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Accession in the EC and its Effect on Total Factor Productivity Growth of Greek Agriculture

by

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ABSTRACT

Despite their importance as efficiency indicators, productivity indices are not officially available in Greece for any economic sector. This paper uses the growth accounting framework to estimate partial and total factor productivity, TFP, indices for the agricultural sector, during 1974-1989. The capacity utilisation is estimated by assuming capital to be a quasi-fixed factor. The results show that Greece's accession in the EC had a favourable effect on the productivity growth of agriculture. TFP grew at a 0.81% per annum during the post-CAP period, 1981-1989, and by 1.56% during 1986-89, while it had a negative growth during 1974-1980. At the aggregate level this change is explained by decreased aggregate input rather than increased output. The estimated data base can also be used for the study of the agricultural sector of Greece on the supply side, an area which has received very little attention.

This paper is based on earlier work presented at the Panhellenic Agricultural Congress, held in Thessaloniki, 11-12 December 1992. The author gratefully acknowledges helpful comments by participants of that Congress (Session: Agricultural Development and Technology). Special thanks are owed to Mrs. Tasia Lambropoulou, Scientific Researcher in KEPE, and Mr. Abathoyiannis, Researcher at the Ministry of Agriculture, for valuable assistance in the data to be used in this paper.

1. INTRODUCTION

Productivity indices are not officially compiled in Greece for any economic sector or any level of aggregation. The National Statistical Service of Greece (ESYE) has overlooked the pressing need for productivity measurement.[1]

However, three of the most important indicators of a sector's or country's economic performance are its rates of inflation, real output growth, and productivity growth. Broadly defined, productivity measures include all measures that relate one or more measured inputs to a measure of output, usually in the form of a ratio. Productivity measures are of interest almost exclusively as differences or changes. In this context, agricultural-productivity measures can be considered as indicators of relative efficiency in agricultural production - efficiency with which inputs like labour, capital, and fertilizers, are converted into economic agricultural output. Thus, changes or differences of productivity in agriculture are used in comparing intra-sectoral, as well as interregional economic performance.

The salient use of a productivity measure is as an indicator of the extent to which real income and the standard of living (as measured by consumption of tangible goods and services) can rise through time.[2] Productivity growth is one of the most important sources of a rise in aggregate output and income. Increases in real income arising from productivity growth are generally distributed as increases in real compensation to suppliers of the factors of production, whose real compensation otherwise can change only through income redistribution. Thus, productivity figures can be used as a guide for setting prices.

Another major use of productivity data is in studying the sources of economic growth, as well as in measuring and forecasting such economic variables as potential GNP and labour requirements, and consequently in analysing business-cycles. Changes in productivity include all sources of growth except increases in the quantity of inputs. This means that accounting for productivity change involves measuring changes in the quality of inputs, the state of technology, and economies of scale.

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[1]. The only systematically available productivity measurement comes from the Research Institute of the Union of the Greek Industries (IOBE) who calculate labour productivity indices at the two-digit level of the manufacturing sector on a quarterly basis.

[2]. In general, productivity measures are used to guide the distribution of economic gains to the providers of tangible factor inputs. However, they can also tell us what our opportunities are to improve the quality of life by allotting a portion of the increase in productivity to a quality-of-life improving programme.

Productivity in agriculture is the relationship between agricultural output and one or more of the associated inputs used in the process of agricultural production. The conceptual framework for the measurement of productivity is the theory of production, which consists of a production function with the conventional neoclassical curvature properties, relating the maximum possible output Y, the flows of services of k inputs X_k combined to produce Y, and the state of technology represented by time.[1] Constant returns to scale[2] are also assumed, together with the necessary conditions for producer equilibrium.

When output and inputs have been measured in constant prices, ratios of output to individual input classes can be calculated to obtain partial productivity measures, or ratios of output to all associated inputs may be calculated to obtain a total-factor productivity (TFP) measure. Changes in agricultural TFP measures reflect the net saving in real costs of agricultural production achieved, that is, increases in productive efficiency generally, if all agricultural inputs are included in the denominator. The main force behind increases in agricultural TFP, assuming comparable rates of capacity utilization, is cost-reducing technological progress.

Partial productivity measures are useful in showing the savings that have been achieved over time in the use of each input per unit of output. Their changes, however, reflect not only changes in productive efficiency, but also factor substitutions that result from changes in relative factor prices. Thus, changes in partial productivity reflect movements along production functions as factor proportions are changed as well as shifts in production functions due to technological change.

Although the importance of agriculture in Greece has been declining through time, it is still of vital significance for the country. In this paper, the agricultural sector is defined to include crop and animal production. Thus defined, agricultural output was 17.3% of GDP in 1970, 13.9% in 1980, 12.4% in 1989 and 10.9% in 1991.[3] Its contribution to employment was 41.1% in 1970, 30.2% in 1980, and 25.3% in 1989.[4] Agriculture participates with a 20%-25% in total exports of the country since 1960, while crops consist

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[1]. An increase in time leads to technology improvements arising from disembodied technical change.

[2]. According to Morrison (1986), the assumption of constant returns to scale is not crucial. However, Haurer and Yee (1992) argue that she is incorrect.

[3]. National Accounts of Greece, National Statistical Service of Greece, 1992.

