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PUBLIC INVESTMENTS AND REGIONAL DEVELOPMENT: THE ROLE OF REGIONAL MULTIPLIERS

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ABSTRACT

In this article, the method of estimation of regional multipliers is analyzed by using a multiregional input–output analysis and the regional multipliers for the 51 prefectures of Greece are also estimated. The regional multipliers are used for the estimation of the impacts, which public investments produce on the economy of regions. Also, the distribution of the investments in the prefectures of Greece is investigated, so that the same level of economic impact and long-term economic convergence are achieved in every region. Finally, the per inhabitant increase of the output for each prefecture resulting from the expenditures for the materialization of public and private investments in the years 1991–95 is estimated. This article refers to the economic changes that are caused in the phase of materialization of public investments, that is, the short-term and the middle-term impacts.
Keywords: input–output models, interregional trade flows, regional development, regional multipliers.

1 INTRODUCTION

Public investments are considered one of the most important tools of regional policy application. Their materialization and the construction of works in a region reinforce the demand for products or services and cause an increase in production, both in the region itself and in the other regions which have developed economic relationships with it and constitute the products and services suppliers. The resulting increase in production is usually greater than the change in investments because the investments have multiplicative effects on the economy and the space.

It is possible to estimate the increase in the production of each region by using the regional multipliers, which estimate the total influence on the production of each region, taking into account the regional relationships and interactions.

The spatial diffusion of economic impacts provoked by the materialization of investments in the regions, depends on the economic interdependence of the regions, which appears in the size and the direction of the interregional trade flows [1]. The interregional trade flows influence the degree and the direction of spatial diffusion of the economic changes, and, in combination with the technology used, the sizes of the multipliers of each region are shaped. Consequently, the trade flows influence the size of total change in production and the economic changes that follow the change in demand [2–5].

At this point, an important question about the impact of public investment on the regional economy is raised. Based on the theories, despite the fact that the regional distribution of public investments is expected to contribute to the production increase in all the regions, this increase, which leads to regional convergence, is ex-ante unknown. Moreover, when the public investments tend to favor the less developed regions, it is not certain whether the final increase in the production will also be favorable because the size of the regional multiplier, which corresponds to each region, is not ex-ante known.

Due to the fact that the regional multipliers depend to a large extent on the size and the type of the economic interaction among regions, two regions can have completely different multipliers and, consequently, benefit in a different way from the programs of public investments.

The next question concerns the possibility of the empirical estimation of regional multipliers in order to ascertain whether the distribution of the program of public investments contributes to

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regional convergence. This type of information will enable the authorities to formulate suitable regulations in the event that the opposite is true.

The aim of the article is to answer these two questions, which are important for the regional policy. The estimation of the regional multipliers is achieved by using the multiregional input–output (MRIO) model, which provides the possibility of estimation of the size of the economic impact that every autonomous change of demand provokes in all the regional systems [2, 4, 6–8]. The regional multipliers have been used for many applications in the regional policy, but are being used for public investments programming – at least in Greece – for the first time. Moreover, in the past, the regional multipliers, using the input–output analysis, have not been estimated in other studies in Greece and the regional inequalities have not been estimated by them.

In the next three sections, we present the estimation of the regional multipliers in each Greek prefecture and evaluate the differences, in order to investigate the impact of public investments on the regional inequalities. The estimations concern the short-term and the middle-term economic impacts that result from the materialization of the investments, without taking into consideration the long-term impacts.

In this context, in Section 5, we propose a method and estimate the equations for the distribution of public investments to accomplish regional convergence. Also, regional multipliers are used for the appraisal of the regional impacts of the program of public investments, which was carried out in Greece during the period 1991–95. The results are then summarized in Section 6.

2 ESTIMATION OF REGIONAL MULTIPLIERS

The estimation of the intersectoral relationships of the economy, both on the national and on the regional level, using the input–output model is achieved. Each change in the demand of one sector changes the level of production of this sector and also that of the other sectors because of the interdependence of the sectors. The determination of the spatial interdependence of regions, by using the trade coefficients and by creating the interregional input–output model, makes it possible to estimate regional multipliers and the more general economic changes caused by the change in demand in one or more sectors in each region.

However, despite its general disadvantages, the input–output model is considered an important instrument for regional planning analysis. Its use shows both the complicated intersectoral relationships in the national economy and the interregional relationships even at the level of economic branches, in a better way than other techniques. Consequently, the input–output model for economic planning can be used on both a national and a regional level [4, 6, 9, 10].

By using the MRIO model, the estimation of the regional multipliers and, consequently, the estimation of the relationships between the production value of a sector and the employment of this sector in natural terms, and the estimation of the employment multipliers for each sector and each region are possible. In fact, the regional multipliers, which in the context of the MRIO methodology require the estimation of interregional trade flows, give the impact of interregional trade and intersectoral exchanges in the regional economies.

The following general equation expresses the MRIO model [4]:

$$X = (I - TA)^{-1}TY, \tag{1}$$

where X is a column vector of total gross output ($mn \times 1$); A is a matrix of technical coefficients ($mn \times mn$); T is a matrix of trade coefficients ($mn \times mn$); Y is a column vector of final demand ($mn \times 1$); and n are the productive sectors of economy, while m are the regions.

