Feedback Effects Based on an Interregional Input - Output Model for Greece

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Abstract

The main objective of this paper is centered to analyze the interregional linkages in order to measure the feedback effects.

The analysis will be implemented with a two region interregional model for the Greek economy constructed by the author by own forces.

Feedback analysis offers additional information in calculating output multipliers. The feedback effects were introduced as the increase in outputs originating in one region that has the possibility to influence production levels in another region and will affect activity back in the first region of origin.

The results of how are spread widely the effects in the economy is important to identity production and establish targets for regional growth.

Keywords: Interregional model, feedback effects, output multipliers, interregional output multipliers.

1. Introduction

The input-output model is a practical version of the general equilibrium theory whose advantage lies on mutual interdependence, which shows how "everything depends upon everything else" quantitatively. The input–output model was introduced by W. Leontief who used it to study the United States economy. Resently the input-output approach has been a popular tool for regional and interregional analysis.

The interregional model of Moses developed in this study is applied to the regions of the Greek economy. The estimation of the interregional input–output model allows calculating the interregional feedback effects in the output multipliers. These effects are defined as the increase in outputs necessary in the sector of a region due to increased demands from sectors of other regions which result from an initial increase in outputs in the first region.

One way to deepen this analysis is to construct an alternative model as an interregional input–output table than estimate the interindustry flows between and within regions. The methodology adopted to estimate this model is presented in the following section.

The author of this study was completed a research by own forces on the compilation of the 2010 two region interregional input – output table for the Greek economy.

This two region table specifically divided the country into: Region 1 – Attiki and Region 2 – the rest of Greece. The 2010 interregional input – output table of Greece was aggregated to 10 sectors.

The resulting interregional model shows, the intra and the interregional economic

transactions.

This paper is composed of five sections. The section 2 makes a literature review about the techniques to assess the feedback effects between regions. Section 3 introduces the model and the estimation method used to determine the feedback effects within and between regions. Section 4 presents the results of the estimations. Finally, section 5 offers some conclusions.

2. Literature Review

The objective of the paper is the analysis of linkages between economic regions and possible feedback effects one region may have on another.

The initial reference in the literature coming from Machlup (1943) and by Metzler (1950) and Chipman (1950). Most recently the same questions raised by Goodwin (1983) who developed a world matrix multiplier, with the same objectives as Machlup and Metzler.

Klein and Glickman (1977) have developed a multiregional model which incorporates other regional interdependencies.

Previous work relevant to this study was by Miller (1966, 1969), Yamada I. (1961) and Hamada H. and Ihara (1968).

More recently, within the context of regional input-output analysis Round (1979) has shown the importance of feedback effects within interdependent systems.

The analysis of industrial linkages within regions presented also in Round (1985) and intented to decompose a complete impact multiplier in an input-output framework into intra–regional and inter–regional multipliers with regional directions.

An elaboration of trade feedback effects employed in several trade–related papers at regional spatial scales (Sonis et. al. 1993, 1995a, 1995a, b, 1997).

A further overview of economic interactions in the Miyazawa work can be found in the collection of papers in Hewings et al. (1999). Miyazawa makes use on internal and external matrix multipliers.

3. The Model

In the case of a two region interregional input–output system, the direct coefficients or technical coefficients can be presented by the following block matrices.

$$A = \begin{pmatrix} A_{11} & A_{12} \\ \\ A_{21} & A_{22} \end{pmatrix}$$

The terms A_{11} and A_{22} indicate the quadrate matrices of direct inputs within region 1 and region 2 (intraregional) respectively.

The cross terms A_{12} and A_{21} are the interregional matrices representing direct input connections from region 1 to region 2 and from region 2 to region 1 (interregional) respectively.

