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Measurement of Total Factor Productivity in the Manufacturing Sector of Greece, 1980-1991

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CONTENTS

LIST OF TABLES

TABLES OF THE APPENDIX

ABSTRACT

Despite their importance as economic performance 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 indices for the manufacturing sector during 1980-1991. The capacity utilization is estimated by assuming capital to be a quasi-fixed factor. The resulting data base appears for the first time in Greece. It is particularly useful for scientifically founded economic policy analysis. Among the most apparent policy suggestions of this data set may be the promotion of industries characterized as "dynamic", like the "Fats and Oils", and "Office Equipment".

1. Introduction

Recently, a lot of discussion is taking place not only in Greece, but also among its European partners, about the disappointing performance of the Greek economy and its possible relationship to productivity growth. Unfortunately, despite their importance as measures of economic performance, productivity indices are not officially available in Greece.[1] However, a falling rate of growth of productivity may imply a falling rate of growth of real per capita income with a resulting drop in the standard of living of the Greek population. It is also possible that phenomena, like the observed high and persistent inflation, as well as the chronic imbalances in the international payments of the country, are closely related to falling rates of productivity growth.

Productivity is broadly defined as the real output per unit of input, and it is expressed in the form of indices which measure the relative efficiency[2] that an economy or sector operates at a macro or micro level.

Productivity increase is one of the most important sources of growth of total output and income. Denison (1974) estimated that during 1929-1969 the 47% of the increase in the real national income of the U.S.A. was due to the increase of output per unit of input, and only the rest, 53%, was due to increases of real inputs. Moreover, regarding the increase of real national income per employee, Denison estimated that during the same period the share of output per unit of input was 79% and the rest was due to increases in the inputs of education and physical capital.[3]

In general, an increase in real income that comes from an increase in productivity implies an equivalent increase in the real compensation of the factors of production, whose real income can only change through an income redistribution. To make this explicit, let us assume that we have only one input, say labor, L. The ratio Q/L, where Q is real output, is

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[1]. The only available productivity estimates are published by IOBE (Research Institute of Greek Industries) on a quarterly basis at the 2-digit level of the International Standard Industrial Classification. The IOBE figures include only a labor productivity index which is defined as the ratio of the index of industrial production for manufacturing, compiled by the National Statistical Service of Greece, to an unweighted employment index.

[2]. Within the context of production functions, in general, a production unit is efficient if it maximizes its output with a given set of inputs, or, if it minimizes its inputs producing a given output, taking into account cost considerations as well.

[3]. Other authors give somewhat different estimates of the contribution of productivity change to the growth of output. See the classic debate between Denison (1969) on the one hand, and Jorgenson and Griliches (1967, 1972) on the other. Also, see Christensen et al. (1980).

an index of labor productivity. This ratio implies that if productivity is constant, then output can increase only if we use more units of labor. All additional output will compensate the additional units of labor at the prevailing prices, and there will be no surplus left to raise the level of real factor compensation for the providers of either the original or the added units. By generalizing for more than one inputs, the above example implies that the providers of any one input could increase their real compensation only at the expense of the providers of some other input, or, in other words, by a redistribution of income. In contrast, if productivity is rising, then all factors' real income can increase without a necessary decrease in the real income of some other factors.

Thus, we can observe that prices may remain constant if we choose to increase real incomes through an increase in productivity. The reason is that the unit factor cost remains unchanged. For instance, if output increases by 5% while labor remains constant, and if the compensation of labor per work hour, w, increases also by 5%, then the unit labor cost, wL/Q, will remain constant. Also, a proportional increase in both, the hour compensation of labor and productivity, will not change the share of labor. In other words, keeping L constant, a 5% increase in both, Q and w, will result to the ratio 1.05wL/1.05Qp, where p is the price of output. These results remain the same independently of whether the increase in productivity takes place through a reduction in the work hours with output constant, or through a combination of an increase in output and a reduction in labor hours.

Consequently, the compensation of the factors' of production per unit of input, measured in current prices, can increase by the same rate as the productivity increase, without a necessary increase in the average price of output. In general, the nominal compensation of the factors' of production can increase faster than the increase in prices, or slower than the decrease in prices. The difference is proportional to the rate of change of productivity.

Summing-up, an increase in the compensation of labor proportional to the increasing trend of average productivity of labor has two interesting properties: (1) The increase in the labor compensation is not inflationary. (2) The increase in the compensation of labor does not necessarily change the distribution of output between labor and the other inputs.

Based on the above argument, governments may use the concept of average productivity as a guide for their incomes policy.[1] However, such an incomes policy presupposes that the share of labor in output remains constant. If it does not, then an incomes policy based on the average productivity would freeze the relative shares of the factors of production which normally change because of the changing economic conditions. Moreover, regarding this issue, interpretation of productivity indexes is crucial. Changes in

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[1]. The first major use of these properties of average labor-productivity change took place in the U.S.A. in the 1948 and 1950 collective bargaining agreements between the General Motors Corporation and the United Automobile Workers.

labor productivity may be considered as changes in the effort that workers are putting. However, such a measure of partial productivity is influenced by other factors as well, like changes in technology, in the capital/labor ratio, in the inputs of intermediate goods, in the rates of capacity utilization, and also by the interrelationships of these factors.

The necessity to have productivity officially measured is also dictated by the following two needs: (1) To measure and predict the potential GNP and the labor requirements. (2) To analyze the business cycle and design the proper monetary and fiscal policies.

The potential GNP is estimated on the basis of labor force growth, the average work hours per week, and the output per work hour in combination with some assumption about unemployment at a high level of employment. Regarding the analysis of business cycles, it is well known that the output per work hour decreases or increases at a lower rate when there is a downturn of economic activity. It has been observed that the output is reduced more than work hours during depression, because the production of any quantity of output requires a relatively bigger number of employees, especially during the first stages of a depression. In addition, some workers may be kept even without full time employment for various business reasons. During booms opposite effects are observed.

Taking into account the dissatisfactory situation of the Greek economy, as well as the pressing need for a scientifically based economic policy in Greece, it would be very useful to create a productivity data base, starting from the agricultural[1] and manufacturing sectors where the data availability is satisfactory. The purpose of this paper, which is based on our KEPE study on productivity measurement, is to present our estimates of total factor and partial productivity growth at the three-digit International Standard Industrial Classification level of the manufacturing sector of Greece for the time period 1980-1991. Our estimates constitute a data base, which appears for the first time in Greece, and which will be very useful for statistical, econometric, and policy analysis, not only within the national boundaries of Greece, but also within the European Union, of which Greece is a member. The methodological framework of our work is the growth accounting approach to productivity measurement, based on the translog production functions. The following section gives a brief but comprehensive presentation of the economic theory of productivity. The third section describes the empirical foundation of our work, while the fourth section presents and discusses the estimated total factor and partial productivity indices. Finally, the last section summarizes the results and concludes the paper.

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[1]. Zoe Georganta (1993) has estimated total factor and partial productivity indices for the agricultural sector of Greece for the time period 1974-1989.

2. The Economic Theory of Productivity

The conceptual framework for the measurement of productivity is found in the theory of production and cost. There are two approaches to productivity measurement[1]: Growth accounting and econometric fitting of production functions. Both approaches have recently been summarized by Diewert (1980, 1989) and Morrison and Diewert (1990). Diewert (1976) derived the formal relationship between growth accounting and econometric fitting of production functions and he showed that both approaches equivalent. He proved that under cost minimizing behavior, and by utilizing a translog mathematical formulation, the input-quantity or the input-price aggregate can be equivalently calculated by means of either the Tornquist index, or the translog production or cost function.

The growth accounting approach to productivity measurement starts with a production function of the following form:

$$Q = F(L,K,M;t) \tag{1}$$

where the volume of output, Q, is a function of the volume of services of the factors of production: labor (L), capital (K), intermediate inputs (M), and the level of productive efficiency which is a function of time, t.

The following assumptions are made: (1) F is logarithmically differentiable and exhibits constant returns to scale. According to Morrison (1986) the assumption of constant returns to scale is not crucial. However, Hauser and Yee (1992) argue that she is incorrect. (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,

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

If $d\log Y/dt = Y/Y$, $\partial \log Y/\partial t = P/P$, then, equation (2) can be expressed as,

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[1]. Recently, a group of researchers argue that productivity growth is an unbiased estimate only if the estimation procedure takes explicit account of the change in efficiency in the Farrell (1957) sense. See Grosskopf (1993).

[2]. Hicks neutral advance requires an unchanged ratio of marginal products when factor proportions are constant. For a recent comprehensive overview of definitions of neutral technical change, see Fare and Chambers (1991).

$P/P = Y/Y$ - an elasticity weighted aggregate input growth (3)

Equation (3) measures Total Factor Productivity (TFP) growth. 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.

If p denotes the price of inputs, and q denotes the price of output, then, equation (3) can be written as,

$$P/P = p/p - q/q \quad (4)$$

Equation (4) implies the basic accounting identity:

$$\Sigma qY = \Sigma pX \quad (5)$$

X represents aggregate input. The prices p and q correspond to the deflators used in order to transform values into real prices. Equ.(3) and (4) hold if we use the Divisia indexes, which are defined as:

$$Y/Y = \Sigma w_i \, Y_i/Y_i \qquad X/X = \Sigma v_j \, X_j/X_j \quad (6)$$

and

$$q/q = \Sigma w_i \, q_i/q_i \qquad p/p = \Sigma v_j \, p_j/p_j \quad (7)$$

The weights w_i, v_j are the relative shares of the ith output in total value of output, and the jth input in total value of input, respectively,

$$w_i = q_iY_i/\Sigma q_iY_i, \quad v_j = p_jX_j/\Sigma p_jX_j \, , \quad \Sigma w = \Sigma v = 1 \quad (8)$$

The weights w and v are arithmetic averages of the relative shares in the two periods considered.