In the event that $\mathrm{d}Y$ is the demand change, the gross output effect changes as:

$$\mathrm{d}X = (I - TA)^{-1} T\,\mathrm{d}Y. \tag{2}$$

In the event that only the impact on the region r is studied and not the impact on the whole regional system, the above equation will be expressed as follows:

$$\mathrm{d}X^s = (I - TA)^{-1} \sum_{s=1}^{m} T^{sr}\mathrm{d}Y^r. \tag{3}$$

Table $(I - TA)^{-1}TY$, after the estimation of the multiplication $(I - TA)^{-1}T$, will analytically have the form:

$$\begin{bmatrix} b_1^1 & b_1^2 & b_1^3 & \cdot & b_1^n & b_1^{n+1} & \cdot & b_1^{n\times m} \\ b_2^1 & b_2^2 & b_2^3 & \cdot & b_2^n & b_2^{n+1} & \cdot & b_2^{n\times m} \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ b_n^1 & b_n^2 & b_n^3 & \cdot & b_n^n & b_n^{n+1} & \cdot & b_n^{n\times m} \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ b_{n\times m}^1 & b_{n\times m}^2 & b_{n\times m}^3 & \cdot & \cdot & \cdot & \cdot & b_{n\times m}^{n\times m} \end{bmatrix} \begin{bmatrix} Y_1^1 \\ Y_2^1 \\ \cdot \\ Y_n^1 \\ Y_1^2 \\ \cdot \\ \cdot \\ Y_n^m \end{bmatrix}.$$

The elements of the first matrix, namely the elements $b_1^1, b_1^2, \ldots, b_i^r$, show how much the production of sector i should be increased in response to a unit increase in the demand. Thus, the elements of this matrix are the partial derivatives $\partial X_1^r/\partial Y_1^r = b_1^r$, $\partial X_2^r/\partial Y_2^r = b_2^r$, etc.

The multiplication $(I - TA)^{-1}TY$ terminates in a matrix with dimensions $[(m \times n) \times 1]$, which is the following:

$$\begin{bmatrix} \sum_{i=1}^{n} b_1^i Y_i^1 + & \cdot\ \cdot\ \cdot\ \cdot\ \cdot & \sum_{i=1}^{n} b_1^{i+(m-1)n} Y_i^m \\ \cdot & \cdot\ \cdot\ \cdot\ \cdot\ \cdot & \cdot \\ \cdot & \cdot\ \cdot\ \cdot\ \cdot\ \cdot & \cdot \\ \sum_{i=1}^{n} b_n^i Y_i^1 + & \cdot\ \cdot\ \cdot\ \cdot\ \cdot & \sum_{i=1}^{n} b_1^{i+(m-1)n} Y_i^m \\ \cdot & \cdot\ \cdot\ \cdot\ \cdot\ \cdot & \cdot \\ \cdot & \cdot\ \cdot\ \cdot\ \cdot\ \cdot & \cdot \\ \sum_{i=1}^{n} b_{m\times n}^{i+(m-1)n} Y_i^1 + & \cdot\ \cdot\ \cdot\ \cdot\ \cdot & \sum_{i=1}^{n} b_{m\times n}^{i+(m-1)n} Y_i^m \end{bmatrix}.$$

In a synoptic form, this table can be written as:

$$\begin{bmatrix} M_1^1 \\ M_2^1 \\ . \\ M_n^1 \\ M_1^2 \\ . \\ . \\ M_n^m \end{bmatrix} = \begin{bmatrix} \sum_{r=1}^{m}\sum_{i=1}^{n} b_1^{i+(r-1)n} Y_i^r \\ . \\ . \\ . \\ \sum_{r=1}^{m}\sum_{i=1}^{n} b_n^{i+(r-1)n} Y_i^r \\ . \\ . \\ \sum_{r=1}^{m}\sum_{i=1}^{n} b_{n\times m}^{i+(r-1)n} Y_i^r \end{bmatrix}, \tag{4}$$

which, when

$$Y_i^r = \begin{bmatrix} 1 \\ 1 \\ . \\ 1 \\ . \\ . \\ . \\ 1 \end{bmatrix},$$

can be written as:

$$\begin{bmatrix} M_1^1 \\ M_2^1 \\ . \\ M_n^1 \\ M_1^2 \\ . \\ . \\ M_n^m \end{bmatrix} = \begin{bmatrix} \sum_{r=1}^{m}\sum_{i=1}^{n} b_1^{i+(r-1)n} \\ . \\ . \\ . \\ \sum_{r=1}^{m}\sum_{i=1}^{n} b_n^{i+(r-1)n} \\ . \\ . \\ \sum_{r=1}^{m}\sum_{i=1}^{n} b_{n\times m}^{i+(r-1)n} \end{bmatrix}.$$

The tables above give the output multipliers M_n^m (m region, n sector), which for all the sectors, in a synoptic form, for the region $r = 1$ will be equal to:

$$M_1 = \sum_{s=1}^{m}\sum_{i=1}^{n} b_1^{i+(r-1)} + \cdots + \sum_{s=1}^{m}\sum_{i=1}^{n} b_n^{i+(r-1)n}. \tag{5}$$

Similarly, the output multipliers of the region r = k for all the sectors will be equal to:

$$M_k = \sum_{s=1}^{m}\sum_{i=1}^{n} b_{n(k-1)+1}^{i+(r-1)} + \cdots + \sum_{s=1}^{m}\sum_{i=1}^{n} b_{n(k-1)+n}^{i+(r-1)}. \tag{6}$$

The total output, which is finally produced from every increase in the whole economy, will quantitatively exceed the initial demand. The excess of total demand is interpreted by using the general input–output model and by analyzing the general equation [4]:

$$(I - A)^{-1} = (I + A + A^2 + A^3 + \cdots). \tag{7}$$

In eqn (7), table I gives the 'initial' effects on the output, table A the 'direct' effects and the terms $A^2 + A^3 + \cdots$ the 'indirect' effects on the output. Consequently, the change in the output is given by the equation:

$$X = (I + A + A^2 + A^3 + \cdots)Y = Y + AY + A^2Y + A^3Y + \cdots. \tag{8}$$

That is, the output X exceeds the demand Y by $AY + A^2Y + A^3Y + \cdots$. Table $(I - A)^{-1}$ gives the multipliers on the national level and corresponds to the table $(I - TA)^{-1}T$ of the multiregional analysis [4, 7].