In this context the interregional trade flows and coefficients were incorporated in the analysis of each region to obtain a more realistic delineation of the economy. From matrix A, we obtain the Leontief inverse matrix B whose structure is similar with matrix A and supply

us with direct and indirect requirements for intraregional and interregional production.

$$B = \begin{pmatrix} B_{11} & B_{12} \\ B_{21} & B_{22} \end{pmatrix}$$

Where $B_{11} = (I - A_{11})^{-1}$ and $B_{22} = (I - A_{22})^{-1}$ are the internal multiplier matrices of region 1 and region 2.

The Leontief inverse matrices $B = (I - A)^{-1}$ can be used to calculate output multipliers for each sector in each region A_1 as the total value of production in all sectors and in all regions of the economy.

4. Results

The results of estimating the interregional model for two regions of Greece, Attiki and the rest of the country are based on a statistical implementation of the Moses model.

Studies attempting to measure the impact on a particular region of exogenous changes in the demand for products of that region have used a regional input–output framework. In this study we attempt to treat two regions specifying a complete input–output matrix for each region, which contains a total of four submatrices, two intraregional and two interregional and ten industries. We start deriving the technical coefficients for the industries of each region dividing each element of the regional input–output flow tables by the total of flows. Trade coefficients are defined by Mose's as $t_i = {r_i^{k1}}/{R_i^1}$ where r_i^{k1} is the shipment of commodity i from region k to region 1, and R_i^1 is the total shipments of i received in region 1.

The trade coefficients are shown in the Table 1 below.

According to the regional technical coefficients and trade coefficients a new matrix TA derived which embodies the structure of production in each region and the structure of regional trade. This is referred to as interregional input-output coefficients matrix, Table A-1 (Appendix). The solution of the interregional input-output matrix TA, is of the form $(I - TA)^{-1}$, and incorporates the direct and indirect input requirements that would result from a unit change in activities of any sector, Table A-1 (Appendix). The interregional inverse matrix or multiplier matrix Table A-2 (Appendix), can be used to calculate the interregional multipliers.

Tables 2 and 3 show the column sum and row sum of elements of the two regions model of the Greek economy or internal and external matrix multipliers for Attiki and the rest of Greece (Table (A-2) Appendix). The intraregional internal multiplier is represented the impacts on the outputs of sectors within the region. On the other hand the interregional external multipliers are shown the impacts on the other region of the system.

The column sum of multipliers indicates the pattern of power of dispersion for sectors in each region. The results in tables 2 and 3 show the relationship between Attiki and the rest of Greece.

Following Miller and Blair (1985) the output multipliers for each region are estimated from the interregional input-output model (Lontief inverse matrix B and from the single

model for region 1 (Leontief inverse matrix $B^1 = (I–A_{11})^{-1}$). The difference between the two output multipliers is calculated and divided by the interregional output multiplier to estimate the amount by which output multipliers for sectors in each region would be underestimated if a single region model were used instead of the interregional model.

The table 4 shows the interregional feedback effects on output of Attiki and on output of the Rest of Greece.

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On average the internal multiplier effect of Attiki (2.015) is little lower than that of the Rest of Greece, while the average about external multiplier of Attiki (1.57) is significantly higher than the Rest of Greece. From the viewpoint of each sector these figures are different, reflecting the characteristics of each region's industrial structure.

Table 1. Trade Coefficients, Greece 2010
(In million euros)

	Sectors	Regions	I	II
1	Agriculture, forestry and fishing	I II	0,2523 0,7477	0,1268 0,8732
2	Mining @ quarrying, manufacturing, electricity, gas, steam, air conditioning and water supply, sewerage, waste management & remediation activities	I II	0,4879 0,5121	0,0290 0,9710
3	Constructions	I II	0,1174 0,8826	0,8119 0,1881
4	Wholesale & retail trade, repair of motor vehicles & motorcycles, transportation & storage, accommodation & food service activities	I II	0,478 0,5922	0,4797 0,5203
5	Information & communication	I II	0,5652 0,4348	0,6941 0,3059
6	Financial & insurance activities	I II	0,4006 0,5994	0,6752 0,3248
7	Real estate activities	I II	0,3218 0,6782	0,7376 0,2624
8	Professional, scientific & technical activities, administrative & support activities	I II	0,1193 0,8807	0,9867 0,0133
9	Public administration & defence, compulsory social security, education, human health & social work activities	I II	0,0390 0,9610	0,9467 0,0533
0	Arts, entertainment, recreation, other service activities, activities of households as employers undifferentiated goods & services producing activities of households for own use, activities of extraterritorial organizations & bodies	I II	0,1765 0,8235	0,6845 0,3155