Divisia indices are the result of the following process: We differentiate equ.(5) with respect to time and we divide both sides by the corresponding total value. The result is the following equation:

$$Y_1(dq_1/dt) + q_1(dY_1/dt) + \ldots = X_1(dp_1/dt) + p_1(dX_1/dt) + \ldots \quad (9)$$

By defining the growth rates as,

$q = dq/dt$, $Y = dY/dt$, $p = dp/dt$, $X = dX/dt$, $q/q = d\ln q/dt =$

$$= \Delta q/q = (q_t - q_{t-1})/q_{t-1}, \tag{10}$$

we get the following equation:

$$\Sigma w_i[q_i/q_i + Y_i/Y_i] = \Sigma v_j[p_j/p_j + X_j/X_j] \tag{11}$$

Consequently, the growth rate of TFP can be expressed as:

$$P/P = \Sigma w\ Y/Y - \Sigma v\ X/X \tag{12}$$

or

$$P/P = \Sigma w\ p/p - \Sigma v\ q/q \tag{13}$$

Thus, Divisia price indices are dual to Divisia quantity indices.

Changes in TFP reflect the net saving in the real cost of production achieved over time, or, in other words, increases in productive efficiency in general. The main force behind increases in TFP (assuming comparable rates in capacity utilization) is cost-reducing technological progress. But other factors affect TFP as well. Among them are economies of scale, changes in the quality of resources, and inter-industry shifts in resources.

Partial productivity indices are obtained on the basis of.
equation (3) as a difference between Y/Y and the growth rate of only one input. 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. Partial productivity indices show the savings that have been achieved over time in the use of each input per unit of output. Their changes reflect not only changes in productive efficiency, but also changes in factor substitutions that are the result of changes in relative factor prices.

According to the definitions of partial and total factor productivity, changes in partial productivity reflect movements along the production function, as the proportions of inputs change. They also reflect shifts in the production function which are due to technical change. For example, changes in the ratio of output to labor, Q/L, are influenced by changes in the factor substitution, as well as by changes in the productive efficiency, as this is measured by TFP. Thus, if total input is denoted by X, then the following equation holds for labor productivity:

$$Q/L = Q/X \bullet X/L \qquad (14)$$

On the other hand, the difference between the rates of growth of labor input and labor-capital inputs combined reflects the rate of substitution of capital for labor. Also, the concept of changes in the ratio of output to labor depends on how we define each term of this ratio. Let us assume that the labor input is measured by non-differentiated hours worked, and the weights for the quantities of products are either factor costs (value added per unit of output), or prices. Then, the change in output per hour, measured for a class of products and industries, reflects relative shifts of production among products with different ratios of costs or prices to hours in the base period, as well as productivity changes in producing each of these products. Similarly, if there are relative shifts of production to less capital intensive industries (and thus more value added relative to capital input), then the aggregate output/capital ratio increases even though the requirements of capital per unit of output remain constant in all individual industries. If production shifts to industries with less energy requirements per unit of output, the effect of this shift increases the corresponding ratio of partial productivity.

The next section discusses problems relating to the empirical measurement of Greek manufacturing output and input indices. Also, it presents the data base used in this paper.

3. Empirical Measurement of Productivity

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:

$$dP/P = dY/Y - (\sum v_j \, dX/X), \quad \sum v_j = 1 \tag{15}$$

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

$$dP/P = \{(Y_1/Y_0)/[(\sum v_j \, X_1)/(\sum v_j \, X_0)]\}^{-1} \tag{16}$$

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.

For discrete data, formula (15) can be used to measure TFP and partial productivity indices by employing the Tornqvist-Theil index[1], which is defined as follows:

$$TFP \equiv P/P = \sum w_{it}[\log Y_{it} - \log Y_{i,t-1}] - \sum v_{jt}[\log X_{jt} - \log X_{j,t-1}] \tag{17}$$

Formula (17) is the productivity growth index[2] which has been used by many authors

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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.

2. In a recent paper, Diewert (1992) proves that the Fisher ideal productivity index, Pr_F, described by the following formula (18), is superior to formula (17) from both viewpoints, the test approach to index numbers, and the economic approach to productivity indices which assumes optimizing behavior.

$$Pr_F \equiv Q_F/Q^*_F \tag{18}$$

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.

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 Bottomley (1992) in agriculture.

Regarding the primary inputs of labor 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].

Starting with the labor input, the main issues involved in the case of the Greek manufacturing sector are age-sex composition, educational attainment, and training-skill qualifications of the labor force. Due to lack of such data for the Greek manufacturing sector, our labor input is not adjusted for characteristics relating to age-sex composition, as well as educational and skill qualities of the labor force. However, such an adjustment of our labor input, if we had the data to implement it, would involve conceptual problems, 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 labor input very difficult in general.

In relation to the capital input, the problems are too well-known to necessitate a long discussion. Data on manufacturing capital stock for Greece have been estimated by Skountzos and Mattheou (1991). They distinguish four capital stock categories: buildings, other construction works, machinery, and transport equipment. This capital stock data base has been obtained by the perpetual inventory method. It extends as back as 1950 for all sectors of the Greek economy. It is officially used by the Greek government, as well as by public and private research institutions and individual analysts. However, it only covers the manufacturing sector as a whole.

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 would reflect a "pure" price change. The same problem of quality adjustment exists for the output deflators as well. This paper does not consider the degree to which output and input deflators are adjusted for quality change.[1] However, the sensitivity of the results to partial adjustment for quality change may be important in areas where technological change has been rapid, as in the case of chemicals.

Our main data source is the Annual Industrial Survey (AIS) of the National Statistical Service of Greece (ESYE) at the three-digit ISIC (International Standard Industrial

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

Classification) level. We have considered the "large scale" industry which includes manufacturing establishments with an annual average employment (aae) of 10 or more persons. The survey covers all manufacturing establishments of the country with an aae of 20 or more persons, and takes a sample of those manufacturing establishments with an aae of 10-19 persons.

The rest of our data sources are the wholesale and input price indices, both at the three-digit level, compiled by the ESYE. The wholesale prices include finished products of local industrial production for home consumption, and exported products of local industrial production. The input price indices correspond to the same three-digit industries as the wholesale price indices. They cover energy consumption, raw materials and intermediate products used in the production process. The classification of both wholesale and input price indices was adjusted to match the ISIC classification of the AIS.

The following table gives a picture of ten main economic variables of the whole manufacturing sector for the years 1980-1991.

TABLE 1.1

Main Economic Variables of Manufacturing Activity, Large Scale, Greece 1980-1991

Var.	1980	1981	1982	1983	1984	1985
F	8551	8564	8547	8533	8544	8433
	4602	*4608*	*4668*	*4760*	*4822*	*4826*
E	383532	385207	371763	361282	361486	358219
	56020	*59860*	*58905*	*58430*	*58072*	*58444*
W	109357	135493	172591	198562	248704	294794
	9849	*12709*	*17170*	*20155*	*24423*	*29272*
GVP	827651	1055667	1182550	1442693	1832106	2263286
	63134	*81006*	*99781*	*120878*	*149635*	*190100*
C	569952	743666	829955	1015381	1303151	1622606
	41969	*53663*	*66653*	*81562*	*101272*	*126132*
I	63789	85399	80576	113367	102099	115624
	3970	*4995*	*5246*	*6173*	*7759*	*5785*
S	697848	889769	1005941	1212918	1556802	1908638
	55720	*70673*	*86462*	*105187*	*129543*	*163020*
PI	100.0	127.5	146.7	175.8	212.4	251.0
PW	100.0	125.1	144.9	174.5	208.0	246.8

Var.	1986	1987	1988	1989	1990	1991	aa%
F	8352	8417	8370	8357	8370	8269	-0.0
	4825	*4844*	*4888*	*4871*	*4888*	*4890*	*0.6*
E	351185	358294	353451	358763	353451	333674	-0.0
	58565	*60216*	*45000*	*64495*	*65888*	*65113*	*1.4*
W	327061	372867	653105	546409	653104	735117	18.9
	33931	*41464*	*78686*	*63456*	*78686*	*91492*	*22.2*
GVP	2493778	2741615	4389539	3748602	4389539	4881198	17.5
	232969	*293386*	*537019*	*443130*	*537019*	*615799*	*23.0*
C	1720165	1861669	2942547	2513305	2942547	3179461	16.9
	158263	*198773*	*367649*	*302989*	*367649*	*416402*	*23.2*
I	134735	145109	177533	220509	264465	276248	14.3
	7210			*21491*	*30176*	*28794*	*19.7*
S	2078255	2853467	3714448	3203905	3714443	4159013	17.6
	203485	*258702*	*452218*	*380172*	*458032*	*536066*	*22.9*
PI	257.7	280.7	304.2	349.3	405.5	446.7	14.6
PW	285.1	308.9	340.7	386.8	446.7	519.0	16.1

Source: Annual Industrial Surveys, ESYE
Note: The numbers in italics refer to establishments with an aae of 10-19 persons
Notation
F: Number of establishments
E: Number of persons employed
W: Annual labor remun., mill. drs
GVP: Gross value of prod., mill. drs
PI: Input prices
C: Total consum., mill.drs.
I: Gross invest., mill.drs.
S: Sales, mill.drs.
aa%: annual aver. % change
PW: Wholesale prices

Table 1.1 shows that during 1980-1991 the number of establishments and employment is slightly decreasing for the Greek manufacturing sector considered as a whole. For those establishments employing 10-19 persons on average per annum (pa), employees' compensation in nominal terms has increased more than it has for the larger establishments, 22.2% average annual growth rate for the former and 18.9% pa on average for the manufacturing sector considered as a whole. Gross value of production, intermediate consumption, and sales have all increased by about 17%. Investment shows a lower record, 14.3% pa on average. In general, growth is higher for the smaller establishments. Intermediate input prices have increased by 14.6% and output prices have increased by 16.1% pa on average. It is noted that the inflation rate during 1980-1991, as measured by the consumer price index, was 19.7% pa on average.