3 THE REGIONAL MULTIPLIERS IN GREECE

To estimate the regional multipliers for the 51 prefectures of Greece, we use eqns (4) and (6) as well as the input–output (I–O) in the existing tables, which have been reduced to the dimensions 10×10 [11]. As it is impossible to estimate the regional technological coefficients and the necessary statistical data do not exist, we use the national technological coefficients to create the multiregional model.

If the essential statistical information existed and the constitution of the regional input–output tables were possible, a more accurate estimation of the impact of intersectoral exchanges on the regional multipliers' values for each prefecture would be feasible. The estimations that follow are based on the hypothesis that the technology used does not differ significantly from prefecture to prefecture. It is noted that the national technological coefficients resulted as mean values of the data that derived from all the prefectures. Then, we suppose that the differences in the 'mix of' inputs, which are used in the productive process for every prefecture, are not important because the national coefficients result from the average data of all the regions.

This 'heroic' assumption is justified as follows: a national I–O table is no more than the aggregate result of all individual industrial linkages, which take place within the economy as a whole. By constructing a single-region table from the national table using the location quotients (LQ) method [10, 12, 13], a reliable method that is often used for the construction of regional I–O tables, we estimate that we make the same errors and the results have the same reliability. The LQ method overstates the multipliers because the conventional location quotient does not take sufficient account of interregional trade. Regional propensities to import are higher than national propensities [10]. Also, according to McCann and Dewhurst [14], the regional I–O coefficients, relative to that of the equivalent coefficient in the national table, fall as the size of the region decreases, and consequently, the regional I–O coefficients do not differ significantly when the size of the regions in a country is the same. In Greece, except for the prefectures of Attica and Thessaloniki, most of the other prefectures have a population between 160,000 and 230,000 residents and consequently, the assumption of a roughly similar technological coefficient is not far from reality.

The trade flows and the trade coefficients derive from an elaboration of the 'New National Research of Origin–Destination', a study that was conducted on behalf of the Ministry of Public Works [1, 15].

On the basis of the study mentioned above, we have estimated the trade exchanges among the 51 prefectures of Greece for tradable transported products except for the services. For this reason, table T does not include the trade coefficients corresponding to the services sector (i.e. the latter coefficients were difficult to measure).

The dimensions of tables A, T and I of eqn (1) are $mn \times mn = 510 \times 510$ ($m = 51$ prefectures and $n = 10$ sectors or productive branches per prefecture). The 'structure' of the vector of final demand, which will be used and has the dimensions $mn \times 1 = 510 \times 1$ for the present research, plays a significant role in the estimation of the regional multipliers. For our estimations, we use the vector that resulted from the national consumption vector [14] with the corresponding percentage distribution of demand among the sectors.

For the regional demand vector layout, the distribution that is valid for the nation is considered to be valid for each prefecture. The sum of the elements in each vector of demand that is used for the 10 sectors in each prefecture is equal to one unit. Thus, the prospective change in the output for each prefecture is estimated. This change corresponds to total demand change in each prefecture and is equal to one unit.

The values of regional multipliers give, indirectly, a 'figure' of the productive autonomy and a balance of trade and commercial exchanges for each prefecture. Consequently, they give the level of changes that result from the construction of works and investment materialization or the change in consumption. In other words, it is possible to have a prefecture ranking of 'privileged' and 'not privileged', depending on the values of regional multipliers or the size of the total changes to the output, which will arise in every prefecture.

4 ESTIMATION RESULTS

The estimation results, which are presented in Table 1, clearly show the interregional inequalities, as these are represented indirectly in the regional multipliers. The estimations were made with the assumptions that:

1. The demand is satisfied by the internal market and consequently, the demand for imports is not included.
2. The technological coefficients of the multiregional model are equal for all the prefectures.
3. For the estimation of trade coefficients, the output for the 10 productive sectors is divided into tradable, which can be the object of trade, and nontradable, which cannot be the object of trade and which refers mainly to services.

As we can see in Table 1, the prefectures of Attiki and Thessaloniki have the highest multipliers and consequently, these prefectures dominate in comparison with the economy of the other prefectures. The prefectures of Achaia, Kavala, Imathia, Korinthia, Evia and Viotia, follow with lower values. The prefectures of Evrytania, Grevena, Fokida and Lefkada have the lowest values, and the other prefectures are in intermediate positions with more unfavorable values for the island prefectures.

The results as expected show exactly the size of the interregional economic inequalities in Greece. Under the assumption of proportional distribution of expenditure for works and investments, the prefectures that are in a favorable position are those with a strong productive base, economic sufficiency and autonomy, greater population concentrations and a higher level of development (Attiki, Thessaloniki, Achaia, Viotia and Korinthos). On the contrary, the difficult situation of less economically developed prefectures is aggravated by the inequalities, which keep increasing.