Table 2. Internal and External Multipliers of an Interregional Model of the Greek Economy, 2010

		Internal Multipliers of Attiki			External Multipliers of Attiki		
Code	**Sectors**	**Column**		**Row**	**Column**		**Row**
1	Agriculture, forestry and fishing	**1.079**		**1.1185**	**0.13002**		**0.53**
2	Mining, quarrying, manufacturing Electricity, gas, water supply	**2.1014**		**3.071**	**1.6763**		**5.2465**
3	Constructions	**1.8365**		**1.4421**	**1.2581**		**0.7271**
4	Wholesale and retail trade Repair of motor vehicles	**1.9142**		**3.1567**	**2.3008**		**2.7954**
5	Information and communication	**2.43**		**2.9546**	**1.8961**		**1.4728**
6	Financial and insurance activities	**2.3635**		**2.2213**	**1.8883**		**1.2564**
7	Real estate activities	**2.4088**		**3.0693**	**2.0158**		**2.1923**
8	Professional, scienctific and technical activities	**2.4122**		**1.053**	**2.1928**		**0.0576**
9	Public administration, defence, education and social security	**1.7845**		**1.0557**	**1.1685**		**0.0583**
10	Arts, entertainment, recreation Other service activities	**1.8206**		**1.1793**	**1.2505**		**0.4211**
	Average	**2.015**		**2.015**	**1.5777**		**1.5777**

Table 3. Internal and External Multipliers of an Interregional Model of the Greek Economy, 2010

		Internal Multiplier of Attiki			External Multiplier of Rest of Greece		
CODE	**SECTORS**	**Column**		**Row**	**Column**		**Row**
1	Agriculture, forestry and fishing	**1.3786**		**1.4525**	**0.1632**		**0.0772**
2	Mining, quarrying, manufacturing Electricity, gas, water supply	**2,4946**		**5.6093**	**0.6441**		**0.7829**
3	Constructions	**2.0834**		**1.1419**	**0.6667**		**0.4712**
4	Wholesale and retail trade Repair of motor vehicles	**2.1138**		**2.9486**	**0.7977**		**1.636**
5	Information and communication	**2.4087**		**1.8669**	**0.1378**		**1.4994**
6	Financial and insurance activities	**2.1125**		**1.7895**	**1.0377**		**1.022**
7	Real estate activities	**3.0292**		**2.3013**	**1.7249**		**1.58145**
8	Professional, scienctific and technical activities	**1.5948**		**1.0228**	**0.4094**		**0.0625**
9	Public administration, defence, education and social security	**1.9546**		**1.0255**	**0.6262**		**0.1512**
10	Arts, entertainment, recreation Other service activities	**1.5053**		**0.157**	**0.414**		**0.186**
	Average	**2.0675**		**2.0675**	**0.6622**		**0.6622**