In relation to capital stock, Skountzos and Mattheou (1991) data, as reported above, are only available for the manufacturing sector as a whole. We have obtained data at the three-digit ISIC level by the following procedure: For each year of the time period 1980-1991 we considered the sum of the fixed capital formation in buildings-structures, transport equipment and machinery-other equipment, reported in the AIS.[1] Let us denote this sum by s_{it}, where i refers to each three-digit industrial branch, and t is time, t=1980, 1981,...,1991. Then, we consider Σs_{it}, which is the sum of fixed capital formation from 1974 up to current year. In other words, for the year 1980, Σs_{it} is the sum of fixed capital formation during the time period 1974-1980, for the year 1981 Σs_{it} is the sum of fixed capital formation during the time period 1974-1981, and so on. Next, we obtained the capital stock at the three-digit ISIC level as follows: For the year 1980 we distributed the capital stock figure, estimated by Skountzos and Mattheou (1991) for the year 1980, in proportion to each three-digit participation in the sum Σs_{it} for the year 1980. For the rest of the years, 1981-1991, the capital stock at the three-digit ISIC level was obtained by increasing the capital stock of any year by the growth rate of the sum of fixed capital formation, Σs_{it}, of the current year with respect to the previous year, taking the year 1980 as initial year.

The capital stock in constant prices was obtained by utilizing the implicit price deflators of Skountzos and Mattheou (1991) and assuming that they do not differentiate among the three-digit industries. This procedure has given very small differences between the capital stock for the whole manufacturing sector in this study and the Skountzos and Mattheou (1991) figures. The panel data on capital stock are presented in Table A.4 of the Appendix.

Tables 2.1 to 2.7 present summary statistics of our data at the three-digit ISIC level. As it is apparent in the above tables, our final number of industries is 96. There are

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[1]. For the years 1978 and 1979 there is no AIS.

all together 109 three-digit industries, but due to confidentiality issues (in cases that it is only one establishment reported) the following three-digit ISIC groups have been considered as one three-digit industry: 322 + 329,335 + 338 + 339,372 + 374 + 377, 385 + 386 + 387 + 389, 392 + 393, 391 + 395 + 398. Also, industries 242 and 382 are not included in our final data set because of inconsistencies in the information reported. Table A.1 of the Appendix shows the two - and three - digit code titles of the respective industry groups and industries.

Tables 2.1 to 2.7 show that variation between the three-digit ISIC industries, as expressed by the coefficient of variation, cv, is very high for output, intermediate consumption, compensation of wage earners, and capital stock. During the whole period considered, 1980-1991, the cv is higher than one for these variables.

TABLE 2.1
Summary Statistics of Gross Value of Production (gvp)
in Thousand Drs., 1980-1991

Variable	Obs	Mean	Std. Dev.	cv	Min	Max
gvp80	96	8586979	1.28e+07	1.49	114502	1.00e+08
gvp81	96	1.10e+07	1.88e+07	1.71	148363	1.63e+08
gvp82	96	1.23e+07	2.05e+07	1.67	170290	1.76e+08
gvp83	96	1.50e+07	2.51e+07	1.67	204493	2.11e+08
gvp84	96	1.90e+07	3.41e+07	1.79	224591	2.91e+08
gvp85	96	2.35e+07	4.44e+07	1.89	283599	3.88e+08
gvp86	96	2.59e+07	3.68e+07	1.42	327291	2.67e+08
gvp87	96	2.85e+07	3.90e+07	1.37	302310	2.72e+08
gvp88	96	3.30e+07	4.31e+07	1.31	328459	2.76e+08
gvp89	96	3.90e+07	5.12e+07	1.31	332448	3.38e+08
gvp90	96	4.56e+07	6.21e+07	1.36	412881	4.38e+08
gvp91	96	5.07e+07	6.71e+07	1.32	458293	4.64e+08

TABLE 2.2

Summary Statistics of Total Consumption Expenditures (totcon)
in Thousand Drs., 1980-1991

Variable	Obs	Mean	Std. Dev.	cv	Min	Max
totcon80	96	5929464	1.11e+07	1.87	53990	9.62e+07
totcon81	96	7736887	1.70e+07	2.20	74043	1.56e+08
totcon82	96	8636303	1.84e+07	2.13	71654	1.67e+08
totcon83	96	1.06e+07	2.23e+07	2.10	94703	2.00e+08
totcon84	96	1.36e+07	3.07e+07	2.26	106770	2.78e+08
totcon85	96	1.69e+07	4.01e+07	2.37	121162	3.68e+08
totcon86	96	1.79e+07	3.04e+07	1.70	131652	2.46e+08
totcon87	96	1.95e+07	3.15e+07	1.62	165506	2.48e+08
totcon88	96	2.22e+07	3.38e+07	1.52	165506	2.47e+08
totcon89	96	2.61e+07	4.04e+07	1.55	142781	2.98e+08
totcon90	96	3.06e+07	5.11e+07	1.67	205761	4.03e+08
totcon91	96	3.31e+07	5.12e+07	1.55	223009	3.77e+08

TABLE 2.3

Summary Statistics of Salaried Employees (sempl),
Number of Persons, 1980-1991

Variable	Obs	Mean	Std. Dev.	cv	Min	Max
sempl80	96	1055.500	978.054	0.93	27	3847
sempl81	96	1090.104	1048.285	0.96	19	4572
sempl82	96	1110.313	1071.640	0.97	31	5065
sempl83	96	1126.458	1110.890	0.99	25	5087
sempl84	96	1157.146	1144.128	0.99	15	4780
sempl85	96	1172.823	1183.458	1.01	11	4938
sempl86	96	1186.167	1213.206	1.02	13	4928
sempl87	96	1264.844	1310.500	1.04	10	5154
sempl88	96	1303.719	1354.933	1.04	13	5581
sempl89	96	1334.948	1384.825	1.04	14	5727
sempl90	96	1346.125	1402.129	1.04	20	5319
empl91	96	3364.167	4509.478	1.34	103	35970

(empl91=sempl91+wempl91)

TABLE 2.4

Summary Statistics of Wage Earners (wempl),

Number of Persons, 1980-1991

Variable	Obs	Mean	Std. Dev.	cv	Min	Max
wempl80	96	2785.135	4183.718	1.50	54	30215
wempl81	96	2773.229	4263.165	1.54	46	30938
wempl82	96	2619.375	4010.155	1.53	45	29427
wempl83	96	2494.260	3827.573	1.53	59	28114
wempl84	96	2464.115	3899.843	1.58	46	29025
wempl85	96	2414.833	3898.155	1.61	42	29120
wempl86	96	2344.906	3854.523	1.64	45	29414
wempl87	96	2352.479	4146.928	1.76	42	33169
wempl88	96	2305.208	4128.343	1.79	48	33873
wempl89	96	2288.781	4147.731	1.81	35	34105
wempl90	96	2222.510	4044.484	1.82	34	34127

TABLE 2.5

Summary Statistics of Capital Stock (capst),

in Million Drs., 1980-1991

Variable	Obs	Mean	Std. Dev.	cv	Min	Max
capst80	96	6500.885	9394.243	1.45	21.604	63327.219
capst81	96	8737.483	12935.301	1.48	22.397	81573.719
capst82	96	10808.321	15673.666	1.45	23.341	91536.406
capst83	96	13585.083	20905.980	1.54	24.780	121074.109
capst84	96	15926.494	24296.901	1.53	25.858	130525.586
capst85	96	18432.606	27999.331	1.52	26.517	155411.016
capst86	96	21135.463	31109.247	1.47	54.779	165446.641
capst87	96	24614.639	35510.607	1.44	65.156	196263.234
capst88	96	28740.225	40322.921	1.40	80.954	247250.469
capst89	96	33860.341	46652.795	1.38	84.189	296074.813
capst90	96	40039.243	54084.150	1.35	107.546	335199.750
capst91	96	46606.280	60007.296	1.29	167.284	353518.969

TABLE 2.6

Summary Statistics on Input Prices (pi)

1980 = 100, 1980-1991

Variable	Obs	Mean	Std. Dev.	cv	Min	Max
pi80	96	100.000	0.000	0.00	100.000	100.000
pi81	96	121.532	8.101	0.07	91.600	146.000
pi82	96	139.409	11.552	0.08	89.500	176.200
pi83	96	166.980	13.060	0.08	133.000	208.500
pi84	96	199.743	17.538	0.09	146.600	239.300
pi85	96	238.152	22.407	0.09	151.200	282.100
pi86	96	281.299	33.264	0.12	159.500	331.215
pi87	96	304.259	34.972	0.11	182.900	362.453
pi88	96	339.512	48.185	0.14	162.800	416.800
pi89	96	386.384	65.644	0.17	209.700	630.600
pi90	96	427.834	69.311	0.16	206.700	801.800
pi91	96	474.740	83.257	0.18	223.900	884.900

TABLE 2.7

Summary Statistics of Wholesale Prices (pw)

1980 = 100, 1980-1991

Variable	Obs	Mean	Std. Dev.	cv	Min	Max
pw80	96	100.000	0.000	0.00	100.000	100.000
pw81	96	123.230	7.883	0.06	96.700	145.448
pw82	96	144.191	13.028	0.09	112.810	178.579
pw83	96	174.278	18.392	0.11	121.830	232.246
pw84	96	205.095	22.006	0.11	136.420	249.671
pw85	96	242.034	27.614	0.11	138.640	297.730
pw86	96	292.474	36.467	0.12	174.700	373.462
pw87	96	319.937	44.015	0.14	198.580	425.490
pw88	96	357.372	54.906	0.15	209.180	465.365
pw89	96	405.198	71.604	0.18	200.900	566.089
pw90	96	459.946	85.642	0.19	266.580	742.088
pw91	96	533.298	108.353	0.20	299.990	866.625

