

Michailidis, Anastasios; Loizou, Efstratios; Mattas, Konstadinos; Melfou, Aikaterini

Conference Paper

Agro-Food Dynamics in a Region's Growth

46th Congress of the European Regional Science Association: "Enlargement, Southern Europe and the Mediterranean", August 30th - September 3rd, 2006, Volos, Greece

Provided in Cooperation with:

European Regional Science Association (ERSA)

Suggested Citation: Michailidis, Anastasios; Loizou, Efstratios; Mattas, Konstadinos; Melfou, Aikaterini (2006) : Agro-Food Dynamics in a Region's Growth, 46th Congress of the European Regional Science Association: "Enlargement, Southern Europe and the Mediterranean", August 30th - September 3rd, 2006, Volos, Greece, European Regional Science Association (ERSA), Louvain-la-Neuve

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Agro-food Dynamics in a Region's Growth

Loizou Efstratios^{*}, Mattas Konstadinos^{}, Michailidis Anastasios and Melfou Aikaterini**

^{*} Department of Agricultural Products Marketing and Quality Control, Technological Educational Institute of Western Macedonia. Terma Kontopoulou, 53100 Florina, Greece.
e-mail: lstratos@agro.auth.gr.

^{**} Department of Agricultural Economics, Aristotle University of Thessaloniki.
P.O. Box 225, 541 24, Thessaloniki, Greece
e-mail: mattas@auth.gr

**Paper to be Presented at the 46th Congress of the
European Regional Science Association (ERSA)**

Enlargement, Southern Europe & the Mediterranean

Volos - Greece

August 30 – September 3, 2006

Correspondence address:

Mattas Konstadinos
Department of Agricultural Economics,
Aristotle University of Thessaloniki
P.O. Box 225,
541 24, Thessaloniki, Greece
e-mail: mattas@auth.gr

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Loizou E., Mattas K., Michailidis A. and Melfou A.

Abstract

Agriculture has always been an important sector for the Greek economy; though, the last years its contribution is continuously decline. Despite the diminishing direct contribution of agriculture's and generally agro-food sectors in the formation of the economy's gross output and employment, their indirect influence upon the rest of the economy is very important and most of the times is not completely cast up. In the present study an attempt is made to examine the indirect contribution of agro-food sectors in a regional economy by constructing a regional I-O model. The regional I-O table as well as the estimated linkage coefficients indicated the indirect importance of agro-food sectors in supporting the generation of output, income and employment from non-agro sectors in the regional economy.

Keywords: agro-food sectors, regional development, regional Input-Output analysis.

1. Introduction

The role of agriculture and agro-food sectors in economic growth became an emerging issue the last years, due mainly to the dwindling of agriculture's significance in countries like Greece. This issue becomes much more essential in regional level. Despite the diminishing direct contribution of agriculture's and agro-food sectors in the formation of an economy's gross output and employment, their indirect influence upon the rest of the economy most of the times is not completely cast up. It is evidence that over the last two decades the share of agriculture in Greece's GDP is substantially dropped. This fact many times used as a guide to support views in directing regional developing funds far from agriculture. Though, it is well known that regional development depends highly in the allocation of developing funds -through development policies- among the various sectors of regional economies. In order to safeguard the most efficient use of such investments, analytical tools visualizing the economy as a whole in the form of a general equilibrium should be adopted. Such tools can identify the significance of a sector both in terms of direct and indirect significance.

On the other side, food sectors' share in processing industries is growing and its contribution and interrelation with other sectors has not been well assessed. Thus in the present study, the indirect contribution of agro-food sectors in a region's economy is measured. Linkage relationships and interdependencies between food and non-food sectors are sought and their role in strengthening the regions growth is contemplated.

The identification of such relationships is very important, as the path to development in some regions is very sensitive to sectoral interdependencies.

To accomplish the aforementioned objectives an Input-Output framework was employed in a regional level, at the Greek region of Thessalia. Utilizing an employment based Location Quotient (LQ), developed by Flegg et al (1995) -the FLQ- the national I-O table is regionalized for the Greek (NUTS 2) region. The regionalization procedure is performed by following the hybrid GRIT technique. Employing the regional I-O table, linkage coefficients, that identify the dynamics of key sectors, were estimated.