[4]. Survey of Labor Force, National Statistical Service of Greece, various years.

a traditional 80%-93% of the sectoral exports.[1]

Agricultural Statistics in Greece traditionally include production, investment and stocks, employment, foreign trade, consumer and producer prices, and finance. There is also data on some intermediate consumption items, but scattered and non-comparable. Since 1974, however, data on final output, crop and animal, intermediate consumption, depreciation, net operating surplus, and net income from agriculture were all put in a detailed and comparable basis. This data together with corresponding prices, paid and received by producers, are officially published in the Eurostat, the Commission of EC Reports, and the OECD publications. This statistical information, covering the time period 1974-1989, is the main data source for this paper, which may be viewed as an effort to fill the gap in the existing economic indices of the agricultural sector of Greece.

There is not, in my knowledge, any previous work dealing with the construction of productivity indices for the agricultural sector of Greece. Thus, the purpose of this paper is two-fold: First, to utilize the growth accounting approach in order to compile partial productivity and TFP growth indices for the agricultural sector, as defined above. Second, to analytically examine the pattern of productivity growth during the following three periods: (1) 1974-1980, a pre-CAP period, (2) 1981-1985, a post-CAP transitory period, and (3) 1986-1989, a full post-CAP period.

In order to achieve its aim, this paper is organized as follows: Section 2 summarizes and outlines the theoretical growth accounting framework for the compilation of partial productivity and TFP growth indices. Section 3 discusses the empirical productivity measurement and the data used. Section 4 presents, explains and analyses the obtained results. Finally, the last section concludes the paper.

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[1]. Monthly Bulletin of the Bank of Greece, Bank of Greece, various issues.

2. THEORETICAL UNDERPINNINGS OF TRADITIONAL PRODUCTIVITY MEASUREMENT

Productivity analysis is based on the theory of production and cost. There are two approaches to the productivity measurement: Growth accounting and econometric fitting of production functions. Diewert first in 1976 derived the formal relationship between the two approaches and he showed that they are both equivalent: Under cost minimizing behaviour, and by utilizing a translog mathematical formulation, the input-quantity aggregate, or the input-price aggregate, can be equivalently calculated by means of either the Tornqvist index, or the translog production or cost function. In spite of this theoretically proved close relationship, economists are still often engaged with both theoretical and empirical examination of the proximity of these two modes of productivity measurement.[1]

The growth accounting approach to productivity measurement uses the production function as an accounting and not as an estimation framework. It starts with a production function of the following form:

$$Y = F(C, L, E, M, S; t) \tag{1}$$

where Y is real output, C is capital, L is labour, E is energy, M, non-energy materials, S is purchased services, and t denotes technical progress. The following assumptions are made: (1) F is logarithmically differentiable and exhibits constant returns to scale. (2) Each input is paid the value of its marginal product. (3) Technical change is Hicks neutral.[2] Then, equation (1) can be written as,

$$\begin{aligned} d\log Y/dt = {} & (\partial\log Y/\partial\log C)(d\log C/dt) + (\partial\log Y/\partial\log L)(d\log L/dt) + \\ & + (\partial\log Y/\partial\log E)(d\log E/dt) + (\partial\log Y/\partial\log M)(d\log M/dt) + \\ & + (\partial\log Y/\partial\log S)(d\log S/dt) + (\partial\log Y/\partial t) \end{aligned} \tag{2}$$

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[1]. See Harper and Gullickson (1989), and Thirtle and Bottomley (1992).

[2]. Hick's neutral advance requires an unchanged ratio of marginal products when factor proportions are constant.

If $d\log Y/dt = \dot{Y}/Y$, $\partial \log Y/\partial t = \dot{P}/P$, then equation (2) can be expressed as
$\dot{P}/P = \dot{Y}/Y$ - an elasticity weighted aggregate input growth (3)
Equation (3) measures TFP growth or $\dot{P}/P$.

Thirtle and Bottomley (1992, pp.384-385) have shown that equation (3) is also the result of a production function derivation of a TFP growth index.

A useful index of the quantity of total output may be defined in terms of the weighted average of the rates of growth of the individual outputs, the weights being the share of each output value to total value of output. This is analogous to the last term in (3). These indices are known as Divisia quantity indices. On the basis of the main accounting identity $qY=pX$ (value of output equals value of input), Divisia price indices are dual to Divisia quantity indices.

Equation (3) can be used to measure TFP from discrete data by employing the Tornqvist index,[1] which is defined as follows:

$$TFP \equiv \dot{P}/P = \sum w_{it}[\log Y_{it} - \log Y_{i,t-1}] - \sum v_{jt}[\log X_{jt} - \log X_{j,t-1}] \quad (4)$$

where Y is output, X is input, w_{it} denotes the relative share of output i at time t in total value of output, v_{jt} denotes the relative share of input j at time t in total cost. The weights w and v are arithmetic averages of the relative shares in the two periods.

Expression (3) can be rewritten in terms of any partial input productivity. For instance, in terms of labour productivity, equation (3) becomes

$$\dot{Y}/Y - \dot{L}/L = \dot{P}/P + \sum^{\neq L} v\,(\dot{X}/X - \dot{L}/L) \quad (5)$$

The summation is over all input factors except labour. Thus, the partial productivity indices are simply the average products of the corresponding factors, while the TFP index is often referred to as the "residual" or the "index of technical progress".

In the next section, problems relating to the empirical measurement of Greek agricultural output, and input indices are discussed. Also, the used data base is presented.