The Two- and Three-Digit ISIC Productivity Indices
Capacity Utilization

For the variables of this paper, formula (17) becomes,

$$TFP/TFP = Y/Y - v_L(L/L) - v_M(M/M) - v_K(K/K) \quad (19)$$

If subscripts 2 and 3 denote two-digit and three-digit ISIC respectively, we have:

$$Y_{3it}/Y_{3it} = (\log Y_{it} - \log Y_{i,t-1}) \quad (20)$$

$$Y_{2rt}/Y_{2rt} = w_{jit}(\log Y_{it} - \log Y_{j,t-1}), \quad w_{jit} = [(gvp_{it}/\sum_{j=1}^{n} gvp_{jit}) + (gvp_{i,t-1}/\sum_{j=1}^{n} gvp_{ji,t-1})]/2 \quad (21)$$

$$L_{3it}/L_{3it} = \{[(s_{it}/\sum (s+w)_{it}) + (s_{i,t-1}/\sum (s+w)_{i,t-1})]/2\}[\log(se)_{it} - \log(se)_{i,t-1}] +$$
$$+ \{[(w_{it}/\sum (s+w)_{it}) + (w_{i,t-1}/\sum (s+w)_{i,t-1})]/2\}[\log(we)_{it} - \log(we)_{i,t-1}] \quad (22)$$

$$L_{2rt}/L_{2rt} = l_{jit}(L_{3it}/L_{3it}), \quad l_{jit} = \{[(se+we)_{it}/\sum_{j=1}^{n} (se+we)_{jit}] +$$
$$+ [(se+we)_{i,t-1}/\sum_{j=1}^{n} (se+we)_{ji,t-1}]\}/2 \quad (23)$$

$$M_{3it}/M_{3it} = [\log(vtotcon)_{it} - \log(vtotcon)_{i,t-1}] \quad (24)$$

$$M_{2rt}/M_{2rt} = m_{jit}[\log(vtotcon)_{it} - \log(vtotcon)_{i,t-1}],$$
$$m_{jit} = [(totcon_{it}/\sum_{j=1}^{n} totcon_{jit}) + (totcon_{i,t-1}/\sum_{j=1}^{n} totcon_{ji,t-1})]/2 \quad (25)$$

$$K_{3it}/K_{3it} = [\log(vcapst)_{it} - \log(vcapst)_{i,t-1}] \quad (26)$$

$$K_{2rt}/K_{2rt} = k_{jit}(K_{3it}/K_{3it}),$$
$$k_{jit} = [(capst_{it}/\sum_{j=1}^{n} capst_{jit}) + (capst_{i,t-1}/\sum_{j=1}^{n} capst_{ji,t-1})]/2 \quad (27)$$

where,

i : 201,...,399, three-digit industries

j : 1,...,n, n = number of three-digit industries included within each two-digit industry group

r : 20,21,...,39, two-digit industry groups

t : 1980,...,1991

s : compensation of salaried employees

t : 1980,...,1991

s : compensation of salaried employees

w : compensation of wage earners

se: Number of salaried employees

we: Number of wage earners

totcon : total intermediate consumption

vtotcon: volume of total intermediate consumption

capst : capital stock

vcapst : volume of capital stock

Any partial productivity index is estimated on the basis of equation (19) as a difference, Y/Y - X/X, where X is any of the three inputs, labor, intermediate consumption, and capital. It is easily observed that the above Divisia-Tornquist indices of output, input, TFP and partial productivity 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 three-digit ISIC level capital stock series, which have been obtained as described above, 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 assume that capital flows are proportional to stocks, so that the one is a perfect surrogate for the other. In such a case, capital utilization (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 manufacturing sector.

Another approach to the capacity utilization problem, which has been 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,

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

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):

$$Z = (qY - pX^{\neq K})/KS \tag{28}$$

where q, p are prices for output and inputs (except for capital) respectively, K is capital input, and KS 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. For this paper, Z is non-parametrically estimated and the capital stock is transformed into a capital input argument by adjusting the corresponding factor shares. According to this approach, the weights v in equation (19) are defined as follows: By assuming constant returns to scale, we have,

$$GVP = Z^K KS + P^L L + P^M M \;\; => \;\; Z^K = (GVP - P^L L - P^M M)/KS \tag{29}$$

$$\text{Then, } v_L = P^L L/GVP,\; v_M = P^M M/GVP,\; v_K = Z^K KS/GVP \tag{30}$$

Thus, Z^K is Berndt and Fuss's (1986) quasi-rent, or shadow rental price of capital.

Consequently, our capital input is adjusted for over- or under- capital utilization. Within this framework, it is easily proved that capital utilization is given by the formula: $cu = Z^K/P^K$, where P^K is the market rental price of capital. If $cu > 1$, unit cost is rising because of decreasing returns to the increasingly utilized fixed capital stock. If $cu < 1$, unit cost is falling, and if $cu = 1$, then the firm's output equals its capacity output and average cost is at a minimum.

By utilizing the methodology developed thus far, we have estimated TFP and partial productivity indices for the manufacturing sector of Greece. The estimates are presented in the following section.

4. The Estimates

The estimated TFP indices at the three-digit, as well as the two-digit ISIC level are presented in tables A.2 and A.3 of the Appendix, respectively. The next Tables 3.1 to 3.7 present summary statistics of the estimated TFP, output, input, partial productivity indices, capital utilization ratios, and the shares of labor, intermediate consumption, and capital, all at the three-digit ISIC level.[1]

TABLE 3.1
Summary Statistics of TFP Chain-Linked Indices,
at the Three-Digit ISIC Level

Variable	Obs	Mean	Std. Dev.	Min	Max
tfp81	96	96.31	10.78	38.60	135.83
tfp82	96	94.46	12.07	41.01	123.40
tfp83	96	94.56	14.56	39.53	132.10
tfp84	96	96.15	14.84	40.44	145.15
tfp85	96	98.89	16.45	42.12	161.05
tfp86	96	99.51	20.53	35.71	182.27
tfp87	96	97.36	19.65	38.10	166.26
tfp88	96	97.99	19.69	40.09	168.60
tfp89	96	100.08	22.29	26.51	205.39
tfp90	96	100.40	22.25	26.17	174.28
tfp91	96	96.14	22.31	39.07	166.24

[1]. All estimated figures at the three- and two-digit ISIC level are available on demand from the authors. They are not presented here because they would enormously increase the size of the paper. However, all our estimates will be presented in our KEPE study, "Productivity Measurement in the Manufacturing Sector of Greece, 1974-1991".

TABLE 3.2

Summary Statistics of Output Chain-Linked Indices,
at the Three-Digit ISIC Level

Variable	Obs	Mean	Std. Dev.	Min	Max
y81	96	102.09	16.34	72.07	168.93
y82	96	101.07	20.74	57.15	187.08
y83	96	100.70	24.09	53.32	182.87
y84	96	104.94	31.46	48.04	264.34
y85	96	109.69	39.20	49.22	312.73
y86	96	108.60	36.49	38.95	241.42
y87	96	116.34	52.60	30.83	333.71
y88	96	122.03	53.78	26.03	339.96
y89	96	125.65	55.08	27.18	350.25
y90	96	128.99	62.55	32.83	459.39
y91	96	127.45	68.10	24.94	437.39

TABLE 3.3

Summary Statistics of Input Chain-Linked Indices,
at the Three-Digit ISIC Level

Variable	Obs	Mean	Std. Dev.	Min	Max
in81	96	106.80	18.49	77.63	232.48
in82	96	107.56	20.49	71.84	208.44
in83	96	107.10	22.80	67.94	202.47
in84	96	109.48	28.07	56.49	221.97
in85	96	111.20	32.64	51.95	251.49
in86	96	110.94	36.75	46.95	304.13
in87	96	123.69	87.11	37.21	875.84
in88	96	128.11	84.62	35.56	847.97
in89	96	127.01	52.52	31.28	348.91
in90	96	128.93	52.98	38.16	378.49
in91	96	131.05	56.39	32.32	374.87

TABLES 3.4

Summary Statistics of Labor Productivity Chain-Linked Indices,
at the Three-Digit ISIC

Variable	Obs	Mean	Std. Dev.	Min	Max
prodl81	96	101.48	21.89	13.95	247.83
prodl82	96	102.09	22.44	16.03	211.97
prodl83	96	105.78	27.93	15.44	219.44
prodl84	96	110.35	29.68	16.06	259.00
prodl85	96	116.38	34.58	16.67	297.11
prodl86	96	117.66	38.40	14.34	338.51
prodl87	96	120.79	44.86	29.93	368.59
prodl88	96	124.71	43.54	28.37	330.79
prodl89	96	130.88	50.14	7.81	418.09
prodl90	96	137.01	60.59	7.74	517.81
prodl91	96	140.45	57.99	12.39	421.75

TABLE 3.5

Summary Statistics of Intermediate Consumption Productivity Chain-Linked Indices,
Three-Digit ISIC

Variable	Obs	Mean	Std. Dev.	Min	Max
prodm81	96	97.84	8.24	71.55	122.86
prodm82	96	96.87	10.97	61.19	123.64
prodm83	96	95.33	12.52	63.28	141.14
prodm84	96	96.95	14.68	67.17	152.07
prodm85	96	98.21	17.53	62.98	172.81
prodm86	96	100.68	50.35	62.68	559.92
prodm87	96	94.19	20.93	33.99	169.03
prodm88	96	95.13	18.97	38.91	164.41
prodm89	96	97.16	21.98	55.59	186.16
prodm90	96	96.14	21.44	60.81	187.48
prodm91	96	94.45	21.55	58.69	179.95