2. The region and agro-food sectors

The region of Thessalia is located in the center-east part of the continental Greece and covers a total area of 14.036 km² and it is the fifth largest region in Greece. Total population in the region of Thessalia accedes to 742.947 inhabitants placing the region in the third place covering the 7.1% of the total population. The population density is 97.5 inhabitants per km² compared to 79.7 inhabitants per km², which is the population density of Greece.

Table 1. The region of Thessalia

	Thessalia	Greece	Regional share
Area (km ²)	14,036	131,957	10.64%
Population (2000)	742,947	10,521,669	7.06%
Labor force (in persons, 2000)	258,395	3,866,979	6.68%
GDP (million drs, current prices, 2000)	2,372,123	32,200,875	7.37%
Employment (in persons):			
Agriculture	84,009	665,194	12.6%
Food manufacture	7,794	119,994	6.5%
Total	258,395	3,866,979	6.7%

Source: National Statistical Service of Greece (NSSG)

The region produces the 7% (table 1) of the Country's total Gross Domestic Product and has the third highest share in Greece. The GDP of the region has been increasing through the last decade in a high rate. The services sector in the region produce the majority of the total GDP and it has been increasing in the last decade in a high rate. On the other hand the GDP in the agricultural sector has been decreasing showing that the agricultural sector is declining. Agriculture is considered as one of the most significant sectors both in the region and the country. In Thessalia are cultivated mostly cereals and cotton, while in the mountainous areas the habitants are engaged

with animal production. The total cultivated agricultural area of the region represents the 12.6 % of the total cultivated agricultural area in Greece.

The 6.7% of the country's labor force is in the region of Thessalia, whereas the region's contribution to the country's labor force in agriculture is double (12.6%) and 6.5% in food manufacturing.

3. Applied methodology and data

I-O analysis was employed to examine the role of agriculture and agro-food sectors in the economy of Thessalia region. I-O analysis framework was originally developed, in the late 1930s, by Wassily Leontief, its flexibility made it ideally suited for many applications. The term interindustry analysis is also used, since the fundamental purpose of the I-O framework is to analyze the interdependence of industries in an economy (Leontief, 1986). The basic Leontief I-O model is a systematic method that quantifies and records the productive relations among the different sectors of economic activity, in a framework of a complicated economy. That economic system can be large, including the whole economic activities of a country, but it can also refer to smaller regional or urban economies. I-O analysis is offered as a quantitative tool to analysts that can contribute substantially to the understanding of the nature of a national or regional economy. Moreover, the comparison of I-O tables can provide a valuable basis for studies of regional economic development¹.

3.1 Input-Output analysis and agro-food sectors

Input-Output analysis is largely utilized in empirical analysis to examine several economic issues at national and regional level; a number of them are focused on agriculture and agro-food sectors. In order to assess the nexus between agro-food sectors with the rest sectors of the economy I-O analysis is employed. I-O analysis having the advantage to examine the whole economy in the framework of general equilibrium is suitable for such a purpose. Undoubtedly agro-food sectors have a significant role in most economies, especially for rural areas as the Thessalia region. Agro-food sectors importance can be seen through their primary role, to supply production inputs the economy and purchase products from all other sectors of the economy. Moreover, very important is agro-food sectors role in supporting an

¹ Detailed presentation of the I-O analysis can be found, among others, at Richardson (1972); Mattas et al (1984); Miller και Blair (1985) and Leontief (1986).

economy's, gross output, employment, labor income and final demand, directly and indirectly.

An emerging issue for studies in modeling agro-food sectors, in a broader way, to examine their dynamics in I-O analysis is the identification of agro-food sector. That is, the sectors that should be considered in classifying agro-food sector in order to more precisely anticipate its importance. A number of studies, employing I-O analysis, appeared in the literature dealing with the issue of defining agriculture and assessing its role in the economy. An analytical examination of the issue is done in the work of Sharma et al. (1999). In their study they review the definition of agriculture in I-O studies, before examining its role in the Hawaii's economy. As they mention, agriculture's impact on an economy depends on what comprises agriculture. Food and Fiber System (FFS) and Farm and Farm Related (FFR) industries are the two definitions discussed; a form of the first one used in their study, as they argue for its suitability in final demand based approaches. Moreover, they consider the final demand based approach as more suitable in identifying the role of agriculture's in an economy compared to output based and hypothetical extraction approaches, as it deals better with the double counting problem.