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[1]. The discrete and continuous index numbers are equal if relative shares are constant; otherwise an error is involved which depends on the variability of shares and the length of the time period. Divisia indices for discrete time satisfy the time reversal test, and as Theil (1967) has demonstrated, they also satisfy the factor reversal test.

3. EMPIRICAL PRODUCTIVITY MEASUREMENT

The two most often used indices of measuring TFP growth are Solow's (1957) geometric index and Kendrick's (1961) arithmetic measure. Solow's TFP change measure is based on the Cobb-Douglas production function, with constant returns to scale, autonomous and neutral technological change, and perfect competition. It is expressed as follows:

$$dP/P = dY/Y - [\sum v_j \, dX/X], \quad \sum v_j = 1 \tag{6}$$

where d denotes time derivatives.

Kendrick measures TFP growth by using the Euler condition and a distribution equation derived from a homogeneous production function with constant elasticity of substitution and disembodied neutral technical change. It is written as

$$dP/P = \left[(Y_1/Y_0)/[(\sum v_j \, X_1)/(\sum v_j \, X_0)]\right]^{-1} \tag{7}$$

where the subscripts 1 and 0 refer to current and base period respectively. Levhari and al. (1966) have shown that the two measures are equivalent for small changes in the quantities of inputs and outputs.

Formula (6) in its Tornqvist form (4) is the productivity growth index which has been used by many authors like Christensen and Jorgenson (1970), Jorgenson and Griliches (1967, 1972), the U.S. Bureau of Labor Statistics (see Mark and Waldorf, 1983, p.15), and more recently by Thirtle and ottomley (1992).[1]

The calculation of the agricultural output index, based on formula (4), utilises annual output data published in the OECD (1990, pp. 168-169, 1991, pp. 170-171) "Economic Accounts for Agriculture". This data cover 14 groups of agricultural crop products, five

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1. In a recent paper, Diewert (1992) proves that the Fisher ideal productivity index, Pr_F, described by the following formula (8), is superior to formula (4) from both viewpoints, the test approach to index numbers and the economic approach (the assumption of optimising behaviour is taken into account) to productivity indexes.

$$Pr_F \equiv Q_F/Q^*_F \tag{8}$$

where, Q_F is the output index, and is given by $Q_F \equiv [Q_L \, Q_P]^{1/2}$, Q^*_F is the corresponding input index, and Q_L, Q_P denote Laspeyres and Paasche indices, respectively.

groups of animals, and four groups of animal products. Thus, the output index is based on 23 agricultural output groups presented in Table 1. This current value data is transformed into volume data by utilising the corresponding producer prices, PP, taken from the Eurostat (1986, pp. 142-143, 1989, pp. 158-159) and the Commission of the EC (1988, 1991).

The calculation of the input index for agricultural materials utilises annual intermediate consumption data on 10 categories of intermediate inputs, presented in Table 1. It is taken from OECD (1990, pp. 170-171, 1991, pp. 172-173). This current value data is transformed into volume data by utilising the corresponding means- of-agricultural-production price indices published in the Eurostat (1986, pp. 180-181, 1989, pp. 202-203) and The Commission of the EC (1988, 1991).

TABLE 1
Crop-animal Product Categories (P1-P23)
and Intermediate Consumption Categories (C1-C10)

P1	Grains	P15	Total cattle	C1	Seeds
P2	Paddy rice	P16	Total pigs	C2	Animal feed
P3	Pulses	P17	Total sheep and goats	C3	Fertilizers
P4	Root crops	P18	Poultry	C4	Plant rotection products
P5	Industrial crops	P19	Other animals	C5	Pharmaceutical products
P6	Fresh vegetables	P20	Milk	C6	Energy and lubricants
P7	Fresh fruit	P21	Eggs	C7	Livestock and animal products
P8	Citrus fruit	P22	Wool	C8	Maintenance and repair
P9	Grapes	P23	Other animal products	C9	Services
P10	Wine			C10	Other intermed
P11	Table olives				
P12	Olive oil				
P13	Nursery plants				
P14	Other				

Regarding the primary inputs of labour and capital, some methodological issues have traditionally been raised. Estimates, parametric or non-parametric, of factor productivity are sensitive to the methods used for measuring real factor inputs in general and the classification of the quantity and quality of each input into its various elements. Such issues have also been very controversial (see the classic debate between Jorgenson and Griliches, 1967, 1972 on the one hand, and Denison, 1969 on the other).

In measuring materials' inputs, the quality issue is focussed on whether the corresponding deflator used to obtain the real magnitude has been adjusted for quality change, so that it reflects a "pure" price change. The same problem of quality adjustment exists for the output deflators as well. In this paper the quality adjustment of output and input deflators is not investigated.[1] However, the sensitivity of the results to partially adjusting for quality change (which most probably happens) may be important in areas where technological change has been rapid, as in the case of agrochemicals. Thirtle and Bottomley (1992, p.390) speak about "little quality adjustment" in their own data for the UK. The agricultural price indices used in this paper are the ones officially published in the Eurostat, as referred above, and are comparable with the agricultural price indices of the other EC member states.

Regarding the labour input, the main issues involved in the case of Greek agriculture are age-sex composition, educational attainment and training-skill qualifications, and extent of underemployment of the labour force. Underemployment and hours worked has been taken into account in the construction of the variable awu, that is annual work units (agricultural work done by a full-time worker in one year). Data on awu is taken from The Commission of the EC (The Agricultural Situation in the Community, various Reports).

