MARGINAL PRODUCTIVITY ANALYSIS FOR THE GREEK TOMATO PROCESSING INDUSTRIES

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ABSTRACT

The industrial tomato-processing factories hold a central and important position in the Greek food-economy sector as a whole. For a number of years now, the industry is facing serious financial problems. In an effort to view closely the situation and to establish the facts before any corrective action is taken, this paper examines the production factors involved through a series of production functions and addresses the question of their marginal productivity to the economic results achieved.

RÉSUMÉ

Les industries de transformation de la tomate jouent un rôle primaire et occupent une position importante dans le secteur de l'économie alimentaire en Grèce. Depuis quelques années, l'industrie se trouve face à des problèmes financiers assez graves. Afin de mieux examiner la situation et établir les faits avant de procéder à une action corrective, ce travail examine les facteurs de productions impliqués à travers une série de fonctions de production et il traite la question de leur productivité marginale vis-à-vis des résultats économiques réalisés.

The sector of industrial tomato processing in Greece, consisting of some sixty seven units, fifty of which operate on a regular basis, contributes in a very dynamic way to the economy of the country, representing a very important source of foreign currency, with exports reaching around 80-100 billion Drachmas per year (1).

Most of them are mixed type enterprises, processing, on parallel production lines, other vegetables and fruits as well (SEKOBE, 1985). Around 50% of these operate on a co-operative basis. Their processing capacity ranges from 300 to 2,250 tonnes per 24 hours while their productive operation period usually ranges from 50 to 55 full 24-hour periods per year (Laiopoulou, 1992; Oustabasidis, 1990).

Foreign competition, in conjunction with the GATT agreements, have had, for a number of years now, an adverse effect on the way the trade of the agricultural products is conducted (Kamenidis et al., 1995). Though the tomato-processing sector was particularly favoured during the 1970-1980 period by a series of state policies, as well as measures adopted by the financial institutions (in the form of loans awarded to them), the modernisation of the facilities and the processing equipment utilised that took place then, was not followed by the necessary actions that would allow the sector to operate profitable within the European Union regulations. As a result the whole sector is, and has been for a number of years now, heavily indebted (Delivani-Negreponti, 1983), continually asking for further financial assistance without being in a position to get out of the perpetual circle of loan-taking.

It is evident that the reorganisation of the factories is imperative. As a first step, this paper offers a closer examination of the production factors employed, having as aim the determination of their degree of importance from a productivity point of view.

MATERIALS - METHODOLOGY

The study upon which this paper is based examined the sector of tomato-processing factories during the 1982-1992 period. The data gathered represent a random sample of twenty five enterprises. However, lack of a reliable body of data spanning a sufficiently large number of years, precluded a time series study of the sector. The discussion on the economic results of the sector, the analyses undertaken and the subsequent conclusions drawn, are based on a cross section analysis of the data covering the 1985-1986 period (Bronfenbrenner et al, 1939; Kitsopanides et al, 1974; Katochianou, 1978). The collection of data, accomplished mainly through questionnaires, faced many difficulties. Reluctance, if not outright unwillingness, on the part of the companies to share their records, and unavailability of the relevant data (in many cases the available records spanned only a one year period), were the norm.

To compensate for the above, the data received through questionnaires from the companies were supplemented by, and collated with, records kept by the Ministry of Agriculture and the Agricultural Bank. Other sources included cultivation agreements between the co-operative organisations and the producers, quality control certificates for exports, as well as application subsidies submitted by both the producers and the industries concerned. Though a number of years have elapsed since the time the survey was conducted, the fact that since then the situation has not changed in any discernible way, ensures the validity of the results and conclusions drawn. An element showing the slow

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(1) Ecu = 280 Drachmas, 1986 prices.

rhythm at which the sector is changing is the fact that during the period from 1986 to 1990 only two new enterprises, of relatively small size, started operating. Since then, no other enterprises were included in the sector. It must also be stressed that this was the first time that a similar survey was undertaken at such a scale.

The twenty five factories in the sample were classified, for the purposes of this study, according to whether they were mixed-type (processing on parallel lines other vegetables and fruits as well) or net-type (processing only tomatoes).