Table 4. Interregional Feedback Effects of Attiki and the Rest of Greece

		Attiki		**Rest of Greece**	
		Interregional feed back effects		**Interregional feed effects**	
		Column	**Row**	**Column**	**Row**
1	Agriculture, forestry and fishing	0.0498	0.0223	0.0486	0.1159
2	Mining, quarrying, manufacturing, electricity, gas, water supply	0.0533	0.0939	0.2677	0.2249
3	Constructions	0.0924	0.1230	0.2204	0.1517
4	Wholesale & Retail trade, Repair of motor vehicles	0.1165	0.1479	0.2074	0.2305
5	Information & communication	0.1338	0.1650	0.2225	0.2197
6	Financial & insurance activities	0.1291	0.1543	0.2600	0.1876
7	Real estate activities	0.2021	0.1784	0.1943	0.2240
8	Professional, scientific & technical activities	0.0408	0.0295	0.5356	0.0306
9	Public administration & defence, education, and social security	0.1032	0.0986	0.2196	0.0336
0	Arts, entertainment, recreation, Other service activities	0.0708	0.0763	0.3265	0.1332
	Average	**0.0999**		**0.2503**	

5. Conlusions

The purpose of this paper was to demonstrate the significance of interregional feedback effects. The analysis of the feedback effects in the output multipliers is included in table 4. In general, the percent average errors in the regional output multipliers are relatively low.

The interregional model developed in this study it would be quite useful to connect a single regional economy extensively to the national economy. So, the findings yielded some policy implications important to development planners to implement programs in order to generate more output and employment among regions.

In summary, the most important conclusion of the interregional input – output model is that growth depends on the strength that makes one region over another when purchasing inputs that force feedback, where purchases of inputs to this region means output growth due to sales. But in order to sell the inputs required for the purchase of other inputs from outside the region that buy supplies have again growth by selling their product as an input in other region.

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Appendix A

Table A – 1

Matrix of Interregional Input Coefficients

A11 Attiki Region

A12 Rest of Greece (except Attiki)

1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
0,0070	0,0179	0,0000	0,0022	0,0001	0,0000	0,0005	0,0000	0,0002	0,0003	0,0092	0,0073	0,0000	0,0010	0,0000	0,0000	0,0002	0.0000	0,0001	0,0001
0,0137	0,2487	0,1238	0,0708	0,0848	0,0237	0,0637	0,1137	0,1296	0,0423	0,0021	0,0119	0,0064	0,0036	0,0037	0,0009	0,0040	0,0024	0,0054	0,0011
0,0000	0,0000	0,0057	0,0011	0,0012	0,0052	0,0170	0,0005	0,0011	0,0064	0,0004	0,0002	0,0339	0,0063	0,0062	0,0180	0,1245	0,0013	0,0052	0,0188
0,0064	0,0706	0,0303	0,0968	0,0650	0,0212	0,0520	0,1046	0,0632	0,0741	0,0198	0,0669	0,0309	0,0992	0,0568	0,0162	0,0647	0,0436	0,0520	0,0373
0,0001	0,0056	0,0041	0,0220	0,1727	0,0683	0,1211	0,0620	0,0129	0,0162	0,0006	0,0056	0,0044	0,0233	0,1572	0,0543	0,1574	0,0269	0,0110	0,0086
0,0021	0,0111	0,0050	0,0188	0,0292	0,1245	0,0409	0,0145	0,0167	0,0352	0,0092	0,0150	0,0074	0,0273	0,0365	0,1360	0,0728	0,0086	0,0197	0,0254
0,0003	0,0168	0,0538	0,0426	0,0466	0,0718	0,0625	0,0480	0,0156	0,0275	0,0020	0,0309	0,1069	0,0844	0,0789	0,1067	0,1516	0,0389	0,0251	0,0271
0,0000	0,0000	0,0000	0,0008	0,0008	0,0000	0,0009	0,0009	0,0014	0,0002	0,0008	0,0002	0,0004	0,0057	0,0050	0,0000	0,0077	0,0025	0,0079	0,0006
0,0000	0,0000	0,0000	0,0000	0,0001	0,0004	0,0001	0,0001	0,0005	0,0003	0,0000	0,0003	0,0000	0,0006	0,0208	0,0057	0,0027	0,0008	0,0843	0,0034
0,0000	0,0005	0,0006	0,0005	0,0046	0,0107	0,0028	0,0001	0,0011	0,0178	0,0003	0,0017	0,0021	0,0023	0,0130	0,0268	0,0114	0,0001	0,0031	0,0296