It is pointed out that the total national output exceeds the total demand, i.e. 51 units. As we observe in the last line of Table 1, the total output is equal to 90.32 units and the national multiplier $M_N = 1.77$ results, which is explained, as mentioned above, by using eqn (8).

Table 1: The values of the investment multipliers, the indices of prosperity and the output for two alternative scenarios of financing of investments.

				Investment share (€) per inhabitant	
	Prefecture (1)	Investment multipliers (2)	Prosperity index (3)	The alternative of maintenance of the regional inequalities (4)	The alternative of regional economic convergence (5)
1	Aitoloakarnania	2.442	22.0	0.893	1.090
2	Attiki	8.508	70.4	0.256	0.161
3	Viotia	2.428	33.1	0.898	0.708
4	Evia	2.347	32.1	0.929	0.804
5	Evrytania	0.824	16.8	2.647	3.346
6	Fthiotida	1.595	28.1	1.367	1.364
7	Fokida	0.867	26.2	2.514	2.480
8	Argolida	1.712	34.7	1.274	1.140
9	Arkadia	1.316	28.2	1.657	1.617
10	Achaia	3.546	36.3	0.615	0.583
11	Ilia	1.173	17.2	1.859	1.840
12	Korinthia	2.215	31.5	0.984	0.787
13	Lakonia	1.289	25.5	1.692	1.813
14	Messinia	1.487	25.7	1.466	1.534
15	Lefkada	0.863	34.0	2.527	2.552
16	Arta	1.272	20.9	1.715	2.322
17	Thesprotia	1.370	20.1	1.591	2.029
18	Ioannina	1.761	33.4	1.238	1.324
19	Preveza	1.443	25.6	1.511	1.741
20	Karditsa	1.052	21.3	2.073	2.216
21	Larisa	2.045	33.7	1.066	1.021
22	Magnisia	1.683	39.2	1.295	1.108
23	Trikala	1.621	27.2	1.345	1.545
24	Grevena	0.919	22.3	2.371	2.306
25	Drama	1.218	25.4	1.791	1.629
26	Imathia	2.155	30.2	1.012	0.902
27	Thessaloniki	8.096	55.5	0.269	0.186
28	Kavala	3.106	35.8	0.702	0.556
29	Kastoria	1.063	27.2	2.052	1.926
30	Kilkis	1.249	24.3	1.746	1.744
31	Kozani	2.378	34.4	0.917	0.696
32	Pella	1.758	24.7	1.240	1.263
33	Pieria	1.168	31.8	1.867	1.959
34	Serres	1.553	21.0	1.404	1.581
35	Florina	1.074	24.7	2.030	2.227
36	Chalkidiki	1.000	31.9	2.181	1.988

Continued

Table 1: *Continued*

	Prefecture (1)	Investment multipliers (2)	Prosperity index (3)	Investment share (€) per inhabitant: The alternative of maintenance of the regional inequalities (4)	Investment share (€) per inhabitant: The alternative of regional economic convergence (5)
37	Evros	1.371	31.3	1.590	1.637
38	Xanthi	1.279	28.0	1.705	2.026
39	Rodopi	1.174	26.4	1.857	2.609
40	Zakinthos	0.889	37.1	2.454	2.344
41	Kerkyra	0.865	35.8	2.520	2.138
42	Kefallinia	0.836	38.5	2.609	2.180
43	Dodekanisos	1.320	49.3	1.652	1.256
44	Kyklades	1.263	46.9	1.726	1.284
45	Lesvos	1.188	34.1	1.835	1.974
46	Samos	0.963	38.9	2.263	2.144
47	Chios	0.975	37.2	2.235	2.035
48	Irakleio	2.052	40.6	1.063	0.960
49	Lasithi	1.425	36.3	1.530	1.357
50	Rethymno	1.519	34.0	1.435	1.552
51	Chania	1.588	41.1	1.373	1.250
	Total	90.325			

For the interpretation of the results, we report that the allocation of €1 in each prefecture of Greece for the construction of public works will barely cause an increase in the output of Attiki by €8.50, of Thessaloniki by €8.09 and of Achaia by €3.54. However, in Evrytania, Fokida, Lefkada, etc., the increase will only be €0.82, €0.86 and €0.86, respectively. According to Fig. 1, long-term changes will result from the exploitation of public works or investments in proportion to its efficiency.

The above results give a basic direction of planning and programming of the public works and investments, in the context of a policy of balanced regional economic development. The values of regional multipliers can be used as a 'basic axis' for the expenditure per inhabitant of a program of public investment per prefecture. A program that will be based on the principle of 'the same public expenditure per inhabitant for all the prefectures' will lead to the maintenance and the enlargement of regional economic inequalities. On the contrary, the co-estimation of the size of the regional inequalities, as these appear in the regional multipliers and their incorporation in the process of regional programming, will help in the economic convergence of regions in the long term.

Furthermore, we will estimate the relationship between the prosperity level and the multipliers of each prefecture, as well as the relationship between the multipliers and the size of the urban population for each prefecture, expecting a positive relationship for these variables. Firstly, we suppose that the multipliers influence the level of economic development and, consequently, the prosperity level for each prefecture. Moreover, we expect that the prefectures with a high prosperity level will have high values of the multipliers. Also, the prefectures with large urban concentrations generate agglomeration economies and economies of scale for their enterprises. These prefectures, apart from being productively autonomous, are also characterised by both high productivity and competitive economy.

Table 2: Parameters of the estimation of eqns (9) and (10) by using the ordinary least squares method.