It is evidence that in most studies the definition of agriculture is not identically identified. Leones et al. (1994) mention this issue in their study and indicate that there is no common definition of agriculture by reviewing a big number of studies that used different definitions. The problem of not having common definitions makes difficult the comparisons since any differences might not be due to structural reasons but due to the definition of the sector. Other studies employing the final demand based approach to identify the role of agro-food sectors are those of Mattas and Shrestha (1989) and Tzouvelekas and Mattas (1999), they examined the role agro-food sectors in the Greek economy. In another study Mattas and Pagoulatos (1990), they assessed the important contribution of investments in agriculture to the whole Greek economy. Bairak and Hughes (1996) and Hughes and Litz (1996) evaluate the impacts of agricultural exports, and linkages of agriculture between rural and urban economy, respectively. The collective volume of Midmore (1991) and Midmore and Harrison-Mayfield (1996) presents a number of studies examining the role of agriculture in an economy by utilizing I-O analysis.

Henry and Schulder (1985) by measuring the backward and forward linkages of food and fiber system in USA, stress the importance of agriculture. They state that the impact of agriculture on the whole economy is influenced not only by the magnitude of

the linkages and the interdependence among the sectors of the economy, but also by the structure of the particular economy and the relative shares of the raw and processed food sectors. Many other studies can be found in the literature dealing with the significance of agro-food sectors. Among them are the studies of Hamilton et al. (1991) and Boumol and Wolff (1994), both studies stress the significance of indirect effects of agriculture (which are many times more important than the direct).

3.2 Validity of the method

Despite the validity of I-O analysis in assessing the role of a sector in an economy, such as agro-food, some critical issues arise. The theoretical hypotheses of I-O analysis induce such critical issues that question its suitability in many cases; a detailed discussion related to studies concerning agriculture can be found in Midmore (1993). The size and the characteristics of the area to be examined are of much importance - rural or urban, small or big- in using the method and interpreting the results. For small-scale regions with weak local productive base economy, depending mostly on imports from other regions, it is stated that I-O analysis many times becomes inappropriate because the impacts extend to sectors outside the examined region. As it is stated by Rabinowicz (1982) small rural regional economies are usually characterized by peripherality and low degree of diversification that depend only on few sectors.

The approach to be utilized in the analysis, either a final demand or output based approach, as well as the linkages to be calculated affect the outcomes of a study. Sharma et al. (1999) suggest that the final demand based approach is more valid in the case where the role of agriculture is sought. The same views are adopted in the present study and in forming the model for the analysis the final demand based approach is used.

The calculated linkages many times should be seen with caution, specific problems should be taken into account otherwise their interpretation might lead to misleading decisions. Hughes (2003) study underlines the use of multipliers for policy purposes and argues that I-O models are the most popular tool in generating economic multipliers. Though, he argues that many times there are issues that should be taken into account. Such that are: the profitability of the sectors, an industry with high multiplier might simultaneously be not profitable; resources availability might also be ignored by multiplier analysis, an expansionary development policy might lead to price increases and hence confine the expansion of final demand when resources are not available. In examining the impact of a policy on employment using employment multipliers it is

crucial to define the source of the new jobs. The new jobs might come from sources like unemployed people in the economy or movements from other sectors. This will firstly lead to less than the expected final demand increase and lower economic activity enhancement. Significant issues are also arising from the generation of a regional I-O table. The regionalization methodology can severely affect the results of such a study. Finally, an issue mentioned above, that significantly affects the analysis is the exact definition of the sectors to be examined. The identification of the dynamics of each sector depends highly on its definition; as in the present study the definition of the agro-food sector.

3.3 Data and regionalization methodology

All the necessary data for Greece were collected from the National statistical service of Greece (NSSG), the latest available table I-O table was the symmetric for 1998, which is consisted of 29 sectors of economic activity, at 2-digit level. Regional and national employment data used in the analysis were observed from the same statistical source and at the same classification level.