A21 Attiki Region

A22 Rest of Greece (except Attiki)

1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
0,0206	0,0529	0,0000	0,0066	0,0001	0,0000	0,0015	0,0000	0,0004	0,0008	0,00631	0,0499	0,0000	0,0066	0,0000	0,0000	0,0017	0,0000	0,0003	0,0004
0,0144	0,2611	0,1299	0,0744	0,0890	0,0249	0,0669	0,1193	0,1360	0,0444	0,0714	0,3985	0,2135	0,1218	0,1249	0,0306	0,1342	0,0801	0,1806	0,0361
0,0002	0,0003	0,0425	0,0079	0,0092	0,0395	0,1279	0,0041	0,0081	0,0477	0,0001	0,0000	0,0079	0,0015	0,0014	0,0042	0,0289	0,0004	0,0012	0,0044
0,0094	0,1026	0,0440	0,1418	0,0945	0,0309	0,0755	0,1520	0,0918	0,1076	0,0215	0,0725	0,0335	0,1076	0,0616	0,0176	0,0702	0,0473	0,0565	0,0405
0,0001	0,0043	0,0032	0,0169	0,1329	0,0525	0,0931	0,2523	0,0099	0,0125	0,0003	0,0024	0,0020	0,0103	0,0693	0,0239	0,0693	0,0119	0,0049	0,0038
0,0031	0,0165	0,0076	0,0281	0,0437	0,1862	0,0611	0,0216	0,0250	0,0526	0,0044	0,0072	0,0035	0,0132	0,0176	0,0654	0,0350	0,0042	0,0095	0,0122
0,0004	0,0353	0,1133	0,0898	0,0981	0,1514	0,1316	0,1011	0,0329	0,0581	0,0007	0,0110	0,0380	0,0300	0,0281	0,0380	0,0697	0,0139	0,0089	0,0096
0,0002	0,0003	0,0004	0,0006	0,0003	0,0065	0,0065	0,0063	0,0101	0,0015	0,0000	0,0000	0,0000	0,0001	0,0001	0,0000	0,0001	0,0000	0,0001	0,0000
0,0000	0,0004	0,0000	0,0007	0,0003	0,0092	0,0025	0,0022	0,0122	0,0083	0,0000	0,0000	0,0000	0,0000	0,0001	0,0003	0,0002	0,0000	0,0047	0,0002
0,0002	0,0026	0,0029	0,0025	0,0212	0,0497	0,0128	0,0003	0,0054	0,0830	0,0001	0,0079	0,0009	0,0011	0,0060	0,0123	0,0052	0,0000	0,0014	0,0136