In order to examine the importance of the different production factors employed and their influence on the gross income and added value achieved, the production function Cobb-Douglas was employed in fitting out the survey data.

While production functions have been well explored and widely discussed in many countries, the relevant attempts in Greece were rather restricted in scope, without paying particular attention to the tomato-processing industry, one of the most important sectors within the food-industry, exporting a great percentage of its main production to other countries (Kokkova-Koutsoyianni, 1965; Ikonomopoulou, 1984; Delivani-Negreponti, 1983; Valassopoulos, 1987).

The analysis proceeded in four stages. First, the mixed-factories data were used and then the net-factories data. In the net-factories case the amounts referring to the other vegetables and fruits processed on parallel lines were excluded (given the fact that the contribution of the other tomato products was rather small, 8% for canned tomatoes and 3% for tomato juice (IOBE, 1981)). In addition, the data were transformed into equivalent to tomato-paste figures.

In both cases (mixed and net-factories), we examined the effect of a series of production factors on:

i) the gross income

ii) the value added (equal to the gross income after subtracting the raw materials cost) The production factors employed were: labour / total - permanent - seasonal, fixed capital, consuming capital, equipment, raw materials, packing and auxiliary materials (Brofenbrenner et al., 1939; Kokkova-Koutsogianni, 1965; Shih et al., 1977). Is was assumed that the market conditions prevailing were those of a perfect competition.

Production functions

The productivity analysis of the production factors was carried out employing the well known Cobb-Douglas production function:

$y = a\, x_1^{b1}\, x_2^{b2}\, x_3^{b3} \ldots x_n^{bn}\, u.$

where x_1, x_2, x_3,..., x_n: the input variables

& y : the output variable,

and applying the least squares method.

In this model, the logarithmic linear relation between inputs and outputs yields an estimate of the economies of scale achieved, and demonstrates the contribution of each input factor to the output, namely gross income or

value added (gross income-raw materials cost).
The aim of the data fitting was first, to reach a better understanding of the current status of the sector, and secondly, to establish the current trends characterising the industry (Hoch, 1962; Manos, 1985; Kamenidis et al., 1987).
It must be noted that a common production factor, that is the use of land (rent), was not included as a separate variable, given its relatively low contribution to the total capital. Seasonal and permanent labour were examined separately because of the nature of work undertaken in these industries (Laiopoulou, 1994a; Dimitrakopoulou, 1969).
The factors taken into consideration were all quantitative, that is they could be measured exactly. A qualitative factor that, despite its paramount importance and significance, was not included in the analyses because of its qualitative nature, was the way the management of the industrial units is conducted, alongside the managerial ability of the decision makers in the individual enterprises (Laiopoulou, 1994b; Georgiadis, 1967).
The problem was examined in four stages, as follows:
Stage I: Mixed-type factories / y = gross income
Stage II: Mixed-type factories / y = gross income - raw materials cost
Stage III: Net-type factories / y = gross income
Stage IV: Net-type factories / y = gross income - raw materials cost

For each one of these stages the relevant equations evaluated are listed alongside the estimated standard errors of the partial regression coefficients (set in brackets) and the corresponding adjusted coefficients of multiple determination (R-^{2}).
The choice of the production functions that are listed in each case depended upon the proportion of the output variation explained by them (Heady et al., 1961).

Stage I: Mixed-factories / Gross Income Case
y = gross income

The production factors were:
x_1 = total labour cost
x_2 = permanent labour cost
x_3 = seasonal labour cost
x_4 = fixed capital annual cost
x_5 = annual cost of equipment used
x_6 = consuming capital
x_7 = cost of raw materials (industrial tomatoes)
x_8 = cost of raw materials (fruits-vegetables other than tomatoes)
x_9 = cost of packing and auxiliary materials
The production functions evaluated were:

1. $y_1 = 0{,}39\ x_1^{-0.202}\ x_4^{0.284}\ x_6^{1.093}$
(0,059) (0,071) (0,113) $\bar{R}^2 = 0{,}967$ s = 0,116 a < 0,0001
2. $y_2 = 0{,}41\ x_1^{-0.197}\ x_5^{0.240}\ x_6^{1.118}$
(0,062) (0,070) (0,119) $\bar{R}^2 = 0{,}963$ s = 0,123 a < 0,0001
3. $y_3 = 0{,}31\ x_2^{0.0408}\ x_3^{0.813}\ x_4^{0.243}\ x_6^{1.088}$
(0,038) (0,055) (0,068) (0,113) $\bar{R}^2 = 0{,}971$ s = 0,111 a < 0,0001
4. $y_4 = 0{,}33\ x_2^{-0.132}\ x_3^{-0.067}\ x_5^{0.230}\ x_6^{1.116}$
(0,041) (0,059) (0,068) (0,121) $\bar{R}^2 = 0{,}967$ s = 0,119 a < 0,0001
5. $y_5 = 283{,}23\ x_2^{-0.131}\ x_3^{0.219}\ x_5^{0.618}\ x_7^{0.315}\ x_8^{0.107}\ x_9^{-0.059}$
(0,041) (0,069) (0,120) (0,072) (0,069) (0,078)
$\bar{R}^2 = 0{,}965$ s = 0,154 a < 0,0001

The elasticity coefficients in **table 1** below give information about returns to scale, that is, the response of the output to a proportionate change in the inputs. If the sum of the individual elasticities is equal to one, the returns are constant; doubling the inputs will double the output. If the sum is less than one, the returns to scale are decreasing; doubling the inputs will less than double the output. For the production functions of **table 1**, the sum of the elasticity coefficients ranges between 1,069 and 1,175 showing increasing return to scale; doubling the inputs will more than double the output (Gujarati, 1976; Walters, 1970).
In addition, **table 1** includes the corresponding marginal productivity coefficients, alongside the real cost of the production factors and the coefficients expressing the relationship between the marginal productivity and the real cost. These coefficients show the different possible reorganisations of the production factors leading to a higher gross income.
The marginal productivity coefficient of a factor expresses the increase in output (gross income, here) that will be achieved if this factor increases by one unit while the rest of the factors stay constant at the same level.
The individual elasticity coefficients show that the contribution of the total, permanent and seasonal labour costs to gross income is quite low; in fact the only non negative contribution is the one pertaining to the seasonal labour in the fifth function. Only the consuming capital shows a relatively high contribution, ranging from 109.3% to 111.8%. The packing and auxiliary materials, by contrast, show a negative contribution, equal to -5.9%.
The adjusted coefficients of multiple determination range from 0,963 to 0,971 showing that the proportion of the variation in gross income explained by the factors included in the production functions ranges from 96.3% to 97.1% respectively, a quite high degree of dependence on the studied factors.
Examining **table 1** we see that the seasonal labour's marginal productivity is lower than the real cost, showing that this cost is excessive and has to be reduced.
The fixed capital productivity is higher by a large margin than the real cost of 1,130 Drs/Dr. This is in contrast to the consuming capital, in which case the marginal

Table 1 ***Marginal Analysis / Mixed-factories - Gross Income Case: y = gross income.***