Due to the non-availability of survey based I-O table the national I-O was used for the construction of the I-O table for the region of Thessalia. The regional table constructed by applying the GRIT technique; the GRIT technique was initially proposed by Jensen et al., (1979). It is a hybrid method which is based on non-survey techniques of location quotients giving, however, simultaneously the possibility to the user to insert external data from surveys or other secondary sources that are considered superior; mainly for the important sectors in the region. The initial scheme of 29 sectors ended to 18 after the aggregation. Small and non-important sectors for the regional economy were aggregated according to their technology, whereas the identity of the significant sectors was preserved; no sectors were eliminated.

Most studies applying the GRIT technique estimate the regional interindustry flows by using an employment-based *Simple Location Quotient* (SLQ) or a *Cross Industry Location Quotient* (CILQ) to the corresponding elements of the national direct requirement matrix.² As Flegg *et al.* (1995) refer in their study (after refreshing some ideas of Round, (1978)), the two above mentioned LQs provide an alternative way of estimating the relevant trading coefficients. Trading coefficients measure the proportion of any given commodity supplied from within the region (that is, measure the degree of

² Detailed discussion and application of GRIT technique can be found in Jensen *et. al* (1979), Johns and Leat (1987) and Tzouvelekas and Mattas (1999).

self sufficiency of a region). Those trading coefficients depend on three variables: 1) the relative size of the supplying sector, 2) the relative size of the purchasing sector and 3) the relative size of the region. SLQ takes into account only the first and the third while CILQ takes into account only the first two, hence both have certain deficiencies.

In order to overcome the above shortcoming, in the present study we applied an adjustment of the traditional *CILQ* suggested by Flegg *et al.*, (1995) and modified after a discussion in the literature by Flegg and Webber (2000)³, for the regionalization of the national I-O table. Specifically, regional technical coefficients were estimated by the following formulae:

$$FLQ_{ij} = CILQ_{ij} \cdot \lambda$$

$$\text{where, } CILQ_{ij} = \frac{E_i^R / E_i^N}{E_j^R / E_j^N} \text{ and } \lambda = \log_2 \left[1 + \left(\frac{\sum_{i=1}^n E_i^R}{\sum_{i=1}^n E_i^N} \right) \right]^\delta ; R, N \text{ stand for the}$$

region and the nation, respectively, $i, j=1, \dots, n$ are the economic sectors, E is the sectoral employment, and $0 \leq \delta < 1$ is the coefficient of adjustment, the magnitude of which depends on the relative size of each region. When $FLQ_{ij} \geq 1$ then the corresponding regional technical coefficient (α_{ij}) is the same with the national one ($\alpha_{ij}^R = \alpha_{ij}^N$), whereas when $FLQ_{ij} < 1$ it is adjusted accordingly ($\alpha_{ij}^R = FLQ_{ij} \cdot \alpha_{ij}^N$). The rest of the national technical coefficients ($\alpha_{ij}^N - FLQ_{ij} \cdot \alpha_{ij}^N$) is included in the imports row as the sector i in the region cannot satisfy the demand from sector j , which in turn comes from imports.

3.4 Sectoral linkages

Following the steps of GRIT, the regional I-O table was constructed and the linkage coefficients were estimated for the identification of the key sectors and the dynamics of agro-food sectors in the regional economy. Following the reasoning of Sharma *et al.* (1999) a final demand based approach was adopted to estimate the linkage coefficients and assess the dynamics of the agro-food sectors of the region. Specifically, the well known I-O multipliers⁴ were estimated, output, income and employment that

³ The original proposal of FLQ by Flegg *et al.* was introduced at 1995, since then a dialogue was opened in the literature (Flegg and Webber 1996a, 1996b, 1997, 2000) and McCann and Dewhurst (1998)) and the original version was improved and modified to the version appeared in the literature by Flegg and Webber 2000.

⁴See, among others, Miller and Blair (1985) for a detailed presentation of the computational procedure.

indicate each sector's direct and indirect linkages in the regional economy. Each multiplier indicates the ability of the corresponding sector to enhance the whole economy's output, income, and employment due to an exogenous increase in its final demand.

