.6
15	803.6
21	583.6
24	553.8
28	579.3
29	2141.1
30	1222.0
32	7405.2
34	862.3
39	546.7
41	1073.2
44	1164.6
45	946.0
53	665.8

**Table 12.** *The sectoral domestic content shares of exports (DVS)*

	<i>DVS</i>	Export shares	Export-weighted <i>DVS</i>
Primary Production	84.9%	4.0%	3.4%
Industry	66.6%	39.2%	26.1%
Services	75.9%	56.8%	43.1%
			Total Economy = 72.6%

(vi). All our findings are compatible with those of empirical studies on the ‘static Sraffian matrix multiplier’ of autonomous demand (government consumption expenditures, investments and exports) for the Greek economy (which use input-output table data for the period 2000-2010).<sup>8</sup> According to those ‘backward linkages’ studies, (a) an effective demand management policy could be mainly based on the service sector; (b) the whole economic system, and especially its industry sector, is heavily dependent on imports; and (c) the highly import-dependent commodities-industries (see Table 9 in the present paper) tend to be characterized by low output and employment multipliers and, at the same time, by high import multipliers

<sup>8</sup> See Mariolis and Soklis (2015, 2018), Ntemiroglou (2016), Mariolis, Ntemiroglou and Soklis (2018).

#### 4. Concluding Remarks

This intersectoral analysis identified main structural features of the Greek economy. It has been detected that a well-targeted effective demand management policy is necessary but not sufficient for the recovery of this economy; that is to say, industrial policy and structural transformation are also needed. More specifically, demand policy could be mainly based on the service and the primary production sectors, which include the vast majority of the revealed comparative advantage and lowly import-dependent commodities. By contrast, the industry sector includes the vast majority of the revealed comparative disadvantage and highly import-dependent commodities; it is also characterized by negative gross domestic savings, low intra-commodity specialization, low domestic content in exports, and unfavourable demand multiplier effects. Industrial policy could primarily focus on nine industrial commodities that exhibit particularly high direct import dependency of capital goods.

It seems that intratemporal and intertemporal applications of this ‘forward and backward’ diagnostic system to input-output table data from the ‘South’ and ‘North’ of the Eurozone would be of particular interest for both structural and policy studies.

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#### **Appendix: A Note on the Data**

The SIOTs of the Greek and Eurozone economies are provided via the EUROSTAT website, <http://epp.eurostat.ec.europa.eu>. The available SIOTs describe 65 products and industries. However, the elements associated with the products ‘Imputed rents of owner-occupied dwellings’ and ‘Services provided by extraterritorial organisations and bodies’ are all equal to zero and, therefore, we remove them from our analysis. Thus, we derive SIOTs that describe 63 product/industry groups.

The described products and their correspondence to CPA (Classification of Products by Activity) are reported in Table A.1. The products 1 to 3 belong to ‘Primary production’. The products 4 to 27 belong to ‘Industry’: (i) the commodity 4 corresponds to ‘Mining and quarrying’; (ii) the products 5 to 23 correspond to ‘Processing products’; (iii) the product 24 corresponds to ‘Energy’; (iv) the products 25 and 26 correspond to ‘Water supply and waste disposal’; and (v) the commodity 27 corresponds to ‘Construction’. The products 28 to 63 belong to ‘Services’, while the products 54 to 57 are primarily related to the ‘Public Sector’.

It should be noted that, in the case of the Greek economy, products 36 (‘Accommodation and food services’) and 52 (‘Travel agency, tour operator and other reservation services and related services’), which are related to tourism activities,

display zero exports and imports because the relevant SIOTs do not record the travel receipts and payments.

**Table A.1. Product Classification**

No	CPA	Nomenclature
1	A01	Products of agriculture, hunting and related services
2	A02	Products of forestry, logging and related services
3	A03	Fish and other fishing products; aquaculture products; support services to fishing
4	B	Mining and quarrying
5	C10-C12	Food products, beverages and tobacco products
6	C13-C15	Textiles, wearing apparel and leather products
7	C16	Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials
8	C17	Paper and paper products
9	C18	Printing and recording services
10	C19	Coke and refined petroleum products
11	C20	Chemicals and chemical products
12	C21	Basic pharmaceutical products and pharmaceutical preparations
13	C22	Rubber and plastics products
14	C23	Other non-metallic mineral products
15	C24	Basic metals
16	C25	Fabricated metal products, except machinery and equipment
17	C26	Computer, electronic and optical products
18	C27	Electrical equipment
19	C28	Machinery and equipment n.e.c.
20	C29	Motor vehicles, trailers and semi-trailers
21	C30	Other transport equipment
22	C31-C32	Furniture; other manufactured goods
23	C33	Repair and installation services of machinery and equipment
24	D35	Electricity, gas, steam and air-conditioning
25	E36	Natural water; water treatment and supply services
26	E37-E39	Sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services
27	F	Constructions and construction works
28	G45	Wholesale and retail trade and repair services of motor vehicles and motorcycles
29	G46	Wholesale trade services, except of motor vehicles and motorcycles
30	G47	Retail trade services, except of motor vehicles and motorcycles
31	H49	Land transport services and transport services via pipelines
32	H50	Water transport services
33	H51	Air transport services
34	H52	Warehousing and support services for transportation
35	H53	Postal and courier services
36	I	Accommodation and food services
37	J58	Publishing services
38	J59-J60	Motion picture, video and television programme production services, sound recording and music publishing; programming and broadcasting services
39	J61	Telecommunications services
40	J62-J63	Computer programming, consultancy and related services; information services
41	K64	Financial services, except insurance and pension funding
42	K65	Insurance, reinsurance and pension funding services, except compulsory social security

43	K66	Services auxiliary to financial services and insurance services
44	L68B	Real estate services (excluding imputed rent)
45	M69-M70	Legal and accounting services; services of head offices; management consulting services
46	M71	Architectural and engineering services; technical testing and analysis services
47	M72	Scientific research and development services
48	M73	Advertising and market research services
49	M74-M75	Other professional, scientific and technical services; veterinary services
50	N77	Rental and leasing services
51	N78	Employment services
52	N79	Travel agency, tour operator and other reservation services and related services
53	N80-N82	Security and investigation services; services to buildings and landscape; office administrative, office support and other business support services
54	O84	Public administration and defence services; compulsory social security services
55	P85	Education services
56	Q86	Human health services
57	Q87-Q88	Social work services
58	R90-R92	Creative, arts and entertainment services; library, archive, museum and other cultural services; gambling and betting services
59	R93	Sporting services and amusement and recreation services
60	S94	Services furnished by membership organisations
61	S95	Repair services of computers and personal and household goods
62	S96	Other personal services
63	T	Services of households as employers; undifferentiated goods and services produced by households for own use