TABLES 3.6

Summary Statistics of Capital Productivity Chain-Linked Indices,
Three-Digit ISIC Level

Variable	Obs	Mean	Std. Dev.	Min	Max
prodk81	96	91.12	19.57	50.13	156.45
prodk82	96	86.10	23.26	40.37	170.47
prodk83	96	88.10	27.30	40.26	176.56
prodk84	96	89.57	28.25	39.73	217.48
prodk85	96	96.83	34.94	43.60	286.41
prodk86	96	104.08	44.16	38.69	335.58
prodk87	96	102.93	51.19	41.03	287.37
prodk88	96	100.03	50.89	29.12	321.54
prodk89	96	101.33	51.52	31.55	415.40
prodk90	96	102.04	49.11	26.59	315.48
prodk91	96	86.02	47.23	19.44	319.37

TABLE 3.7

Summary Statistics of Capital Utilization,
at the Three-Digit ISIC Level

Variable	Obs	Mean	Std. Dev.	Min	Max
cu80	96	0.372	0.429	-0.099	3.792
cu81	96	0.340	0.378	-0.014	3.425
cu82	96	0.313	0.435	0.017	3.741
cu83	96	0.317	0.469	0.037	4.276
cu84	96	0.316	0.478	0.020	4.386
cu85	96	0.335	0.480	-0.003	4.582
cu86	96	0.365	0.453	0.074	4.083
cu87	96	0.374	0.728	-0.136	6.935
cu88	96	0.370	0.799	0.061	7.840
cu89	96	0.258	0.292	-1.747	1.755
cu90	96	0.255	0.341	-2.309	1.605
cu91	96	0.310	0.369	0.062	3.199

TABLE 3.8

Summary Statistics of the Shares of Labor (vl), Intermediate Consumption (vm), Capital (vk), at the Three-Digit ISIC Level

Variable	Obs	Mean	Std. Dev.	Min	Max
vl80	96	0.188	0.096	0.015	0.621
vl81	96	0.184	0.093	0.012	0.579
vl82	96	0.204	0.100	0.015	0.695
vl83	96	0.194	0.095	0.015	0.641
vl84	96	0.197	0.095	0.014	0.531
vl85	96	0.189	0.092	0.012	0.541
vl86	96	0.175	0.088	0.019	0.513
vl87	96	0.173	0.081	0.023	0.499
vl88	96	0.178	0.079	0.026	0.487
vl89	96	0.192	0.115	0.030	0.957
vl90	96	0.197	0.124	0.031	1.050
vl91	96	0.190	0.088	0.032	0.563
vm80	96	0.607	0.126	0.242	0.962
vm81	96	0.612	0.120	0.265	0.957
vm82	96	0.608	0.120	0.279	0.949
vm83	96	0.614	0.117	0.276	0.948
vm84	96	0.617	0.124	0.235	0.955
vm85	96	0.618	0.124	0.226	0.948
vm86	96	0.611	0.129	0.113	0.921
vm87	96	0.624	0.104	0.343	0.912
vm88	96	0.613	0.105	0.279	0.895
vm89	96	0.607	0.117	0.280	0.882
vm90	96	0.600	0.114	0.263	0.920
vm91	96	0.586	0.113	0.238	0.844
vk80	96	0.206	0.067	-0.062	0.379
vk81	96	0.205	0.064	-0.039	0.400
vk82	96	0.188	0.058	0.026	0.402
vk83	96	0.191	0.055	0.037	0.364
vk84	96	0.186	0.065	0.014	0.368
vk85	96	0.193	0.065	-0.004	0.448
vk86	96	0.214	0.080	0.060	0.743
vk87	96	0.203	0.073	-0.146	0.394
vk88	96	0.209	0.062	0.070	0.407
vk89	96	0.201	0.077	-0.242	0.398
vk90	96	0.203	0.084	-0.338	0.368
vk91	96	0.223	0.062	0.048	0.389

On the basis of Tables A.2 and A.3 we can distinguish the following categories of TFP behavior:

(1) A growth trend during the entire period. For example, the following industries belong to this category: 204, 213, 221 and 222, 259, 332, 337, 361, 368, 383. We call these industries "Dynamic".

(2) A growth trend until 1985 or 1986, followed by a decline thereafter. For example, the following industries belong to this category: 207, 236, 237, 244, 367, 381. We call these industries "EC-Undesirable". We note that Greece officially joint the EC (European Community) in 1981, but the time period 1981-1985 was a transition period.

(3) A growth trend from 1986 or 1987. Examples of this group behavior include the following industries: 209, 393, 394, 398. We call these industries "EC-Favored".

(4) Finally, a declining time path includes industries like the 205, 272, 301, 378. We call these industries "Dying".

Another observation based on Table A.2 is that since 1986 there is a declining number of industries which shows an increase in TFP with respect to the previous year. The actual number of these industries during 1980-1991 is shown in the following table:

TABLE 4.1
Number of Three-Digit Industries Showing an Increase in
TFP Indices, 1980-1991

1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
30	39	42	58	62	51	44	50	59	49	21
	11	5	4	3	2	0				

The second line of Table 4.1 shows that only 11 out of the 30 industries showing an increase in 1981 also show an increase in 1982; this number becomes 5 for 1983, and in 1987 there are no common industries which show an increase during 1980-1987 included.

Tables 3.1 to 3.8 show that for some industries, although output has grown satisfactorily, the intermediate inputs used have grown even "more satisfactorily", being responsible for a stagnant or falling TFP growth rate. Regarding partial productivity indices, shown in Tables 3.4, 3.5, and 3.6, we observe that labor productivity has increased, most probably because of the reduction or non-increase in the number of persons employed. Intermediate-inputs productivity is rather falling, while capital productivity is slightly

Intermediate-inputs productivity is rather falling, while capital productivity is slightly increasing, with the exception of 1991 that records a -15.7% decrease in relation to 1990.

Capital utilization ratios are below unity for all two-digit manufacturing industries, meaning decreasing unit costs. Factor shares in Table 3.8 show that intermediate consumption absorbs most of the sector's income, more than 60% on average. Capital follows with a share slightly above 20%. Labor scores last with a share of slightly below 20%. The minus signs in Tables 3.7 (capital utilization) and 3.8 (share of capital) are explained by the fact that some three-digit ISIC industries, in particular years, generated a gross value of output well below their expenditures for intermediate consumption and employees' compensation summed together. The result was a negative outcome in equation (29).

5. Conclusions

This paper has used the traditional growth accounting statistical framework in order to compute partial and total factor productivity indices for the manufacturing sector of Greece during the time period 1980-1991. It has covered a gap existing in the coverage of the official economic statistics for manufactures in Greece. This data base is particularly useful for a scientifically based policy analysis regarding the Greek manufacturing sector. One of the immediate conclusions that come out of this data is that a number of industries, the "dynamic", may be considered under a set of policy measures which differentiates from that set of policy measures directed towards the "dying" or "EC-undesirable" industries. Also, the development of "EC-favored" industries could be analysed so that we could draw some lessons or conclusions for other industries.

APPENDIX

Titles of ISIC Codes, TFP at the Three-Digit and Two-Digit ISIC

TABLE A.1

Titles of ISIC Two - and Three - Digit Codes

20 Food and Kindred Products

201 Meat Products

202 Dairy Products

203 Canned, Frozen, and Preserved Fruits, Vegetables, and Food Specialties

204 Fats and Oils

205 Grain Mill Products

206 Bakery Products

207 Sugar

208 Chocolate and Confectionery Products

209 Miscellaneous Food Preparations and Kindred Products

21 Beverages

211 Alcoholic Drinks and Alcohol

212 Wines

213 Beer

214 Non-alcoholic Drinks, Mineral Water

22 Tobacco Manufactures

221 Tobacco

222 Cigarettes and Cigars

23 Textile Mill Products

231 Manmade and Natural Wool Fiber and Fabrics

232 Manmade and Natural Cotton Fiber and Fabrics

233 Manmade and Natural Silk Fiber and Fabrics, and Nylon Fiber

234 Manmade Fiber and Fabrics, except Nylon

235 Jute, Linen and Canvas and Related Products

236 Knitting Mills

237 Coloring, Printing and Finishing Plants

238 Threads and Yarns

239 Miscellaneous Textiles

24 Apparel and Other Textile Products

241 Shoe Making

242 Shoe Repair

243 Apparel

244 Clothing and Other Textile Goods

TABLE A.1 (Continued)

25 Lumber, Wood and Cork Products
251 Sawmills and Planing Mills
252 Construction Wood Works
253 Wood Containers and Small Wood Goods
259 Cork and Cork Products
26 Furniture and Fixtures
261 Wood Household Furniture
262 Metal Household Furniture
27 Paper and Allied Products
271 Pulp and Paper Mills
272 Paper Products
28 Printing and Publishing
281 Printing and Editing of Newspapers, Journals, Books and Pamphlets
282 Miscellaneous Printing Works
29 Leather, Leather Products and Furs
291 Leather Plants
292 Fur and Fur Products, Except Apparel
293 Manmade and Natural Leather Products, Except Apparel and Shoes
30 Rubber and Miscellaneous Plastics Products
301 Rubber Plants
302 Miscellaneous Plastics Products
31 Chemicals and Allied Products
311 Acids, Salts and Fertilizers
312 Plastics Materials and Resins, Manmade Fibers
313 Other Primary Chemical Plants
314 Paints, Printing Inks and Allied Products
315 Pharmaceuticals
316 Cosmetics, Perfumes and Toilet Preparations
317 Soaps and Detergents
319 Miscellaneous Chemicals Products
32 Petroleum and Coal Products
321 Petroleum Refining
322 Coal Products and Lignite
329 Petroleum Byproducts
33 Non-metallic Minerals and Allied Products

TABLE A.1 (Continued)

331 Minerals and Earths for Structures
332 Glass and Glass Products
333 Clay, Porcelain and Related Products
334 Cements
335 Lime, Gypsum and Related Products
336 Cement Products
337 Marble and Marble Products
338 Asbestos Products
339 Miscellaneous Non-Metallic Minerals Products

34 Primary Metal Industries

341 Iron
342 Other Metals

35 Fabricated Metal Products, except for Machinery and Transport Equip.

351 Iron Tubes
352 Chains, Wire Springs, Nails and Related Products
353 Metal Structures
354 Metal Tools
355 Household Metal Appliances
356 Cast Iron Products
357 Copper and Lead Products
358 Aluminum Products
359 Miscellaneous Metal Products, except Machinery and Transport Equip.