		1	2	3	4	5
I.	**Elasticities of production**					
	1. Labour cost (total)	–0.202	–0.197	–	–	–
	2. Labour cost (pennanent)	–	–	–0.137	–0.132	–0.131
	3. Labour cost (seasonal)	–	–	–0.067	–0.067	0.219
	4. Fixed capital (annual cost)	0.284	–	0.276	–	–
	5. Equipment (annual cost)	–	0.240	–	0.230	0.618
	6. Consuming capital	1.093	1.118	1.088	1.116	–
	7. Raw materials cost (tomatoes)	–	–	–	–	0.315
	8. Raw materials cost (fruit/vegetables)	–	–	–	–	0.107
	9. Packing and auxiliary materials	–	–	–	–	–0.059
	Total	**1.175**	**1.161**	**1.160**	**1.147**	**1.069**
II.	**Adjusted multipledetermination coefficients**	**0.967**	**0.963**	**0.971**	**0.967**	**0.965**
III.	**Marginal productivity**					
	1. Labour (total) *(Drs/8 hours)*	–	–	–	–	–
	2. Pennanent labour *(Drs/8 hours)*	–	–	–	–	–
	3. Seasonal labour *(Drs/8 hours)*	–	–	–	–	3,601
	4. Fixed eapital (annual cost) *(Drs/Dr)*	6.100	–	6.487	–	–
	5. Equipment (annual cost) *(Drs/Dr)*	–	7.316	–	1.130	7.318
	6. Consuming eapital *(Drs/Dr)*	1.522	1.558	1.516	1.080	–
	7. Raw materials (tomatoes) *(Drs/Kgr)*	–	–	–	–	7.241
	8. Raw materials (fruit/veget.) *(Drs/Kgr)*	–	–	–	–	1.029
	9. Packing & auxiliary materials *(Drs/Dr)*	–	–	–	–	–
IV.	**Realcost**					
	1. Labour (total) *(Drs/8 hours)*	–	–	–	–	–
	2. Permanent labour *(Drs/8 hours)*	–	–	–	–	–
	3. Seasonal labour *(Drs/8 hours)*	–	–	–	–	1,468
	4. Fixed eapital (annual cost) *(Drs/Dr)*	1.130	–	1.130	–	–
	5. Equipment (annual cost) *(Drs/Dr)*	–	1.130	–	6.050	1.130
	6. Consuming capital *(Drs/Dr)*	1.080	1.080	1.080	1.439	–
	7. Raw materials (tomatoes) *(Drs/Kgr)*	–	–	–	–	8.264
	8. Raw materials (fruit/veget.) *(Drs/Kgr)*	–	–	–	–	1.080
	9. Packing & auxiliary materials *(Drs/Dr)*	–	–	–	–	–
V.	**Productivity & Cost relationship**					
	1. Labour (total)	–	–	–	–	–
	2. Permanent labour	–	–	–	–	–
	3. Seasonal labour	–	–	–	–	2.453
	4. Fixed capital (annual cost)	5.398	–	5.740	6.205	–
	5. Equipment (annual cost)	–	6.470	–	1.439	6.476
	6. Consuming capital	1.409	1.443	1.403	–	–
	7. Raw materials (tomatoes) *(Drs/Kgr)*	–	–	–	–	0.876
	8. Raw materials (fruit/veget.) *(Drs/Kgr)*	–	–	–	–	0.953
	9. Packing & auxiliary materials *(Drs/Dr)*	–	–	–	–	–

productivity is only slightly higher than its real cost. Hence the improvements we can achieve in its use are very small, at least as long as the selling price of the final products does not increase. The marginal productivity of the equipment used is much higher than its real cost. However, given the high degree of automation involved, the existing equipment in use are not yet fully exploited. The marginal productivity of the raw materials used (industrial tomatoes), equal to 7,241 Drs/Kgr, is lower than the real cost of 8,264 Drs/Kgr, showing that the price of the industrial tomatoes paid to the producers is already quite high.

Stage II: Mixed-factories / Value Added Case
y = gross income - raw materials cost

The production factors were:
x_1 = total labour cost
x_2 = permanent labour cost
x_3 = seasonal labour cost
x_4 = fixed capital annual cost
x_5 = annual cost of equipment used
x_6 = consuming capital
x_7 = cost of packing and auxiliary materials
x_8 = consuming capital - cost of raw materials

The production functions evaluated are listed below:

1. $y_1 = 0{,}39\ x_1^{-0{,}216}\ x_4^{0{,}817}\ x_8^{0{,}581}$
   (0,173) (0,156) (0,201) $\bar{R}^2 = 0{,}857$ s = 0,295 a < 0,0001
2. $y_2 = 30{,}69\ x_1^{-0{,}150}\ x_5^{0{,}725}\ x_8^{0{,}535}$
   (0,179) (0,153) (0,213) $\bar{R}^2 = 0{,}836$ s = 0,312 a < 0,0001
3. $y_3 = 0{,}31\ x_2^{0{,}208}\ x_3^{0{,}025}\ x_4^{0{,}774}\ x_8^{0{,}552}$
   (0,112) (0,159) (0,155) (0,219) $\bar{R}^2 = 0{,}869$ s = 0,286 a < 0,0001
4. $y_4 = 32{,}73\ x_2^{-0{,}176}\ x_3^{0{,}067}\ x_5^{0{,}676}\ x_8^{0{,}501}$
   (0,112) (0,159) (0,213) (0,153) $\bar{R}^2 = 0{,}850$ s = 0,35 a < 0,0001