However, awu, or the labour input is not adjusted for issues relating to age-sex composition, as well as educational and skill characteristics of the agricultural labour force. Except for the lack of available data in Greece, there are conceptual issues involved, like the double character of education as both an investment and a consumption good, the quality of education, and the existence of externalities associated with education. All these issues make the quality adjustment of the labour input very difficult. Thirtle and Bottomley (1992, p.390) also use the unadjusted-for-quality variable awu as their labour input for the UK.

In relation to the capital input, the problems are too well-known to necessitate a long discussion. Data on agricultural capital stock for Greece distinguish four categories: buildings, other construction works, machimery, and transport equipment. They are taken from Skountzos and Matheou (1991),[2] who have used the perpetual inventory method for their calculations. These capital stock series have to be transformed into flows of capital services, since the production function is conventionally interpreted as a relationship between the flow of output and the flow of input services. One approach could be to

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[1]. In Georganta (1992) the output deflators for the Greek manufacturing sector have been found to incorporate measurement errors, most probably attributable to lack of quality-adjustment of the corresponding price indices.

[2]. Their capital stock database, which extends as back as 1950 for all sectors of the Greek economy, is officially used by the Greek Government, as well as by private research institutions and individual analysts.

assume that capital flows are proportional to stocks, so that the one is a perfect surrogate for the other. In such a case, capital utilisation (ratio of flow to stock) is assumed to remain constant over time and, in particular, over the business cycle, which is an unrealistic assumption. Another approach is to multiply the estimated capital stock by an estimate of capital utilisation. This has been applied by various researchers, as Jorgenson and Griliches (1967, 1972), by considering the ratio of used energy to installed energy as a proxy for capacity utilisation. This proxy variable is not available for the Greek agricultural sector.

Another approach to the capacity utilisation problem, which was followed in this paper, is to introduce into the analysis the distinction between the long-run and the short-run by assuming that capital is a quasi-fixed factor (fixed in the short-run and variable in the long-run).[1] Within this framework, capacity utilisation is defined as the ratio of actual output, Y, to capacity output, Y_0. At capacity level of output Y_0, the short-run and the long-run unit cost curves are at their minimum. Thus, it is assumed that $Y \neq Y_0$, leading to a gross quasi-rent or ex-post rental price, Z, realized from the capital stock when the other inputs are adjusted to meet fluctuations in demand. Z is thus the residual income accruing to the quasi-fixed stock (revenue minus payments to all variable inputs):

$$Z = (qY - pX^{\neq C})/CS \tag{9}$$

where q, p are prices for output and inputs (except for capital) respectively, C is capital input, and CS is capital stock. Berndt and Fuss (1986) showed that Z equals the value of the realized marginal product of capital in each period. Jorgenson and Griliches (1967) and Christensen and Jorgenson (1969) constructed such a measure, but they did not develop it theoretically as Berndt and Fuss (1986) did.

Thus, the capital stock in this paper is first compiled as a Tornqvist index based on the above four capital categories. Then, Z is non-parametrically estimated and the capital stock is transformed into a capital input argument by adjusting the corresponding factor shares.

The factor land is considered together with the capital input. Land rental prices are available in Greece together with those for capital, and a big study is needed in order to estimate them separately.

Data on compensation of employees, and subsidies, as well as production taxes is taken from the OECD "Economic Accounts for Agriculture". Detailed data on product subsidies became available for this work by the Ministry of Agriculture in Greece. This data,

[1]. See Berndt and Fuss (1986), and Hulten (1986, 1990).

together with data on depreciation, rent and other payments, and interest, are used to obtain the input shares in total cost, and also to get the final output indices in factor-cost prices.

4. PRODUCTIVITY INDICES AND INTERPRETATION

Table 2 presents the computed output, input, and TFP indices. Their values are derived from equations (4) and (5). Thus, they are Divisia-Tornquist indices, which are chain-linked. For each year the current values are used as a base in estimating the rate of growth to the following year. The advantages of chained indices are thoroughly discussed in Diewert (1986).

The output index is computed taking into account the 23 crop-animal product categories, P1-P23, presented in Table 1. Similarly, the input index covers the labour input, the four capital-input categories (machinery, transportation equipment, buildings, and other construction), land, and the ten intermediate consumption categories, C1-C10, presented in Table 1. Table 2 also includes another two columns: (1) The capacity utilization index, cu, which is non-parametrically estimated along the lines of section three, and (2) The product subsidies, subout, as a percentage of total output for the time period 1974-1989.

Output, input, and TFP are plotted in Figure 1. The partial productivity indices are plotted in Figure 2, and Figure 3 shows the output index split in two subindices, one for crops and one for animal production.

Table 3 presents the annual average growth rates of output, input, and TFP indices, as well as the annual average growth rates of the three partial productivity indices, labour, capital-land, and intermediate consumption. The sample period, 1974-1989, has been considered in three sub-periods: (1) 1974-1980, a pre-CAP period, (2) 1981-1985, a post-CAP transitory period, and (3) 1986-1989, a full post-CAP period.

Table 4 shows the average income shares of output and inputs. It also shows the annual average growth rates of these income shares considered during the pre-CAP as well as during the post-CAP periods described above. Figures 4a, 4b, and 4c show the development of the eight most important individual input indices.