Estimations for eqn (9)		Estimations for eqn (10)	
a_0	27.921* (14.64)	b_0	1.688* (7.96)
a_1	2.406* (3.30)	b_1	1.92×10^{-6}* (4.32)
R^2	0.23	R^2	0.34
R^2-adjusted	0.21	R^2-adjusted	0.30
N	51	N	51

*Statistical significance in confidence level 1%.

Therefore, they are expected to have high multiplier. For the depiction of the prosperity level of each prefecture (level NUTS III according to the classification of the EU), indicators that are estimated in another study are used and presented in Table 1 [16].

We suppose the following linear relationships among the above-mentioned variables:

$$E_r = a_0 + a_1 M_r + u_r, \quad u_r \sim N(0,\ \sigma_\varepsilon^2),\ a_1 > 0, \tag{9}$$

$$M_r = b_0 + b_1 U_r + u_r, \quad u_r \sim N(0,\ \sigma_\varepsilon^2),\ b_1 > 0, \tag{10}$$

where M_r is the multiplier of the prefecture r; E_s is the prosperity level of the prefecture r; and U_s is the urban population of the prefecture r.

By using the existing statistical data, we estimate the values of the parameters of eqns (9) and (10) and the results of these estimations are presented in Table 2, in which we can observe suitable explanatory ability and statistical significance at a satisfactory level of confidence. From the results, it is obvious that the initial expectations are verified and a positive relationship exists between the multipliers and the other variables. Consequently, the multipliers' value influences the extent of economic development and contributes to the configuration of regional inequalities.

5 PROGRAMMING OF PUBLIC INVESTMENTS

Public investments that are materialized in the regions of a country increase the regional public capital. Public capital could be considered as relevant inputs in the production process and has a positive and significant effect on private output and total factor productivity. Basic infrastructure (fundamentally those of transport, energy, water and sewer facilities) has shown a positive influence on the regional production and productivity. The influences of other types of public capital, such as those devoted to health, education or to services of a general nature, on these economic sizes, i.e. production and productivity, are smaller [17]. Many authors show the effect of public capital on private sector productivity and point out that the network feature of most of the infrastructure should lead to different expectations of their impact, depending on the level of development and the amount of public capital already accumulated [18].

In the next step, the multipliers will be used for the distribution of a public investments program in the prefectures by using the following criteria: (1) the achievement of the same quantitative economic development per prefecture, (2) development which will lead to the reduction of regional inequalities and, in the long term, to economic convergence. It is obvious that the investments per region (prefecture) should be inversely proportional to the economic development level so as to achieve a balance of regional inequalities, as these are presented in the different prosperity levels.

Each investment causes short-term, middle-term and long-term effects in the region where it is implemented. The extent and the size of the short-term and the long-term effects on the output depend on the value of the regional multipliers, which is derived from eqns (4) and (6).

The effects, which the investments cause in each region, are shown diagrammatically in Fig. 1. The production increase, which is denoted by the broken line in the diagram , is the short-term and the middle-term increase. This increase, as mentioned above, has its origin in the change in demand for goods or services, which is necessary for the materialization of works and investments program.

Furthermore, the problem of the distribution of the national investments program is studied by using the regional multipliers, so that the per inhabitant output will be equal for all the prefectures. Supposing that I is the amount of the public investments for the country, the per inhabitant investments for the prefecture s will be equal to:

$$W_r = \frac{Ws_r}{P_r}, \tag{11}$$

where W_r is the public investments in prefecture r; P_r is the population of prefecture r; and s_r is the share of the investment in prefecture r.

In order for the initial hypothesis to be valid, e.g. for output per inhabitant and per prefecture to be the same, the following equation should be valid:

$$\frac{M_r Ws_r}{P_r} = \frac{M_{r+1} Ws_{r+1}}{P_{r+1}} \acute{\eta} \frac{M_r s_r}{P_r} = \frac{M_{r+1} s_{r+1}}{P_{r+1}} \quad (r = 1, \ldots, 51). \tag{12}$$

By using the general relationship eqn (12), we obtain 50 equations for the 51 prefectures of Greece, while the following should also be in effect:

$$\sum_{r=1}^{51} s_r = 1. \tag{13}$$

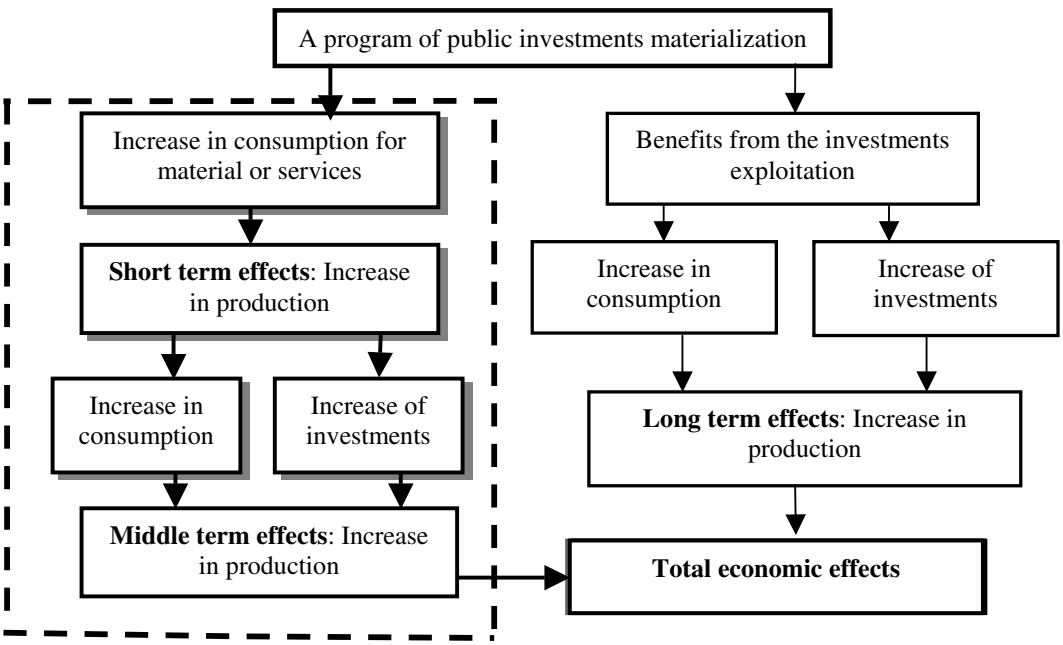

Figure 1: The sequences of economic changes.

The solution of the system of eqns (12) and (13) gives the percentage of investments for prefecture k equal to:

$$s_k = \frac{1}{\frac{M_k P_1}{M_1 P_k} + \frac{M_k P_2}{M_2 P_k} + \cdots + \frac{M_k P_k}{M_n P_k}} \quad (k = 1, 2, \ldots, 51).$$

In a synoptic form:

$$s_k = \frac{1}{\sum_{s=1}^{51} \frac{M_k P_r}{M_r P_k}} \quad (k = 1, 2, \ldots, 51). \tag{14}$$

By using eqn (14) and the values of the regional multipliers M_s for the investments vector (Column 2 of Table 1), the investments per inhabitant and per prefecture are estimated for a national program of €10,000,000 so that the per inhabitant output is equal for all the prefectures. The results of these estimations are presented in Table 1 (Column 4). As expected, the prefectures with high multiplier values require smaller per capita investments, while the opposite is valid for prefectures with small multiplier values.

The problem of the distribution of a national investment program will be studied, assuming the per inhabitant output is inversely proportional to the economic development level of each prefecture. Based on the hypothesis that E_s is the prosperity level of prefecture s, the programming of investments is possible with a relationship inversely proportional to the prosperity level of each prefecture, assuming that the economic development is proportional to the propensity level of each prefecture. It is obvious that with such financing, the output in the less developed regions is increased more rapidly and therefore the long-term economic convergence of the prefectures is achieved.

For the estimation of the percentages of investments r_k the following relationships, where E_k is the prosperity level of the prefecture k will be used:

$$\frac{M_k s_k}{P_k E_k} = \frac{M_{k+1} s_{k+1}}{P_{k+1} E_{k+1}} \quad (k = 1, \ldots, 51), \tag{15}$$

$$\sum_{k=1}^{51} r_k = 1. \tag{16}$$

The solution of the above system gives the percentage of investments for prefecture k, equal to:

$$s_k = \frac{1}{\frac{M_k P_1 E_k}{M_1 P_k E_1} + \frac{M_k P_2 E_k}{M_2 P_k E_2} + \cdots + \frac{M_k P_k E_k}{M_n P_k E_n}} \quad (k = 1, 2, \ldots, 51).$$

In a synoptic form:

$$s_k = \frac{1}{\sum_{r=1}^{51} \frac{M_k P_r E_k}{M_s P_k E_r}} \quad (k = 1, 2, \ldots, 51) \tag{17}$$

By using the prosperity data, which is available for each prefecture and is presented in Table 1, and eqn (17), we estimate the per inhabitant expenditure for each prefecture. The estimation results are presented in Table 1 (Column 5). As expected, the prefectures with high multipliers (Attiki, Thessaloniki, Achaia, etc.) require a smaller percentage of investments, in contrast to the 'not privileged' prefectures (Evrytania, Fokida, Grevena, etc.), which require a bigger expenditure per inhabitant.

Finally, we will study the level of the output per inhabitant for all the Greek prefectures by using the multipliers that were previously estimated and the level of the expenditures that were used during the years 1991–95 for the materialization of public and private investments [19, 20]. It is noted that the spatial distribution of the public investments is influenced, to a certain degree, by the policy applied by the government via means of development incentives that are in effect at any given time. The results of the estimation are presented in Table 3. Comparing the values of the prosperity level of prefectures and the level of the output from Table 3, we conclude that the spatial distribution

Table 3: Investments and output for the Greek prefectures during the years 1991–95.