As it can be seen from **table 2** below, labour's contribution to gross income is very low (-15% and -21.6% for the total labour cost, -20.8% and -17.6% for the permanent labour cost while for the seasonal labour cost the elasticity coefficients range from 2.5% to 6.7%). The

Table 2 ***Marginal Analysis / Mixed-factories - Value Added Case: y = gross income - raw materials cost.***

		1	2	3	4
I.	**Elasticities of production**				
	1. Labour cost (total)	–0.216	–0.150	–	–
	2. Labour cost (permanent)	–	–	–0.208	–0.176
	3. Labour cost (seasonal)	–	–	0.025	0.067
	4. Fixed capital (annualcost)	0.817	–	0.774	–
	5. Equipment (annual cost)	–	0.725	–	0.678
	6. Consuming capital	–	–	–	–
	7. Packing and auxiliary materials	–	–	–	–
	8. Consuming capital - Raw materials	0.581	0.535	0.552	0.501
	Total	**1.182**	**1.110**	**1.143**	**1.070**
II.	**Adjusted multiple determination coefficients**	**0.854**	**0.836**	**0.869**	**0.850**
III.	**Marginal productivity**				
	1. Labour (total) *(Drs/8 hours)*	–	–	–	–
	2. Permanent labour *(Drs/8 hours)*	–	–	–	–
	3. Seasonal labour *(Drs/8 hours)*	–	–	176	473
	4. Fixed eapital (annual cost) *(Drs/Dr)*	10.539	–	9.733	–
	5. Equipment (annual cost) *(Drs/Dr)*	–	11.284	–	10.552
	6. Consuming capital *(Drs/Dr)*	–	–	–	–
	7. Packing & auxiliary materials *(Drs/Dr)*	–	–	–	–
	8. Consuming capital - Raw materials *(Drs/Kgr)*	1.298	1.196	1.234	1.120
IV.	**Real cost**				
	1. Labour (total) *(Drs/8 hours)*	–	–	–	–
	2. Pennanent labour *(Drs/8 hours)*	–	–	–	–
	3. Seasonal labour *(Drs/8 hours)*	–	–	1,486	1,486
	4. Fixed capital (annual cost) *(Drs/Dr)*	1.130	–	1.130	–
	5. Equipment (annual cost) *(Drs/Dr)*	–	1.130	–	1.130
	6. Consuming capital *(Drs/Dr)*	–	–	–	–
	7. Packing & auxiliary materials *(Drs/Dr)*	–	–	–	–
	8. Consuming capital - Raw materials *(Drs/Kgr)*	1.080	1.080	1.080	1.080
V.	**Productivity & Cost relationship**				
	1. Labour (total)	–	–	–	–
	2. Pennanent labour	–	–	–	–
	3. Seasonal labour	–	–	0.118	0.318
	4. Fixed capital (annual cost)	9.326	–	8.613	–
	5. Equipment (annual cost)	–	9.986	–	9.338
	6. Consuming capital	–	–	–	–
	7. Packing & auxiliary materials *(Drs/Dr)*	–	–	–	–
	8. Consuming capital - Raw materials *(Drs/Kgr)*	1.202	1.107	1.143	1.037

contribution of the fixed capital ranges from 77.4% to 81.7%, of the equipment used from 67.8% to 72.5%, while that of the consuming capital (after subtracting the raw materials cost) ranges from 50.1% to 58.1% (the corresponding figures from **table 1**, referring to the consuming capital, ranged from 108.8% to 111.8%). In addition, the adjusted coefficients of multiple determination range from 83.6% to 86.9% showing that the proportion of variation in gross income (after subtracting the raw capital cost) is relatively high too.

Seasonal labour's marginal productivity is much lower than the real cost, showing that labour cost is excessive and has to be reduced. For labour's marginal productivity to increase, the current trend in wage increases has to be reversed or/and accompanied by a possible parallel reduction in personnel. The fixed capital productivity (ranging from 9,733 to 10,539 Drs/Dr), is also higher by a large margin than the real cost of 1,130 Drs/Dr.

The same holds true for the equipment in use, implying, once again, under-utilisation of the machinery in place.