TABLE 2

Chained-Linked Productivity Indices, Greek Agriculture, 1974-1989

Year	Output	Input	tfp	Labour	Capital	Intermed. Comsumpt.	cu %	Subout %
1974	100	100	100	100	100	100	44	2.8
1975	109	104	104	111	105	101	42	2.8
1976	108	108	100	112	100	97	42	3.3
1977	103	111	92	110	92	90	37	5.0
1978	110	114	97	120	96	95	38	4.4
1979	106	118	90	118	90	83	33	3.6
1980	115	121	95	131	96	84	34	3.0
1981	118	122	96	137	98	84	34	5.1
1982	121	122	98	143	100	85	35	5.9
1983	115	124	92	137	94	79	30	5.2
1984	123	127	96	146	98	82	32	5.6
1985	126	130	96	148	98	81	33	5.0
1986	124	129	96	151	96	85	29	5.0
1987	128	128	98	164	100	85	30	9.0
1988	132	129	101	161	103	85	32	6.2
1989	133	129	102	161	104	88	33	9.0

TABLE 3
Annual Average Growth Rates of Chained-Linked Productivity Indices, Greek Agriculture (%)

Variable	1974-79	1974-80	1981-89	1981-85	1986-1989
Output	1.90	2.32	1.62	1.83	1.35
input	1.70	3.17	0.71	1.43	-0.19
tfp	0.20	-0.88	0.81	0.40	1.56
labour	3.18	4.51	2.29	2.44	2.10
capit-land	0.25	-0.68	0.88	0.41	1.49
intermed.	-0.85	-2.85	0.59	-0.72	2.07
Mean Values (%)					
cu	34.85	38.48	32.02	32.81	31.03
subout	5.00	3.50	6.20	5.40	7.30

TABLE 4
Average Income Shares and Average Annual Growth Rates of Output and Input

Variable	Share 1974-89 (%)	Growth Rate % 1974-89	Growth Rate (%) 1974-80	Growth Rate (%) 1981-85	Growth Rate (%) 1981-89	Growth Rate (%) 1986-89
Output						
crops	67.27	1.76	3.15	2.27	0.83	-0.98
animal	32.73	0.19	0.82	-1.68	-0.23	1.59
input						
feed	7.14	-1.29	0.96	-0.43	-2.79	-5.74
seed	1.00	0.39	1.12	-0.37	-0.10	0.24
fertiliser	2.61	-1.94	1.08	-3.05	-3.96	-5.10
energy	3.96	3.00	11.08	0.86	-2.38	-6.42
livestock	0.25	7.75	5.00	7.45	9.58	12.25
repair	3.72	1.16	3.20	-0.22	-0.20	-0.18
chemicals	1.31	2.60	0.72	6.32	3.43	-0.19
services	0.73	-1.51	-0.81	-1.22	-1.98	-2.94
intermed.	22.19	0.25	2.71	0.11	-1.40	-3.29
labour	4.59	1.24	6.96	-3.77	-2.57	-1.08
capit-land	73.23	-0.13	-1.20	0.22	0.58	1.04