36 Machinery Except Electrical

361 Internal Combustion Engines
362 Air Conditioning Machines
363 Agricultural Machinery
364 Machinery for Roads, Quarries and Structures
365 Machinery for the Food, Beverages and Tobacco Industries
366 Machinery for the Textile, Wood and Metal Industries
367 Pumps, Blowers and Industrial Spraying Machinery
368 Office Equipment and Balances
369 Machinery and Repair non specifically Named

37 Electric and Electronic Equipment

371 Electrical Machinery
372 Transformers and Dry Electrical Elements

TABLE A.1 (Continued)

373 Electrical Coil Windings and Electrical Wiring
374 Lamps and Lighting Fixtures
375 Other Electrical Materials
376 Telecommunications, Materials and Hearing Devices
377 Electrical Scientific Instruments
378 Other Electrical Apparatuses
379 Repair of Electrical Equipment

38 Transportation Equipment

381 Boats and Repair
382 Rail Materials
383 Cars
384 Car Repair
385 Motorcycles and Bikes
386 Repair of Motorcycles and Bikes
387 Repair of Airplanes
389 Other Transportation Equipment

39 Miscellaneous Manufacturing Establishments

391 Medical Instruments, Measuring and Control Instruments
392 Photographic and Optical Products
393 Repair of Photographic and Optical Products
394 Watches and Cosmetics
395 Repair of Watches
396 Musical Instruments
397 Toys and Athletics Products
398 Manmade Teeth
399 Miscellaneous Plants

TABLE A.2

Chained TFP Indices at the Three-Digit ISIC Level

	code	tfpl80	tfpl81	tfpl82	tfpl83	tfpl84	tfpl85	tfpl86	tfpl87	tfpl88	tfpl89	tfpl90	tfpl91
1.	201	100.00	97.47	99.66	103.05	106.88	107.18	102.39	108.65	107.77	109.81	107.11	100.90
2.	202	100.00	96.77	87.82	85.14	90.61	89.93	86.34	87.04	88.16	84.74	79.04	82.87
3.	203	100.00	93.74	93.15	96.63	93.94	90.84	83.93	82.54	81.16	81.36	85.12	87.53
4.	204	100.00	98.28	96.82	107.67	106.88	104.29	112.38	114.25	117.46	116.23	117.83	121.41
5.	205	100.00	95.74	94.05	90.60	92.34	86.70	90.00	86.54	85.24	89.31	88.14	83.15
6.	206	100.00	95.71	97.13	100.75	102.12	97.43	93.75	88.62	90.50	91.47	91.57	90.24
7.	207	100.00	101.77	104.53	100.34	111.52	118.93	93.67	97.57	88.37	88.54	99.31	88.80
8.	208	100.00	97.87	95.98	91.34	93.23	94.47	86.92	92.45	88.61	85.04	79.98	71.86
9.	209	100.00	100.80	102.00	98.92	95.99	93.77	84.28	86.03	90.87	93.50	96.25	95.32
10.	211	100.00	77.47	69.97	68.98	75.55	75.93	79.92	80.90	82.46	74.70	74.29	72.32
11.	212	100.00	96.88	97.47	92.26	84.85	87.48	84.44	80.13	80.01	73.07	66.98	57.91
12.	213	100.00	102.73	88.35	80.66	96.10	96.83	105.29	117.84	117.36	113.99	121.50	115.26
13.	214	100.00	91.73	79.72	80.47	84.62	91.01	92.29	87.30	99.09	97.56	95.58	92.09
14.	221	100.00	96.94	100.50	104.42	112.88	110.08	113.60	106.33	113.64	118.25	133.63	137.87
15.	222	100.00	92.91	93.03	99.75	102.30	106.82	120.67	115.77	127.32	135.48	155.46	163.82
16.	231	100.00	95.97	86.13	80.33	89.10	93.47	93.93	89.16	91.00	82.77	75.79	73.85
17.	232	100.00	98.16	94.57	97.11	101.83	97.27	96.86	92.81	91.39	93.84	90.72	92.62
18.	233	100.00	95.98	100.01	98.36	106.87	107.58	120.82	114.49	108.45	110.32	112.80	108.73
19.	234	100.00	82.16	81.14	76.33	82.86	85.18	89.09	80.50	75.16	71.29	72.73	77.16
20.	235	100.00	94.87	84.78	90.31	104.90	112.81	103.22	91.88	94.39	108.22	109.38	118.13
21.	236	100.00	93.75	91.20	93.43	93.73	99.60	92.46	85.76	79.88	78.45	75.60	71.46
22.	237	100.00	102.64	101.59	103.14	99.89	106.18	113.75	131.85	122.11	101.16	100.95	97.09
23.	238	100.00	91.76	95.41	88.32	87.29	80.87	80.66	82.17	74.63	75.62	73.47	73.08
24.	239	100.00	93.66	100.10	93.81	84.22	80.82	90.35	84.50	76.25	76.94	71.17	74.33
25.	241	100.00	102.92	99.60	98.61	105.84	104.36	103.89	91.39	91.36	92.04	89.09	81.37
26.	243	100.00	93.62	92.64	96.36	100.29	103.11	96.09	92.94	88.28	88.22	88.62	87.52
27.	244	100.00	135.83	119.69	126.50	145.15	155.62	152.49	151.49	151.49	128.74	124.02	117.00
28.	251	100.00	92.92	90.34	95.90	105.85	104.59	105.09	102.10	100.04	114.19	120.47	112.19
29.	252	100.00	95.37	97.35	87.31	80.10	85.01	79.45	89.15	95.24	100.11	87.51	80.64
30.	253	100.00	77.94	64.66	63.43	66.41	91.04	182.27	74.71	71.45	80.47	90.38	89.65
31.	259	100.00	97.81	105.34	95.83	87.73	93.31	94.58	110.68	111.44	123.29	129.34	132.07
32.	261	100.00	95.13	93.89	98.23	103.39	106.17	111.16	108.24	107.02	111.09	109.73	102.76
33.	262	100.00	90.24	88.00	88.25	90.34	92.59	92.50	96.91	97.13	104.16	101.57	94.97
34.	271	100.00	92.04	104.54	110.71	95.85	94.02	123.47	118.65	112.47	104.77	110.94	113.71
35.	272	100.00	93.46	75.15	69.61	74.50	81.39	83.75	77.92	74.11	71.50	62.79	57.65
36.	281	100.00	88.94	81.36	71.49	75.41	68.09	64.77	66.08	71.25	78.79	81.75	70.93
37.	282	100.00	100.96	94.65	89.98	88.56	85.02	77.19	78.46	80.02	75.92	62.73	62.25
38.	291	100.00	93.35	82.10	91.46	99.16	94.10	106.83	114.57	116.80	120.88	118.77	96.57
39.	292	100.00	88.75	106.41	106.27	101.35	103.80	111.16	120.43	104.36	96.34	113.51	96.82
40.	293	100.00	98.06	107.81	106.30	104.10	110.83	100.32	102.95	106.99	101.55	105.26	96.55
41.	301	100.00	92.71	84.94	90.87	94.58	93.63	92.77	86.32	85.69	76.87	68.03	60.52
42.	302	100.00	97.56	94.79	94.61	95.05	98.08	104.55	99.41	97.29	97.70	96.97	86.38
43.	311	100.00	100.69	100.93	103.41	90.69	87.20	98.68	118.18	98.67	81.65	95.28	93.83
44.	312	100.00	112.54	123.40	126.74	137.21	161.05	177.35	151.70	158.21	205.39	174.28	145.67
45.	313	100.00	104.80	96.62	96.45	107.77	107.96	98.88	104.71	101.00	104.69	110.50	70.31
46.	314	100.00	100.89	91.71	85.88	84.98	90.32	82.47	87.66	82.99	83.02	84.49	84.38
47.	315	100.00	97.41	99.40	96.00	92.58	93.61	103.72	115.63	120.67	125.63	127.94	117.45
48.	316	100.00	103.88	98.55	87.27	94.92	98.94	92.18	92.56	94.41	95.06	87.67	81.02
49.	317	100.00	103.60	97.87	97.23	103.05	106.58	110.43	99.61	102.95	103.30	95.15	92.61
50.	319	100.00	94.59	75.15	77.52	76.92	81.68	84.58	76.46	80.85	79.46	82.45	84.54
51.	321	100.00	111.76	119.15	114.22	113.99	114.51	68.74	76.25	71.84	85.36	95.28	86.84
52.	329	100.00	98.98	100.42	98.87	100.20	98.12	72.40	82.67	76.68	90.05	89.63	82.37
53.	331	100.00	85.49	92.64	94.90	79.67	89.91	91.67	82.52	96.44	96.63	88.54	81.39
54.	332	100.00	87.58	83.54	80.60	86.59	86.50	98.28	104.21	96.02	102.43	106.09	104.87
55.	333	100.00	87.38	80.11	89.10	93.02	94.11	93.99	84.37	79.83	84.59	83.71	72.19
56.	334	100.00	85.61	81.94	75.55	81.64	78.90	87.67	98.08	98.08	92.08	97.23	90.74
57.	336	100.00	87.93	82.52	75.36	78.98	77.91	81.37	83.53	81.68	80.19	81.93	76.45
58.	337	100.00	102.94	109.75	113.51	125.29	124.83	140.49	166.26	168.60	163.87	170.21	166.24
59.	339	100.00	83.15	86.65	82.56	86.07	93.95	99.64	105.53	94.86	91.46	88.82	86.73
60.	341	100.00	92.54	87.53	77.57	80.64	83.35	98.18	98.38	97.33	101.78	105.77	101.56
61.	342	100.00	91.85	70.72	90.59	86.35	87.21	92.45	99.19	93.46	84.75	101.51	97.42
62.	351	100.00	104.92	110.15	104.97	105.52	98.45	101.40	105.32	109.19	112.61	110.87	102.30
63.	352	100.00	103.58	93.01	92.15	97.88	103.59	101.30	107.10	115.01	118.53	115.23	108.22
64.	353	100.00	100.23	91.68	91.87	90.42	92.92	96.56	92.94	95.83	95.23	74.06	62.25
65.	354	100.00	93.09	90.46	101.72	94.68	93.62	82.97	98.89	105.30	101.39	101.04	89.77
66.	355	100.00	99.40	102.41	108.83	104.91	113.71	115.22	101.43	103.00	100.39	105.03	92.71
67.	356	100.00	84.46	89.42	77.93	84.29	85.67	82.09	78.09	107.78	130.92	122.90	94.28
68.	357	100.00	112.03	89.50	97.70	89.47	95.70	115.51	123.69	92.81	90.09	109.74	108.05
69.	358	100.00	95.27	93.75	104.38	85.03	86.88	108.87	92.98	96.59	105.03	108.59	98.03
70.	359	100.00	94.12	98.90	104.87	95.80	96.03	90.40	90.01	92.81	94.12	100.58	94.98
71.	361	100.00	108.31	111.41	104.84	96.59	114.48	125.49	118.25	130.20	123.73	127.84	125.57
72.	362	100.00	102.23	101.07	90.32	103.64	119.38	110.13	87.70	81.22	92.92	88.10	83.43
73.	363	100.00	95.07	92.73	90.99	99.20	111.77	106.23	115.22	119.12	119.02	111.25	105.62
74.	364	100.00	113.40	113.19	108.67	123.68	126.63	133.07	133.84	139.02	146.17	135.00	115.71
75.	365	100.00	105.49	99.08	119.33	99.77	94.57	101.36	104.76	93.23	92.48	93.45	92.37
76.	366	100.00	110.23	107.55	132.10	96.87	114.86	105.22	82.84	73.18	86.91	92.79	79.09
77.	367	100.00	101.57	103.78	107.02	107.97	131.44	107.41	98.04	86.89	100.05	101.49	91.96
78.	368	100.00	73.33	106.69	119.65	115.25	112.19	131.50	125.99	125.82	129.83	131.67	152.67
79.	369	100.00	95.90	102.86	96.79	90.89	99.90	104.98	124.23	111.57	116.36	112.88	101.96
80.	371	100.00	97.42	106.29	123.71	119.89	117.50	105.78	101.22	116.80	143.92	132.73	130.34
81.	373	100.00	106.51	101.11	104.03	113.78	108.01	108.86	113.73	114.10	106.84	107.04	101.76
82.	375	100.00	92.04	95.38	95.99	100.32	101.78	102.95	101.85	102.44	96.17	97.75	88.81
83.	376	100.00	91.56	94.59	85.55	84.69	83.80	76.99	74.93	82.28	97.75	100.87	122.98
84.	377	100.00	103.67	105.54	109.21	109.28	111.70	117.77	103.78	109.71	113.43	111.16	103.72
85.	378	100.00	93.93	85.84	81.62	80.92	86.58	86.39	79.83	81.55	83.61	81.50	78.39
86.	379	100.00	38.60	41.01	39.53	40.44	42.12	35.71	38.10	40.09	26.51	26.17	39.07
87.	381	100.00	123.63	111.57	125.75	125.76	126.79	68.54	51.26	69.11	75.36	74.23	80.30
88.	383	100.00	99.42	87.29	77.51	74.34	87.81	89.94	84.92	96.38	102.74	113.47	127.41
89.	384	100.00	92.35	86.51	78.81	98.34	109.96	96.05	88.06	102.66	113.54	112.51	98.05
90.	389	100.00	83.35	76.94	82.24	110.53	116.40	106.51	100.31	117.47	124.15	113.46	110.24
91.	393	100.00	87.57	94.14	91.56	88.10	94.69	83.50	88.47	87.29	93.69	102.21	118.25
92.	394	100.00	109.06	102.73	94.58	91.33	88.96	102.97	104.29	102.84	109.15	121.38	116.68
93.	396	100.00	94.11	92.50	91.97	89.34	89.29	92.17	85.62	89.43	98.15	98.96	103.19
94.	397	100.00	101.81	102.44	97.48	119.09	124.35	120.61	108.50	97.52	98.87	94.63	101.27
95.	398	100.00	92.72	101.60	93.93	102.31	92.32	102.55	83.45	117.76	117.44	122.08	122.03
96.	399	100.00	98.10	88.18	82.99	85.03	82.96	69.62	62.25	72.89	81.17	83.76	83.98