Stage III: Net-factories / Gross Income Case
y = gross income

The production factors were:

x_1 = total labour cost
x_2 = permanent labour cost
x_3 = seasonal labour cost
x_4 = fixed capital annual cost
x_5 = annual cost of equipment used
x_6 = consuming capital
x_7 = cost of packing and auxiliary materials
x_8 = cost of raw materials

The production functions evaluated are listed below:

1. $y_1 = 1{,}162\ x_1^{0.040}\ x_5^{0.243}\ x_6^{0.813}$
   (0,092) (0,095) (0,110) $\bar{R}^2 = 0{,}944$ s = 0,153 a < 0,0001
2. $y_2 = 1{,}670\ x_2^{0.0408}\ x_6^{0.813}\ x_4^{0.243}$
   (0,092) (0,110) (0,095) $\bar{R}^2 = 0{,}966$ s = 0,123 a < 0,0001
3. $y_3 = 1{,}759\ x_3^{0.0408}\ x_6^{0.813}\ x_4^{0.243}$
   (0,092) (0,110) (0,095) $\bar{R}^2 = 0{,}962$ s = 0,131 a < 0,0001
4. $y_4 = 0{,}779\ x_2^{0.064}\ x_6^{0.865}\ x_8^{0.151}$
   (0,037) (0,095) (0,078) $\bar{R}^2 = 0{,}938$ s = 0,162 a < 0,0001

Table 3 ***Marginal Analysis / Net-factories - Gross Income Case: y = gross income.***

		1	2	3	4
I.	**Elasticities production**				
	1. Labour cost (total)	0.040	–	–	–
	2. Labour cost (permanent)	–	0.040	–	0.064
	3. Labour cost (seasonal)	–	–	0.040	–
	4. Fixed capital (annual cost)	0.243	–	–	–
	5. Equipment (annual cost)	–	0.243	0.243	–
	6. Consuming capital	0.813	0.813	0.813	0.865
	7. Packing and auxiliary materials	–	–	–	–
	8. Raw materials cost	–	–	–	0.151
	Total	**1.096**	**1.096**	**1.096**	**1.086**
II.	**Adjusted multiple determination coefficients**	**0.944**	**0.944**	**0.944**	**0.938**
III.	**Marginal productivity**				
	1. Labour (total) *(Drs/8 hours)*	743	–	–	–
	2. Permanent labour *(Drs/8 hours)*	–	1,528	–	1,189
	3. Seasonal labour *(Drs/8 hours)*	–	–	1,429	–
	4. Fixed capital (annual cost) *(Drs/Dr)*	6.068	–	–	–
	5. Equipment (annual cost) *(Drs/Dr)*	–	7.547	7.547	–
	6. Consuming capital *(Drs/Dr)*	1.239	1.129	1.129	–
	7. Packing & auxiliary materials *(Drs/Dr)*	–	–	–	9.997
	8. Raw materials (tomatoes) *(Drs/Kgr)*	–	–	–	2.578
IV.	**Real cost**				
	1. Labour (total) *(Drs/8 hours)*	1,688	–	–	–
	2. Pennanent labour *(Drs/8 hours)*	–	2,971	–	2,971
	3. Seasonal labour *(Drs/8 hours)*	–	–	1,486	–
	4. Fixed capital (annual cost) *(Drs/Dr)*	1.130	–	–	–
	5. Equipment (annual cost) *(Drs/Dr)*	–	1.130	1.130	–
	6. Consuming capital *(Drs/Dr)*	1.080	1.080	1.080	–
	7. Packing & auxiliary materials *(Drs/Dr)*	–	–	–	17.033
	8. Raw materials (tomatoes) *(Drs/Kgr)*	–	–	–	8.264
V.	**Productivity & Cost relationship**				
	1. Labour (total)	0.440	–	–	–
	2. Permanent labour	–	0514	–	0.400
	3. Seasonal labour	–	–	0.962	–
	4. Fixed capital (annual cost)	5.370	–	–	–
	5. Equipment (annual cost)	–	6.679	6.679	–
	6. Consuming capital	1.147	1.088	1.194	–
	7. Packing & auxiliary materials *(Drs/Dr)*	–	–	–	0.587
	8. Raw materials (tomatoes) *(Drs/Kgr)*	–	–	–	0.312

As it can be seen from **table 3** below, the sum of the elasticity coefficients ranges between 1,086 and 1,096 showing slightly increasing return to scale. At the same time the adjusted coefficients of multiple determination range from 0,938 to 0,944.