Table A – 2

Interregional Inverse Or Multiplier Matrix, Greece 2010

1,0082	0,0338	0,0093	0,0101	0,0108	0,0076	0,0106	0,0124	0,0094	0,0065	0,0118	0,0170	0,0065	0,0070	0,0074	0,0049	0,0106	0,0033	0,0060	0,0027
0,0236	1,4077	0,2319	0,1721	0,2394	0,1486	0,2122	0,2762	0,2326	0,1268	0,0181	0,0810	0,0751	0,0794	0,1137	0,0886	0,1724	0,0424	0,0734	0,0388
0,0018	0,0295	1,0440	0,0388	0,0540	0,0721	0,0800	0,0546	0,0256	0,0417	0,0051	0,0210	0,0596	0,0340	0,0416	0,0555	0,1842	0,0151	0,0227	0,0324
0,0189	0,2529	0,1643	1,2429	0,2765	0,2049	0,2614	0,3401	0,1920	0,2030	0,0520	0,2060	0,1416	0,2247	0,2187	0,1381	0,2940	0,1099	0,1559	0,0951
0,0072	0,1120	0,1149	0,1479	1,4021	0,2966	0,3473	0,2968	0,1016	0,1282	0,0194	0,0870	0,0956	0,1313	0,3308	0,2049	0,4057	0,0851	0,0811	0,0585
0,0081	0,0917	0,0749	0,0997	0,1537	1,2839	0,1715	0,1417	0,0806	0,1155	0,0251	0,0775	0,0646	0,0960	0,1302	0,2399	0,2142	0,0432	0,0704	0,0609
0,0099	0,1554	0,1800	0,1817	0,2532	0,2977	1,2872	0,2706	0,1237	0,1582	0,0272	0,1385	0,2081	0,2007	0,2320	0,2491	0,3866	0,0986	0,1094	0,0831
0,0003	0,0042	0,0039	0,0054	0,0075	0,0063	0,0076	1,0088	0,0048	0,0042	0,0016	0,0033	0,0033	0,0093	0,0097	0,0037	0,0145	0,0044	0,0105	0,0022
0,0002	0,0032	0,0030	0,0038	0,0085	0,0092	0,0080	0,0110	1,0043	0,0048	0,0006	0,0027	0,0024	0,0037	0,0265	0,0105	0,0104	0,0025	0,0869	0,0050
0,0008	0,0110	0,0103	0,0118	0,0243	0,0366	0,0230	0,0199	0,0099	1,0317	0,0023	0,0101	0,0099	0,0116	0,0272	0,0425	0,0323	0,0049	0,0099	0,0353
0,0266	0,1296	0,0452	0,0456	0,0532	0,0389	0,0527	0,0617	0,0447	0,0318	1,0788	0,1082	0,0371	0,0396	0,0399	0,0257	0,0572	0,0183	0,0336	0,0140
0,0524	0,8404	0,5356	0,4490	0,6347	0,4859	0,6291	0,7367	0,5138	0,3689	0,1747	1,8724	0,5620	0,4483	0,5462	0,3310	0,7425	0,2599	0,4925	0,1798
0,0025	0,0347	0,0812	0,0484	0,0679	0,1118	0,1943	0,0642	0,0362	0,0859	0,0064	0,0287	1,0470	0,0414	0,0512	0,0602	0,1140	0,0200	0,0255	0,0244
0,0247	0,3275	0,2092	0,3226	0,3577	0,2588	0,3349	0,4423	0,2509	0,2668	0,0602	0,2391	0,1686	1,2629	0,2637	0,1710	0,3568	0,1291	0,1844	0,1127
0,0044	0,0694	0,0700	0,0936	0,2747	0,1916	0,2320	0,3917	0,0645	0,0809	0,0121	0,0529	0,0594	0,0794	1,1810	0,1195	0,2280	0,0492	0,0504	0,0353
0,0083	0,0867	0,0680	0,0989	0,1548	0,3274	0,1767	0,1316	0,0810	0,1230	0,0183	0,0608	0,0549	0,0765	0,1058	1,1677	0,1681	0,0359	0,0556	0,0459
0,0090	0,1594	0,2243	0,2151	0,2908	0,3589	0,3333	0,2972	0,1299	0,1744	0,0229	0,1035	0,1340	0,1421	0,1806	0,1865	1,3079	0,0710	0,0874	0,0654
0,0003	0,0024	0,0024	0,0028	0,0036	0,0108	0,0101	0,0097	0,0118	0,0037	0,0004	0,0017	0,0020	0,0024	0,0032	0,0036	0,0048	1,0011	0,0024	0,0012
0,0001	0,0022	0,0016	0,0026	0,0032	0,0135	0,0057	0,0051	0,0138	0,0105	0,0004	0,0014	0,0015	0,0018	0,0029	0,0039	0,0041	0,0009	1,0070	0,0015
0,0017	0,0239	0,0206	0,0222	0,0554	0,0906	0,0472	0,0329	0,0219	0,1047	0,0044	0,0262	0,0170	0,0194	0,0343	0,0433	0,0459	0,0095	0,0157	1,0253