Note: 329=322+329, 339=335+338+339, 377=372+374+377, 389=385+386+387+389, 393=392+393, 398=391+395+398

TABLE A.3

TFP Chain-Linked Indices at the Two-Digit ISIC Level

	twodig	tfp80	tfp81	tfp82	tfp83	tfp84
1.	20	100.00	96.92	94.80	94.49	94.85
2.	21	100.00	92.32	84.59	79.27	80.51
3.	22	100.00	95.11	94.03	98.02	103.75
4.	23	100.00	96.57	93.94	93.14	95.10
5.	24	100.00	97.74	95.71	96.17	100.14
6.	25	100.00	92.27	87.34	87.42	91.92
7.	26	100.00	93.86	90.02	90.75	94.22
8.	27	100.00	96.20	94.17	93.62	92.06
9.	28	100.00	94.62	88.46	81.19	78.42
10.	29	100.00	92.43	88.33	91.76	97.84
11.	30	100.00	96.46	92.76	91.56	92.83
12.	31	100.00	102.11	101.08	98.75	97.52
13.	32	100.00	111.39	121.39	122.64	120.03
14.	33	100.00	86.54	79.63	76.49	75.55
15.	34	100.00	91.79	82.30	79.19	81.71
16.	35	100.00	99.06	97.76	98.53	98.05
17.	36	100.00	100.32	101.77	102.48	101.09
18.	37	100.00	97.29	95.08	93.82	94.22
19.	38	100.00	105.11	102.36	97.79	101.38
20.	39	100.00	97.98	96.48	93.81	95.94

	twodig	tfp85	tfp86	tfp87	tfp88	tfp89	tfp90	tfp91
1.	20	93.84	90.09	87.72	88.01	88.20	88.60	88.77
2.	21	84.17	86.27	87.95	90.66	91.20	88.86	85.57
3.	22	106.77	110.28	111.32	111.62	119.05	130.06	140.98
4.	23	96.73	96.86	95.39	91.88	89.71	87.97	86.48
5.	24	103.77	102.01	96.79	92.61	90.48	89.81	88.32
6.	25	96.23	98.50	95.42	91.16	96.37	103.42	101.23
7.	26	97.38	100.16	101.35	100.57	102.62	104.15	99.85
8.	27	92.17	101.36	106.43	100.92	95.60	90.76	87.42
9.	28	76.38	71.08	69.22	71.62	75.21	74.64	69.04
10.	29	98.77	101.35	107.81	108.89	107.16	109.03	102.83
11.	30	94.50	97.76	97.24	93.69	91.87	89.60	83.30
12.	31	97.46	101.01	106.73	108.58	107.23	108.26	105.82
13.	32	120.18	93.73	76.90	78.45	83.02	95.46	95.88
14.	33	76.88	80.04	85.58	87.63	86.32	86.22	84.28
15.	34	82.48	88.44	95.50	95.58	92.97	97.16	100.94
16.	35	96.35	96.23	95.40	96.56	98.67	99.45	95.27
17.	36	105.63	109.63	111.06	110.39	109.49	110.57	105.23
18.	37	95.33	94.66	92.18	92.06	94.95	96.13	97.48
19.	38	109.00	101.68	84.43	86.58	98.74	103.05	105.33
20.	39	100.97	101.34	95.38	93.54	99.50	103.53	105.89

TABLE A.4

Estimated Capital Stock at the Three-Digit ISIC Level, million Drs.