FIGURE 1

Chained-Linked Output, Input and TFP Indices

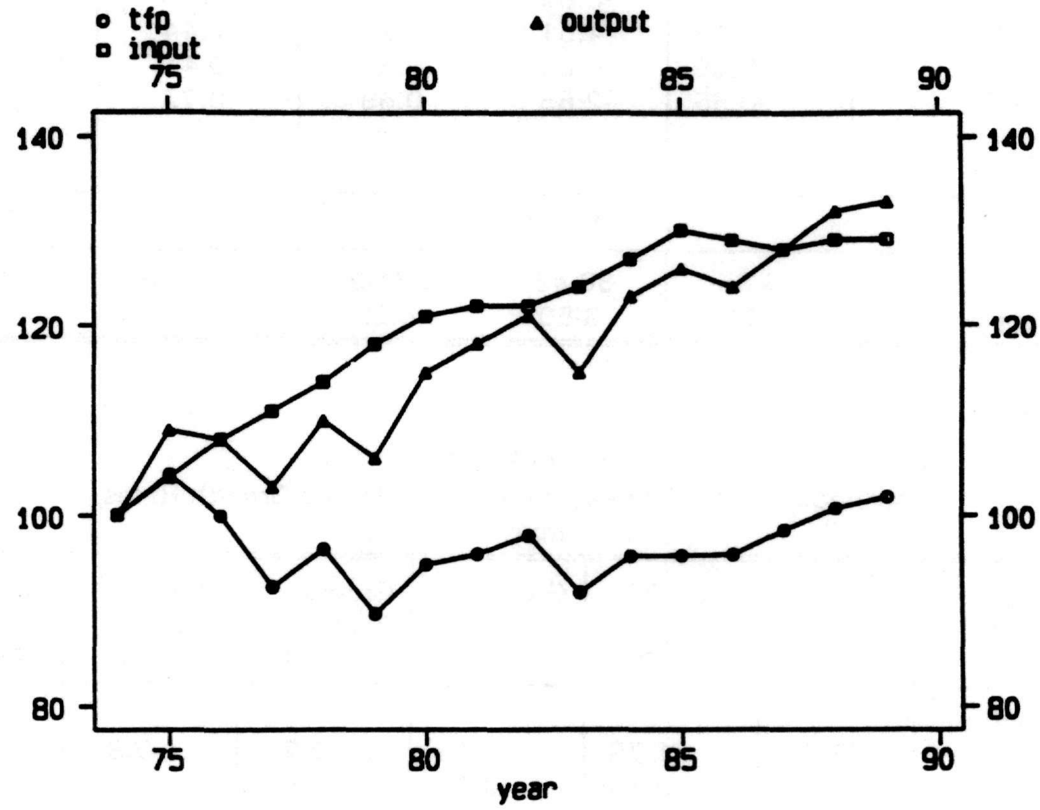


FIGURE 2

Partial Productivity Indices

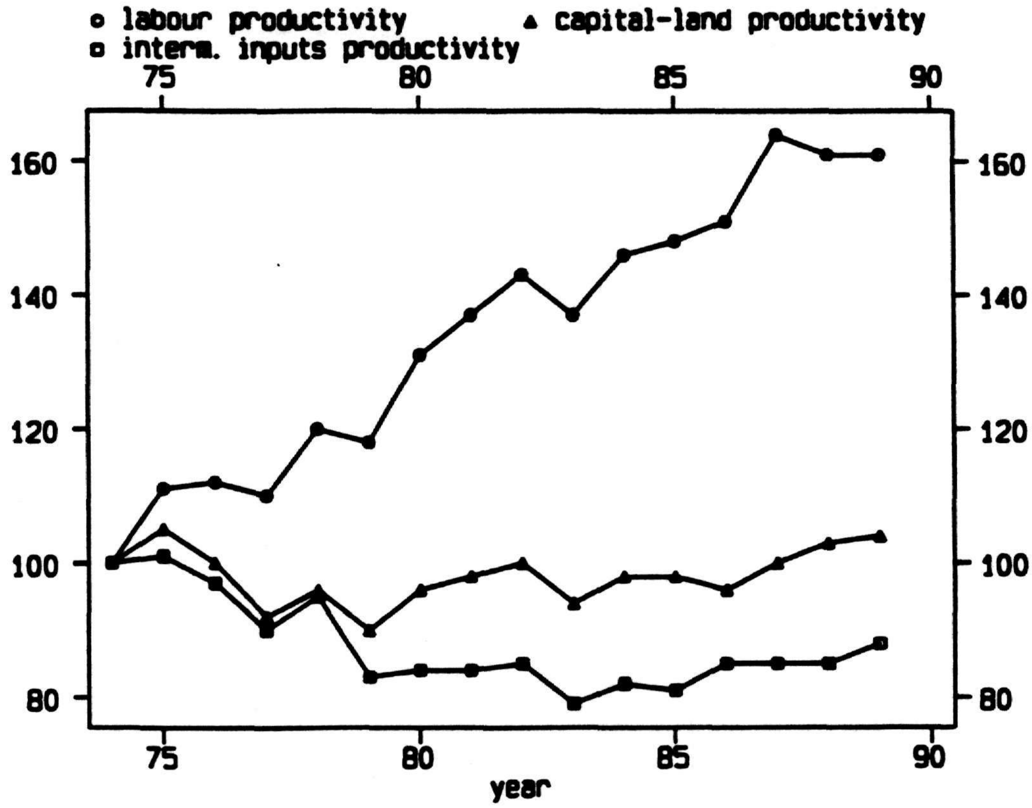


FIGURE 3

Output Indices