		Average investment for the years 1991–95 (million drachmas)		Output per inhabitant (thousand €)		
	Prefecture	Private investments	Public investments	Private investments	Public investments	Total output
1	Aitoloakarnania	21,518.8	19,768.6	0.687	0.631	1.318
2	Attiki	390,013.0	106,612.6	2.588	0.707	3.296
3	Viotia	10,560.6	9,082.6	0.574	0.493	1.067
4	Evia	34,599.2	7,380.2	1.108	0.236	1.344
5	Evrytania	1,579.0	3,543	0.119	0.267	0.386
6	Fthiotida	19,383.8	9,238.8	0.507	0.242	0.749
7	Fokida	5,297.0	4,677.6	0.279	0.246	0.525
8	Argolida	14,268.8	4,198.6	0.677	0.199	0.877
9	Arkadia	11,614.0	3,911.0	0.439	0.148	0.587
10	Achaia	42,424.8	13,948.4	1.367	0.449	1.817
11	Ilia	29,547.8	7,370.4	0.526	0.131	0.657
12	Korinthia	22,803.6	3,958.8	0.959	0.166	1.125
13	Lakonia	12,072.2	3,966.4	0.458	0.150	0.609
14	Messinia	24,255.8	7,417.2	0.598	0.183	0.781
15	Lefkada	5,553.6	2,040.4	0.625	0.229	0.854
16	Arta	8,286.0	3,534.0	0.395	0.168	0.564
17	Thesprotia	8,089.4	3,768.8	0.705	0.328	1.034
18	Ioannina	19,645.4	14,860.2	0.596	0.451	1.047
19	Preveza	8,709.8	5,121.6	0.621	0.365	0.986
20	Karditsa	11,522.2	7,634.4	0.274	0.181	0.456
21	Larisa	33,377.6	8,433.0	0.717	0.181	0.898
22	Magnisia	30,231.4	9,451.4	0.721	0.225	0.947
23	Trikala	17,535.6	5,289.6	0.604	0.182	0.786
24	Grevena	3,487.2	4,778.6	0.248	0.339	0.588
25	Drama	12,093.2	7,631.4	0.415	0.262	0.678
26	Imathia	13,567.0	3,910.0	0.597	0.172	0.769
27	Thessaloniki	118,579.0	33,803.2	2.663	0.759	3.422
28	Kavala	17,380.0	7,332.6	1.092	0.460	1.553
29	Kastoria	3,570.8	3,908.6	0.208	0.228	0.436

Continued

Table 3: *Continued*

	Prefecture	Average investment for the years 1991–95 (million drachmas)		Output per inhabitant (thousand €)		
		Private investments	Public investments	Private investments	Public investments	Total output
30	Kilkis	9,780.6	2,541.2	0.402	0.104	0.507
31	Kozani	14,613.4	6,567.6	0.656	0.295	0.951
32	Pella	15,955.0	4,728.8	0.564	0.167	0.732
33	Pieria	19,893.6	5,071.4	0.525	0.133	0.659
34	Serres	18,394.8	5,908.6	0.417	0.134	0.551
35	Florina	4,810.4	2,685.2	0.276	0.154	0.431
36	Chalkidiki	25,484.2	5,118.6	0.712	0.143	0.856
37	Evros	10,128	10,623.0	0.272	0.286	0.559
38	Xanthi	10,550.8	8,101.0	0.388	0.298	0.687
39	Rodopi	6,361.8	6,651.4	0.197	0.206	0.404
40	Zakinthos	7,094.0	2,774.2	0.474	0.185	0.659
41	Kerkyra	17,833.4	8,283.0	0.404	0.187	0.592
42	Kefallinia	9,269.4	2,985.2	0.575	0.185	0.761
43	Dodekanisos	23,746.8	9,574.4	0.484	0.195	0.679
44	Kyklades	31,000.2	7,364.0	1.020	0.242	1.263
45	Lesvos	10,754.2	7,431.0	0.343	0.237	0.581
46	Samos	5,511.2	5,377.6	0.357	0.348	0.706
47	Chios	6,775.0	4,722.4	0.363	0.253	0.616
48	Irakleio	26,480.0	11,238.0	0.545	0.231	0.776
49	Lasithi	10,281.8	4,440.6	0.563	0.243	0.807
50	Rethymno	13,008.0	4,741.2	0.707	0.258	0.965
51	Chania	17,686.8	13,239.6	0.548	0.410	0.958

of the investments, increased by the economic inequalities, 'did not move' in the direction of the convergence of economies.

The graphs in Fig. 2 provide an overview of the impact of the private and the public investments on the maintenance and increase of regional inequalities during the years 1991–95. In these graphs, the relationship between the prosperity level and the output produced per inhabitant for each prefecture from the materialization of private and public investments is presented. The value of the coefficient of determination for the two cases is satisfactory and also the results of the estimations presented statistical importance at a significant level of confidence (about 1%).

The positive slope of the middle line for the two cases is indicative of the impact of the private and public investments on the maintenance or the increase of regional economic inequalities. The prefectures with high prosperity levels have been favored from the spatial distribution of private and public investments. Comparing the two diagrams and the dissemination of observations with reference to the middle line, we realize that in the case of private investments, the positive relationship between prosperity and investments is more intense in relation to public investments, which is reflected in the different values of the coefficients of determination.