Apart from the I-O multipliers, recently appeared in the literature sectoral linkage coefficients are also estimated, in order to assess sectoral dynamics. The Mattas and Shrestha (1991) I-O elasticities; the Heimler (1991) vertical integration index and the Dietzenbacher and Van der Linden (1997) linkages that are based on the hypothetical extraction concept.

A disadvantage of the I-O multipliers concerns their inability to incorporate the relative size of each sector in the economy; this means that I-O multipliers do not assess satisfactorily the relative importance of each sector. Bearing in mind the above mentioned problem Mattas and Shrestha (1991) proposed the use of I-O elasticities. I-O elasticities (output, employment and income) are expressed in percentages and take into account the relative share of each sector in final demand.

Heimler (1991), based on the theoretical contributions of Schultz (1976) and Milana (1985) on the issue of vertical integration linkages, proposed an indicator for sectoral evaluation that takes into consideration both the intermediate and final requirements of each sector. The vertical integration index of Heimler for a sector j constitute a quantitative measurement of the indirect results of a change in the gross output of this sector in the intermediate consumption and in the final demand of the remainder sectors in the economy.

The last estimated contribution in linkage analysis is that of Dietzenbacher and Van der Linden (1997); it is based on the idea of hypothetical extraction. The basic idea of this approach lays in the analysis of the direct and indirect impacts in the system from the hypothetical extraction of one sector from the model. This quantitative measurement of impacts can give us an explicit and completed picture for the sectoral linkages of each sector. This approach, as stated by Dietzenbacher and Van der Linden (1997) takes into consideration both the relative size of each sector and the problem of double counting of the intersectoral transactions.

4. Results

From the application of the GRIT technique the regional I-O table was constructed; important information revealed that indicate the significance of agro-food sectors for the regional economy. Below in table 2, the share of the agro-food sectors in

the regional sectoral output and final demand can be seen. Their direct significance can be seen through their very high share in total output and final demand. Totally the three agro-food sectors constitute almost the one third (27.7%) of the region's final demand and 29% of the region's total output.

Table 2. Sectoral Share in Total Regional Output and Final Demand

Sectors	SIC Code	Share in Regional Final Demand	Share in Regional Output	Share in regional employment
Agriculture	01, 02, 05	13.86%	16.0%	32.5%
Food Manufacture	15-16	10.55%	10.2%	3.0%
Textile	17-19	3.29%	2.8%	1.6%
Rest sectors		72.3%	71.0%	62.9%

More or less the significance of the abovementioned sectors, in the regional economy, is also verified by the employment shares. The 37% of the regional labor force is engaged in agro-food sectors. The employment force in agriculture is not high in regional level but also contributes significantly to the country's labor force as shown in table 1.

Table 3 below, indicates the shares of each sector in intermediate and final purchases and sales. Agriculture allocates the 28% of its total output to the sectors of the regional economy, (it is used as input) and the rest 72% is allocated to final demand. A number of local industries depend and use as source of inputs the agro-food sectors; the linkages among them induce significant economic activity in the region. Food manufacturing is the sector with the highest share in intermediate inputs (46%); this indicates its degree of connection with other sectors of the local economy and its ability to stimulate the local demand.

Table 3. Sectoral Shares of Intermediate and Final Demand and Intermediate and Primary to Total Output

Sectors	Share of Total Intermediate Demand to Total Output	Share of Total Final Demand to Total Output	Share of Total Intermediate Inputs to Total Output	Share of Total Primary Inputs to Total Output
Agriculture	28.1%	71.9%	4.0%	96.0%
Food Manufacture	14.1%	85.9%	46.1%	53.9%
Textile	3.4%	96.6%	21.6%	78.4%

In order to assess both the direct and indirect dynamics of agro-food sectors in the regional economy I-O linkage coefficients were calculated, below in table 4 are shown only the multipliers of the agro-food sectors. Output, Income and employment multipliers were estimated to reveal each sector's potentials to induce multiplicative impacts in the regional economy due to change in the final demand of a sector. In terms of output the sector with the highest linkage is Food Manufacture (1.4928), indicating its importance for the regional economy. Food Manufacture alone can stimulate the region's economy more than any other sector. On the other hand agriculture is the sector with one of the highest income and employment multipliers. A unit increase in the final demand for agricultural products (i.e., exports, consumption or investments) will increase the total (direct and indirect) household income in the region of Thessalia by 0.6394 units.