Examining the individual elasticity coefficients we see that labour's contribution to gross income is very low (ranging from 4% to 6.4%).

The contribution of the permanent capital is equal to 24.3%, of the consuming capital ranges from 81.3% to 86.5% while the contribution of the packing and auxiliary materials is equal to 15.1%.

Examining **table 3** we see that labour's marginal productivity (for all cases: total, permanent and seasonal) is lower than the real cost, showing that this cost unit has to be reduced.

The fixed capital productivity is equal to 6,068 Drs/Dr, higher by a large margin than the real cost of 1,130 Drs/Dr while the consuming capital is only slightly higher than its real cost.

The marginal productivity of the equipment used is, here too, higher than its real cost (7,547 Drs/Dr compared to 1,130 Drs/Dr). The raw materials marginal productivity, equal to 2,578 Drs/Kgr, is much lower than the real cost of 8,264 Drs/Kgr, showing that the price of the industrial tomatoes paid to the producers is high. The marginal productivity of the packing materials though, is low (equal to 9,997 Drs/Dr) not covering the real cost (equal to 17,033 Drs/Dr).

Stage IV: Net-factories / Valute Added Case
y = gross income - raw materials cost

The production factors were:

x_1 = total labour cost
x_2 = permanent labour cost
x_3 = seasonal labour cost
x_4 = fixed capital annual cost
x_5 = annual cost of equipment used
x_6 = consuming capital - raw materials cost
x_7 = cost of packing and auxiliary materials
x_8 = cost of raw materials

The production functions evaluated are listed below:

Table 4 ***Marginal Analysis / Net-factories - Value Added Case: y = gross income - raw materials cost.***

		1	2	3
I.	**Elasticities of production**			
	1. Labour cost (total)	0.095	–	–
	2. Labour cost (permanent)	–	0.095	–
	3. Labour cost (seasonal)	–	–	0.138
	4. Fixed capital (annual cost)	0.550	–	–
	5. Equipment (annual cost)	–	0.550	–
	6. Consuming capital - raw materials	0.559	0.559	–
	7. Packing and auxiliary materials	–	–	0.761
	8. Raw materials cost	–	–	0.269
	Total	**1.204**	**1.204**	**1.1681**
II.	**Adjusted multiple determination coefficient**	**0.829**	**0.839**	**0.811**
III.	**Marginal productivity**			
	1. Labour (total) *(Drs/8 hours)*	912	–	–
	2. Permanent labour *(Drs/8 hours)*	–	1,855	–
	3. Seasonal labour *(Drs/8 hours)*	–	–	2,547
	4. Fixed capital (annual cost) *(Drs/Dr)*	7.060	–	–
	5. Equipment (annual cost) *(Drs/Dr)*	–	8.825	–
	6. Consuming capital *(Drs/Dr)*	1.222	1.122	–
	7. Packing & auxiliary materials *(Drs/Dr)*	–	–	2.517
	8. Raw materials *(Drs/Kgr)*	–	–	2.578
IV.	**Real cost**			
	1. Labour (total) *(Drs/8 hours)*	1,688	–	–
	2. Pennanent labour *(Drs/8 hours)*	–	2,971	–
	3. Seasonal labour *(Drs/8 hours)*	–	–	1,486
	4. Fixed capital (annual cost) *(Drs/Dr)*	1.130	–	–
	5. Equipment (annual cost) *(Drs/Dr)*	–	1.130	–
	6. Consuming capital *(Drs/Dr)*	1.080	1.080	-
	7. Packing & auxiliary materials *(Drs/Dr)*	–	–	17.033
	8. Raw materials *(Drs/Kgr)*	–	–	8.264
V.	**Productivity & Cost relationship**			
	1. Labour (total)	0.540	–	–
	2. Permanent labour	–	0.624	–
	3. Seasonal labour	–	–	1.714
	4. Fixed capital (annual cost)	6.248	–	–
	5. Equipment (annual cost)	–	7.810	–
	6. Consuming capital - raw materials *(Drs/Dr)*	1.131	1.039	–
	7. Packing & auxiliary materials *(Drs/Dr)*	–	–	0.148
	8. Raw materials *(Drs/Kgr)*	–	–	0.312