FIGURE 4a

Individual Input Indices

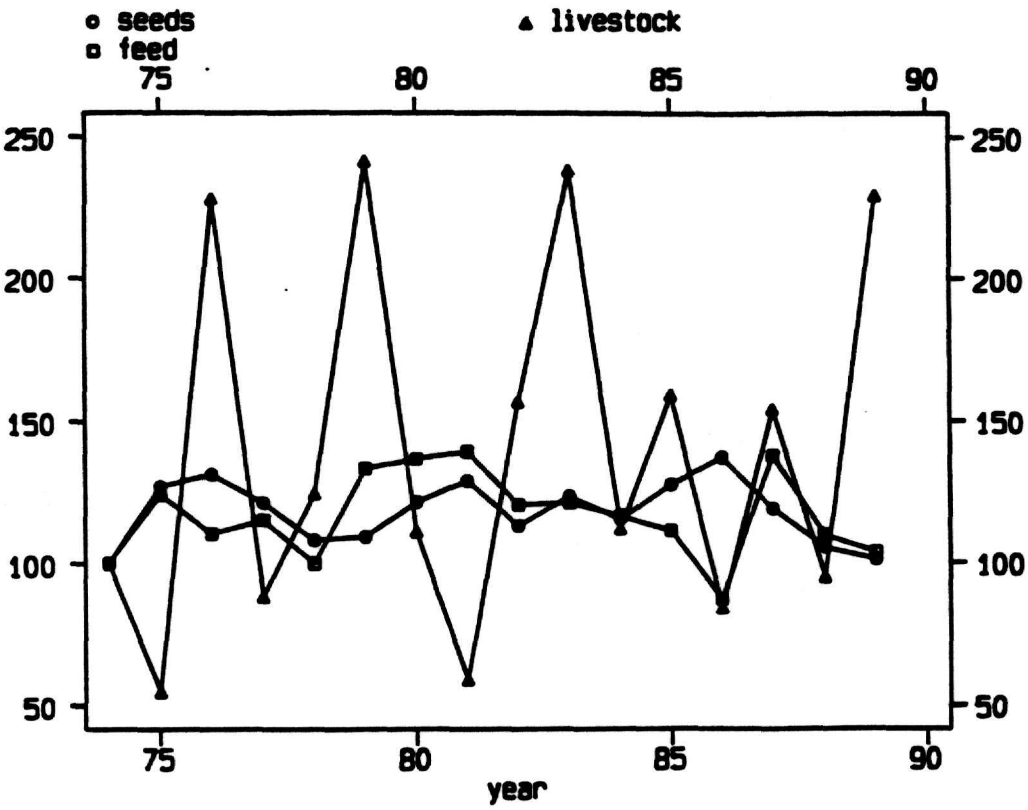


FIGURE 4b

Individual Input Indices

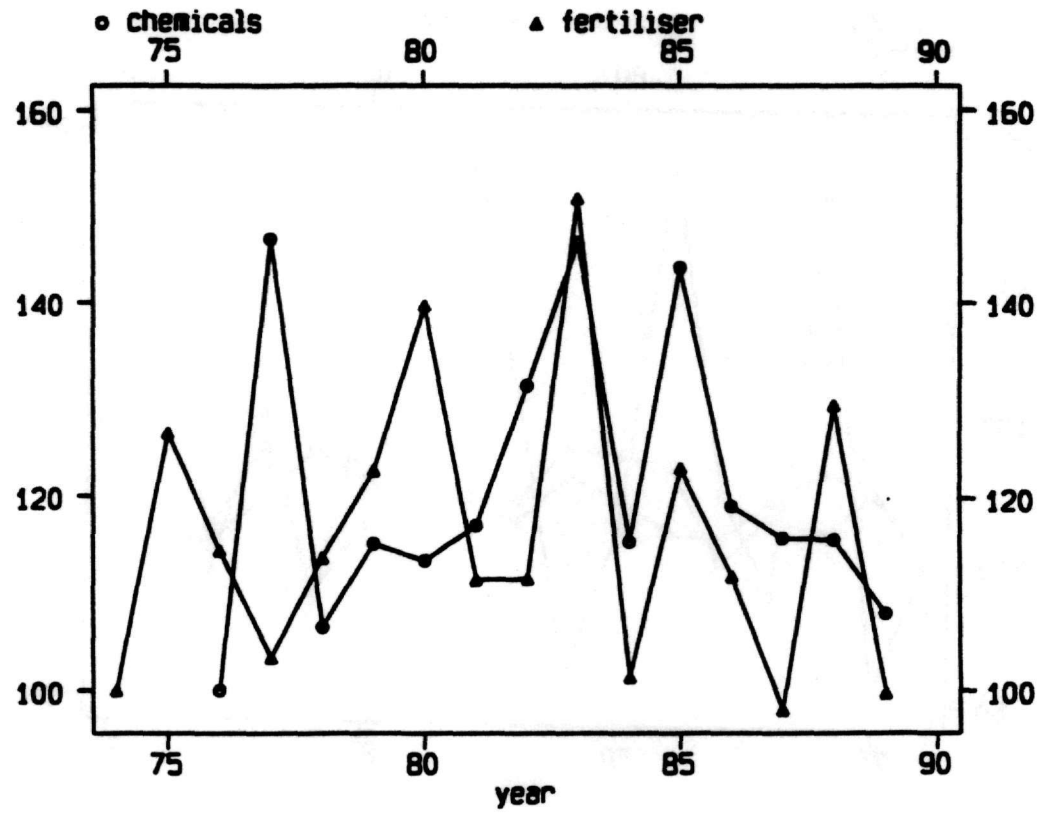
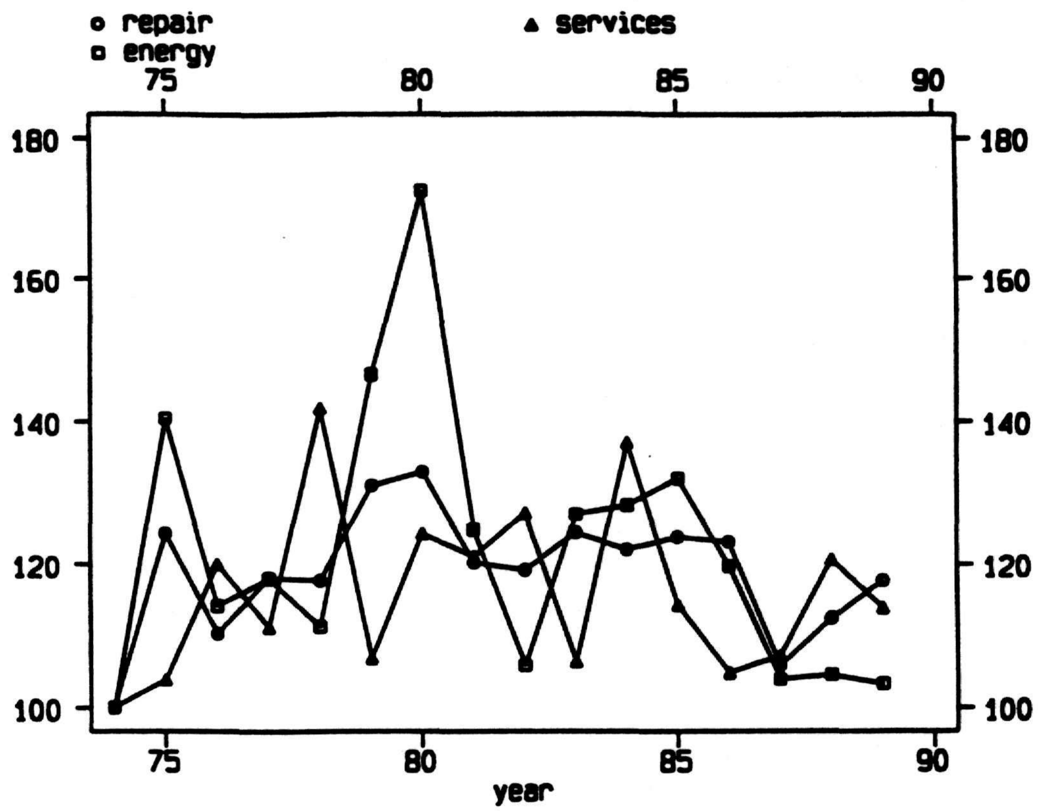