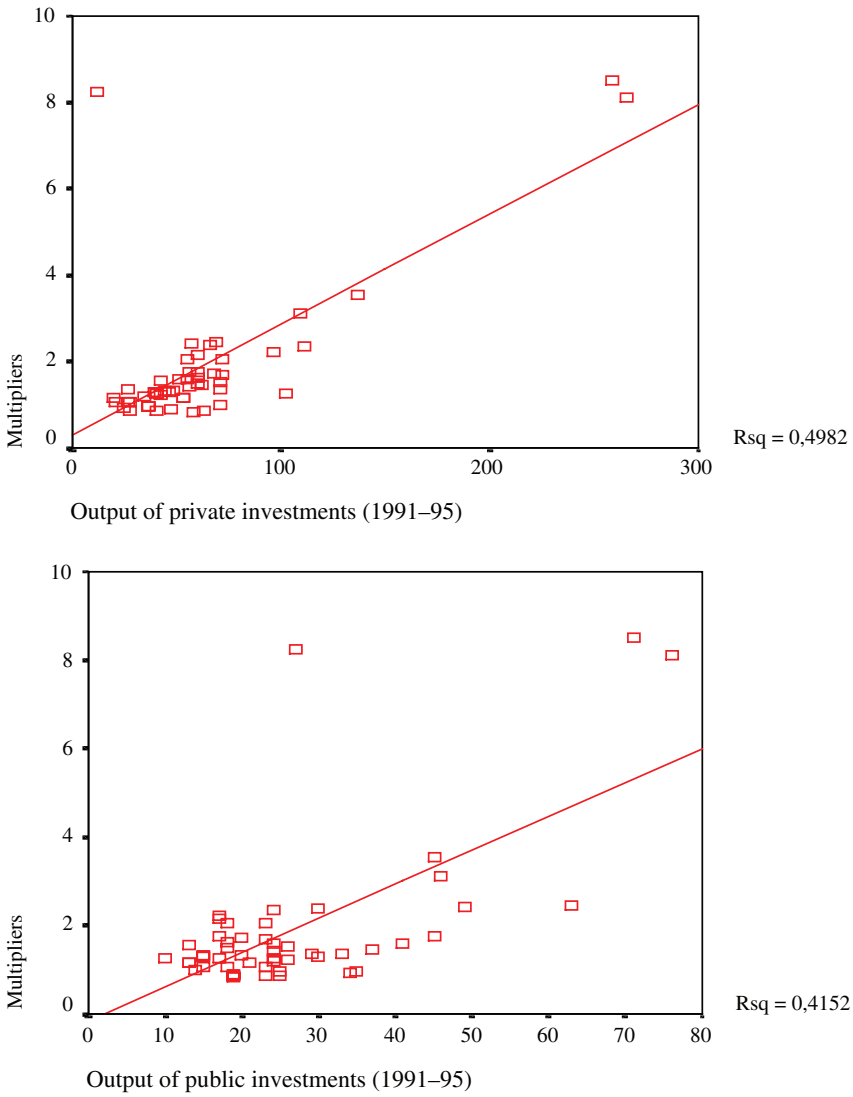

Figure 2: Diagrammatic presentation of the relationship between the prosperity level and the output per inhabitant from private and public investments.

Finally, if it is taken into consideration that private investments in the prefectures during the years 1991–95 were quantitatively twice or thrice those of the corresponding public investments, one realizes that the total influence on the increase of regional inequalities is more important than the total influence of public investments.

6 CONCLUSIONS – PROPOSALS

The regional inequalities have been studied by other authors in their articles on Greece; these authors agree on the existence of regional inequalities, independent of the size of the inequalities [21–24]. The estimation of the regional multipliers shows the size of the regional inequalities under a different

aspect, and simultaneously it composes a base for a successful regional policy exercise. Furthermore, the correlation of the regional multipliers with the prefectures' prosperity level shows a positive relation between the regional multipliers and the regional inequalities. Consequently, the regional multipliers can be used as a tool to construct methodologies, which concern the distribution of public or private investments.

Both the size of the multipliers and the analysis of the increases caused by external expenditure in the output of the Greek prefectures, show the important differences in the possibilities for the economic development of each prefecture. Moreover, the size of the named 'regional problem' appears under a different aspect. Simultaneously, the above-mentioned estimations and the results give a basic direction, which will supposedly be followed in the public investments programming and also in the policy of reinforcement of private investments, provided a combination of economic and balanced spatial development is sought.

The influence of the prefectures of Attiki and Thessaloniki on the economies of the other prefectures is reflected in the relative size of the multipliers. If the influence of the 'satellite' prefectures of Attiki (e.g. Viotia, Evia and Korinthia) is also included, then it is apparent that the influence increases and, in effect, these prefectures dominate in the national economy.

As has been mentioned above, for the estimation of the trade coefficients, the flows of tradable goods are used, e.g. goods whose exchange can be measured. Consequently, if any interregional exchanges in the level of services (trade, banks, insurance, transport, etc.) are included, then the dependence of the other prefectures on the prefectures of Attiki and Thessaloniki is increased, since the highest percentage of the services of the country is concentrated in these two prefectures and therefore, their allocated 'export surplus' exceeds that of the other prefectures.

Also, the lower values of the multipliers of certain prefectures (Evrytania, Grevena, Fokida, etc.) are worthy of observation, as they correspond to the place they occupy in the economic map of the country. The economic and productive autonomy of these prefectures is limited and therefore, each program at their development will supposedly include their economic dependence, which is expressed in the regional multipliers.

In conclusion, each policy of regional development should include the differences of the regional multipliers and differentiate proportionally the distribution of expenditure for investments among the regions. The proportional distribution of expenditure (the same public expenditure per inhabitant in all the prefectures) extends the regional inequalities, while the distribution that makes the per capital output equal for each prefecture (eqn (14)), maintains them. The goal of long-term economic convergence of the levels of the economy of the prefectures requires a distribution proportional to the level of prosperity of each prefecture and adaptation according to eqn (17).

Finally, it should be reported that the estimations that were made 'suffer' to some degree from the inadequacy of the statistical data that were used. The existence of more and better data would enable a broader analysis and consequently a better depiction of the characteristics of the regional economy (constructing a more precise MRIO model) and interregional economic interaction and interdependence. We think, in any case, that the final results give, to a satisfactory degree, the size and the direction of the spatial economic asymmetry in Greece.

The regional inequalities in Greece are maintained or increased, and the inability of the existing policies to influence, in relative terms, the regional problem has been ascertained [16]. Also, public programs require suitable planning. In this direction, this article contributes to the improvement of the appraisal process of the applied regional policy. This policy is commonly applied by means of public investments or the reinforcement of private investments. Therefore, the article achieves the estimation of the distributive effects that are reflected on the regional economic development, and in the configuration of economic evolution.

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