Table 4. Output, Income and Employment Multipliers

Sector	Output multiplier	Income multiplier	Employment multiplier
Agriculture	1.0531 (18)	0.6394 (2)	0.1710 (2)
Food Manufacture	1.4928 (1)	0.4685 (10)	0.0968 (8)
Textile	1.2464 (6)	0.2560 (15)	0.0696 (13)

* numbers in parenthesis indicate sectoral ranking.

The relative importance of agro-food sectors is also underlined from the computed Mattas and Shrestha (1991) I-O elasticities shown in table 5. In particular, Agriculture has the highest output elasticity value, (0.1601) which implies that a one percent increase in the final demand for agricultural products will increase the total regional output in Thessalia region by 0.1601 percent. Food manufacture (0.1019) has the fifth highest output elasticity in the regional economy. Concerning income elasticities food manufacture is ranked first (0.2722), agriculture (0.1169) fourth and textile (0.0953) sixth. Very high are also the elasticities of agro-food sectors in terms of employment. With an exogenous increase of one percent in the final demand of agriculture the regional economy's employment will be increased by 0.1159 percent. Agro-food sectors appear with very high I-O elasticities because elasticities take into account the final demand size of each sector.

Table 5. Mattas and Shrestha Input-Output Elasticities

Sector	Output elasticity	Income elasticity	Employment elasticity
Agriculture	0.1601 (1)	0.1169 (4)	0.1159 (1)

Food Manufacture	0.1019 (5)	0.2722 (1)	0.0549 (5)
Textile	0.0283 (13)	0.0953 (6)	0.0944 (2)

* numbers in parenthesis indicate sectoral ranking.

Heimler's (1991) indices of vertical integration (table 6) also reveal agriculture as one of the most important economic sectors in the region. Specifically agriculture's vertical integration index is the largest one (1.1071) followed by food manufacture (1.1034). A unitary direct increase in the output of agriculture will induce an indirect increase in the intermediate and final demand of all other sectors of the economy by 1.107 units; the indirect contribution of the sector in the whole economy is 1.107 times greater than its direct.

Table 6. Heimler's Index of Vertical Integration and Dietzenbacher and Van der Linden Output Linkage Coefficients

Sector	Index of vertical integration	Output linkage coefficients
Agriculture	1.1071 (1)	0.1917 (18)
Food Manufacture	1.1034 (2)	1.7785 (1)
Textile	0.0926 (13)	0.8933 (6)

* numbers in parenthesis indicate sectoral ranking.

Food manufacture is still ranked first according to the computed Dietzenbacher and Van der Linden (1997) output backward linkages. Specifically, food manufacture exhibit a value of 1.7785 which means that the hypothetical extraction of this sector from the regional economy will result in a reduction of total regional output by 177% of this sector total output.

The indirect significance of agro-food sectors in the regional economy has been proved with almost all the above calculated linkage coefficient, though each coefficient is calculated in a different way.

5. Conclusions

The diminishing direct contribution of raw agriculture's the last years in the formation of an economy's gross output and employment, raised questions for its role in supporting economic growth. Notwithstanding, the indirect role of agricultural related sectors –namely agro-food sectors in the study- and their influence upon the rest of the economy many times is either ignored or partially examined. Such a situation occurred in the Greek economy over the last two decades. This issue is much more present in

local economies where agriculture had traditionally a significant role; such as the region of Thessalia.

In order to examine the indirect role of agro-food sectors in the regional economy; that is their ability to induce the rest sectors of the economy to generate output, income and employment, a regional I-O model was constructed. For this, the GRIT technique was employed by utilizing a recently developed employment-based location quotient. Agro-food sectors were defined so as to include raw agriculture, food manufacture and textiles.

The results have shown high shares of agro-food sectors in final demand and intermediate inputs indicating their ability to support indirectly the local economy. The estimated various linkage coefficients of agro-food sectors were among the highest in the regional economy, in terms of output, income and employment. From the overall analysis becomes very clear that by supporting agro-food sectors the whole economy is benefited leading to regional economic growth.

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