FIGURE 4c

Individual Input Indices



The TFP index, which is reported in Table 1 and plotted in Figure 1, has grown by 0.20% per year for the entire period 1974-1989 (Table 3). During the pre-CAP period, 1974-1980, TFP had an annual average decline equal to 0.88%, while during the full post-CAP period, 1986-1989, it reached an annual average growth rate equal to 1.56%. Thirtle and Bottomley (1992) have estimated a 1.66% annual growth rate of the U.K. agricultural TFP during 1985-1990. This rise in Greek agricultural TFP growth comes from a decrease in the growth rate of agricultural inputs used. Thus, during the pre-CAP period the average growth rate of inputs per annum was 3.17% compared with 2.32% for output. From the beginning of the post-CAP period, in 1981, the input growth starts slowing down, and the gap in the growth rates of output and inputs starts getting reduced. The slowdown is stronger for the labour and intermediate consumption inputs. As Table 4 shows, during the entire post-CAP period, 1981-1989, the share of labour declined by 2.57% per annum (pa), and the share of the intermediate inputs declined by 1.4% pa. In terms of the individual intermediate inputs, Table 4 shows that livestock has increased its share by 9.58% pa during 1981-1989, and by 12.25% during 1986-1989.

The growth rate of the agricultural output has in general slowed down during the entire post-CAP period. Its rate of growth was 2.32% pa during the pre-CAP period, 1974-1980, while it was 1.62% pa during 1981-1989. In terms of developments in the particular agricultural sub-sectors, the combination of Table 4 and Figure 3 shows that although crops maintain a high share in total agricultural output, its rate of growth is continuously declining. The animal production showed a reduction of 1.68% during the post-CAP transitory period, 1981-1985, but it starts rising during the full post-CAP period, 1986-1989, reaching an annual average growth rate of 1.59%.

These productivity developments in the agricultural sector of Greece show that Greece's accession into the EC had favourable effects on the growth of the sector. Thus, the conclusions of other studies about Greece's agricultural sector are not founded if productivity growth is taken into account.[15]

Another point worth noticing is the capacity utilisation rate, which has slightly declined, from 38.48% on average during 1974-1980, to 31.03% on average during 1986-1989 (Table 3). This estimate, taken together with the developments in TFP and factor shares, implies that Greek agriculture was overmechanised, so that it could afford growth even with a slight decrease in capacity utilisation. Overmechanisation may be the result of the small size of the average agricultural lot existing in Greece.

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[15]. Demoussis and Sarris (1988), for example, argue that "Greece's accession to the EC has hardly affected her agricultural sector".

A final point to note is that the product subsidies as a percentage of total output have increased, from 3.5% on average during 1974-1980, to 7.3% on average during 1986-1989. This policy may not have a positive developmental character for the long-run. Previous work (see Georganta, 1993) has shown that abolishment of CAP's interventional policies may lead to higher TFP growth. Also, Mergos (1991, p.18) argues that "...to the extent that subsidies have blurred or distorted price incentives, they had a negative impact on output..."

5. CONCLUSIONS

This paper has used the growth accounting statistical framework in order to compute partial and total factor productivity indices for the agricultural sector in Greece during the time period 1974-1989. This effort has covered a big gap existing in the economic coverage of the official agricultural statistics in Greece. Thus, one of the main results of this work is a database that is suitable for the analysis of the agricultural sector on the supply side, which is very little studied in Greece (see Mergos, 1991, p. 39).

As it was pointed out above, in contrast with the conclusions of previous studies of the agricultural sector, this paper, based exclusively on the estimated productivity indices, shows that Greece's accession in the EC had positive effects on the total factor productivity growth of the whole sector. TFP grew at a 1.56% pa during the full post-CAP period, while it had a negative growth rate during the pre-CAP period. Labour productivity has declined from 4.51% pa, during 1974-1980, to 2.1% pa, during 1986-1989. This decline has been more than balanced out by the increase in capital-land and the intermediate inputs productivity: Capital-land productivity rose to 1.49% pa, during 1986-1989, from a -0.68% pa during 1974-1980, and the intermediate-inputs productivity rose to a significant 2.07% pa, during 1986-1989, from a -2.85% pa during 1974-1980 (Table 3).

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