1. $y_1 = 2{,}127$ $x_1^{0.092}$ $x_5^{0.550}$ $x_6^{0.559}$
   (0,178) (0,180) (0,206) $\bar{R}^2 = 0{,}829$ s = 0,230 a < 0,0001
2. $y_2 = 2{,}575$ $x_2^{0.0095}$ $x_4^{0.550}$ $x_6^{0.559}$
   (0,178) (0,180) (0,208) $\bar{R}^2 = 0{,}839$ s = 0,295 a < 0,0001
3. $y_3 = 1{,}655$ $x_3^{0.138}$ $x_8^{0.269}$ $x_7^{0.761}$
   (0,106) (0,133) (0,140) $\bar{R}^2 = 0{,}811$ s = 0,311 a < 0,0001

As it can be seen in **table 4** the sum of the elasticity coefficients ranges between 1,168 and 1,204, something that shows increasing return to scale. The adjusted coefficients of multiple determination range from 0,811 to 0,839. The individual elasticity coefficients reveal that the labour's contribution to gross income is very low (from 4% to 6.4%).

The contribution of the permanent capital is equal to 55%, that of the consuming capital (after the deduction of the cost of the materials) ranges from 55.9% to 76.1% while the contribution of the packing and auxiliary materials is equal to 7.61%.

Labour's marginal productivity (except for the seasonal labour in which case it is higher) is lower than the real cost, showing that labour cost has to be reduced.

The fixed capital productivity is equal to 7,060 Drs/Dr, higher by a large margin than the real cost of 1,130 Drs/Dr, while the value added is only slightly higher than the relative real cost. The marginal productivity of the equipment used is much higher than its real cost (8,825 Drs/Dr compared to 1,130 Drs/Dr). The raw materials marginal productivity, equal to 2,578 Drs/Kgr, is much lower than the real cost of 8,264 Drs/Kgr, showing that the price of the industrial tomatoes paid to the producers, is quite high. The marginal productivity of the packing materials, though, is low, not covering the real cost.

Discussion of the Results - Conclusions

Though the importance of the sector of tomato processing in Greece is not disputed by anyone, the long standing problems faced by practically all concerned factories have not met, till now, the appropriate attention they deserve. It is certain that the competition the sector is currently facing, and will face in the years to come, will intensify. Fitting the survey data to a series of

Cobb-Douglas models it was found that the contribution of the labour costs to gross income is quite low, showing that labour costs are excessive and have to be reduced. Equally, packing & auxiliary materials and raw materials are two other cost units that have to be reduced. Both mixed and net-type factories must adoxt a series of measures if they are to remain competitive in the market.

These measures should include: decrease labour costs, achieve full exploitation of existing facilities and equipment in use, improve the use of the consuming capital. It appears that the difficulties the companies have in securing short term capital has a subsequent negative effect on the production costs. One general conclusion that can be drawn is that the current operational structure and organisation of the tomato processing factories is not productive.

Apart from a series of decisions that have to be taken with respect to the huge debts accumulated by the sector over the years, attention, accompanied with immediate action, should be paid to the production reorganisation of the factories, utilising in a more productive way the existing resources (processing equipment, labour, capital).

It is important to note that in the decade that has elapsed since the conduct of the survey, no corrective measures were taken so as to provide solutions to the problems the sector is facing.

The overall situation has not changed during that period in any discernible way.

The accuracy of the results and conclusions drawn from this cross-sectional analysis has been verified a number of times over the years, confirming both the reliability of the sample data and the theoretical structure of the model upon which the study was based. Since the time the survey was conducted the situation worsened and some enterprises went bankrupt and closed. Some other ones were forced to downgrade stopping the operation of some of their production lines, while the ownership status of some companies had to change too. It must also be stressed that since 1992, the Agricultural Bank of Greece in collaboration with the Ministry of Agriculture, has stopped awarding loans to those enterprises of the sector that are facing serious financial problems. ●

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