	code	capst80	capst81	capst82	capst83	capst84	capst85	capst86	capst87	capst88	capst89	capst90	capst91
1.	201	4382.342	6233.089	8185.458	10289.254	12609.667	15526.854	18406.102	23047.672	27834.453	36234.852	44695.832	59904.895
2.	202	8144.558	10528.104	13626.641	15705.417	19138.920	25702.496	31133.238	43051.070	55829.656	74061.617	93272.453	115474.469
3.	203	27041.068	35609.961	43670.441	52035.047	67784.531	83135.672	103444.141	120432.508	135023.656	166343.594	198780.063	220774.766
4.	204	4791.017	6263.240	8251.731	9870.870	12243.631	14223.881	16679.838	19568.096	24810.883	26869.432	30861.572	34697.625
5.	205	4714.950	7252.946	10854.501	12554.967	14566.631	17365.293	19343.217	21259.043	24606.773	27981.086	32205.129	39805.070
6.	206	3170.656	4614.740	5836.449	6786.412	7789.407	8664.924	13114.204	15760.007	20171.070	25058.559	30750.070	40117.590
7.	207	7200.735	7865.182	8858.992	11350.230	11350.230	14150.533	15539.782	16514.176	17263.107	19944.898	21970.734	23121.863
8.	208	3182.259	3982.337	4799.721	5652.199	6919.394	8119.296	9875.587	12751.687	17883.459	23080.145	27367.934	32707.666
9.	209	10262.308	15641.251	17606.865	24333.355	34071.586	41015.484	45861.113	52273.457	62604.184	73125.234	93427.320	114089.133
10.	211	3089.525	4833.500	7144.295	8562.298	9098.327	10712.546	12042.295	14320.538	16323.661	19294.170	20185.439	23726.176
11.	212	3901.770	5592.329	7749.239	10353.102	12701.318	15205.520	18722.117	22699.377	26283.756	32905.500	40308.348	46637.262
12.	213	17138.547	26123.715	35901.543	42651.090	45085.172	59328.348	68556.031	72163.484	77433.742	84300.430	98796.172	113722.063
13.	214	5579.086	7330.395	9662.571	12198.833	16622.020	18129.072	20420.713	27721.184	33060.867	44820.195	53995.785	65237.020
14.	221	2049.427	2638.390	3498.353	5253.336	6116.963	7271.696	9091.752	10414.754	13446.650	17971.104	22009.533	28168.527
15.	222	7057.538	9322.764	10875.067	14451.418	16557.270	20519.137	24019.023	31983.129	38484.199	42355.473	47318.191	56970.723
16.	231	15738.158	16865.961	18014.561	19884.639	20852.855	21810.949	23478.158	26328.752	28539.049	30514.871	32755.262	35542.508
17.	232	63327.219	81573.719	91536.406	109714.570	125215.250	142851.656	165446.641	196263.234	247250.469	296074.813	335199.750	353518.969
18.	233	16566.463	18199.615	19425.506	20547.551	22888.707	27035.508	29093.258	30916.773	35576.152	37995.605	48173.645	51400.023
19.	234	2307.782	4378.810	5500.136	6357.748	7270.583	8655.346	10119.264	10755.229	11908.588	13175.553	13932.427	14716.283
20.	235	845.547	1172.029	1511.608	1875.214	2048.238	2197.518	2224.944	2324.593	3071.381	3753.561	4697.092	6141.498
21.	236	12090.467	16351.580	20267.086	24297.117	28853.268	33312.801	41330.039	51390.223	68029.102	85240.828	106562.945	123927.414
22.	237	8179.458	10527.479	13767.354	16049.135	18282.982	20158.096	24161.094	29758.914	35763.406	46869.691	56330.480	63487.414
23.	238	942.108	1730.169	2527.972	3090.458	3744.350	4497.324	5836.035	6821.121	10795.351	12875.770	14229.802	16889.928
24.	239	2659.324	3845.515	4764.666	5647.669	6871.096	8409.644	10214.440	12830.433	14533.895	16919.936	19544.471	21123.070
25.	241	3080.294	4010.797	5238.960	6589.582	7555.893	9236.079	10640.761	12627.046	15139.777	17707.023	19604.199	21222.201
26.	243	12132.088	15895.687	19211.879	23208.553	27853.193	35250.906	44550.156	54754.410	70268.727	86248.031	105984.953	122033.883
27.	244	1129.304	1408.599	1581.191	1724.061	1813.585	2002.007	2271.035	3051.240	4750.214	5901.174	7703.211	8695.982
28.	251	13806.797	16977.580	19248.621	21939.225	23781.625	25152.627	31141.061	34812.996	38702.844	44582.340	57916.613	78777.477
29.	252	2072.422	2409.778	2702.724	2989.801	3143.017	3312.084	3472.045	3900.557	4328.149	5198.515	8729.032	11509.317
30.	253	883.090	1378.769	1542.427	1685.708	1810.698	1900.047	2519.994	2700.146	3296.684	3811.938	4554.238	5464.768
31.	259	520.736	550.923	601.460	797.852	976.918	985.718	1137.109	1316.698	1348.925	1558.608	1649.219	2032.081
32.	261	3341.888	4086.900	4808.366	6067.127	7117.655	8276.437	9877.304	11840.888	14794.423	18108.980	24651.146	30101.928
33.	262	1079.938	1811.504	2321.497	2650.366	2967.911	3474.057	4637.979	5646.062	6685.994	8757.853	10512.992	13193.294
34.	271	17135.590	18864.736	20157.387	23188.578	24313.857	27398.660	30195.492	35165.906	39619.152	54719.004	57099.488	61415.965
35.	272	5418.836	7931.818	10728.680	14576.103	18514.662	20582.023	25065.115	31215.451	35869.566	42115.785	50199.070	60105.391
36.	281	3036.060	4517.790	6522.385	8540.672	10998.941	12965.753	18515.773	22295.459	26170.859	31300.461	36629.574	42840.500
37.	282	4134.140	5030.318	6670.741	7943.565	9936.728	11711.174	13562.418	15782.651	20163.977	24315.270	35595.480	44897.891
38.	291	1914.835	2778.786	3143.188	3469.013	3898.556	4372.100	4967.898	5824.451	7036.436	7711.366	9077.365	12929.431
39.	292	213.976	293.077	323.684	567.196	871.827	927.021	944.068	1040.488	1727.805	2524.377	2600.416	4398.112
40.	293	204.489	236.942	279.500	321.512	579.520	658.177	915.605	1031.393	1273.099	1581.360	1795.314	2122.973
41.	301	4242.026	5675.825	6764.270	8408.632	9465.851	11941.727	15373.717	18890.881	22264.023	25464.877	32421.729	39542.523
42.	302	18763.951	25121.416	30082.422	34423.551	39430.777	44423.445	52174.535	60642.867	72737.305	90863.391	114738.914	140955.500
43.	311	13440.099	15684.442	25589.238	32325.553	46524.867	56675.473	60735.625	62623.078	66952.313	71418.336	74507.469	77117.492
44.	312	9858.879	11828.721	13593.568	14457.286	15266.638	17138.379	19066.832	21060.451	23054.107	25838.068	28357.334	32883.980
45.	313	5332.255	6323.094	8151.099	9146.582	10333.245	12385.629	14568.483	18559.381	27198.650	34092.387	38602.488	42352.160
46.	314	1938.708	2521.896	3030.406	3449.357	3991.807	4689.352	5459.355	7189.559	8941.040	10672.682	12195.204	14213.491
47.	315	5753.379	7080.474	9499.779	11096.778	13320.453	17634.684	21428.252	26352.064	32469.627	38858.164	47946.926	60309.148
48.	316	1593.685	2229.930	3050.121	4165.176	5182.361	6539.736	9825.505	11920.426	14517.027	16092.613	17988.258	23412.744
49.	317	3659.440	4663.985	5571.556	6888.530	7879.073	9259.391	10842.228	15683.203	19539.525	24360.840	29707.939	34814.461
50.	319	4514.971	5627.005	6794.060	7497.695	8607.295	9859.377	11346.968	12372.860	14278.377	17525.209	19548.848	23266.371
51.	321	30224.947	35843.371	50425.508	68042.172	88246.414	92829.016	108198.508	156179.359	174570.531	203405.328	244670.234	273117.938
52.	329	3120.371	4072.978	5076.991	6173.729	6859.458	7645.366	8326.894	10783.153	13488.815	17189.684	22054.307	27823.650
53.	331	7963.950	12153.681	14922.034	16684.322	21547.502	25093.813	28936.768	30830.486	32763.676	39536.828	51922.660	64564.707
54.	332	6567.222	9944.953	12399.935	14554.795	15389.924	16305.897	17597.660	19304.453	23375.342	25415.850	27873.268	32562.723
55.	333	3991.667	5644.695	7008.755	7910.824	9503.834	11510.708	14440.556	18636.588	23083.166	27492.967	30186.609	36871.176
56.	334	42319.895	69062.188	84980.273	121074.109	130525.586	155411.016	161892.391	165876.109	171031.781	177932.500	193027.328	212378.188
57.	336	6229.864	9098.092	11224.869	13828.724	15193.132	16783.539	18839.953	22499.189	29600.572	36545.207	48072.090	61885.113
58.	337	3613.714	5214.791	6642.772	7463.592	8842.403	10207.280	12007.901	14464.321	20141.430	25636.426	31981.336	36623.766
59.	339	5275.105	10699.251	13099.049	16982.646	18421.105	18917.711	21258.422	22660.160	29041.879	31040.166	33875.145	35981.727
60.	341	30567.469	48302.195	60802.832	90888.016	106533.180	119786.070	126113.859	128757.305	131802.719	140025.281	152961.219	172689.516
61.	342	17914.811	25598.076	34598.262	54490.504	69253.133	76103.547	82648.195	87679.297	95740.141	107345.117	130582.430	162286.313
62.	351	6447.704	8270.667	9259.265	9975.375	11072.069	12481.951	13499.891	13999.590	15306.737	18017.469	20174.908	23231.473
63.	352	4535.407	5754.924	7118.445	8018.582	8989.987	10014.447	11336.778	12724.565	14600.469	16741.363	20188.010	26547.350
64.	353	5659.116	7842.250	9607.449	12209.664	13445.988	14283.509	16187.120	18392.488	26692.215	30663.400	36367.266	44300.031
65.	354	371.203	567.662	602.388	744.125	858.135	1018.571	1091.429	1450.339	1741.264	2796.727	3699.687	4287.341
66.	355	1060.741	1169.913	1336.185	1540.917	1847.739	2205.480	3695.064	5012.445	6191.462	6872.817	7706.997	8701.172
67.	356	437.207	454.796	499.644	499.919	723.121	782.435	911.770	1000.460	1031.901	1352.362	1501.376	2026.000
68.	357	1067.553	1436.075	1972.435	2350.756	2467.997	2854.323	3125.351	3633.315	3940.906	5476.554	7724.170	8921.521
69.	358	1420.291	1536.325	1750.440	1855.036	2072.271	2113.955	2635.124	3599.148	4168.224	5449.570	6789.201	7147.362
70.	359	10442.501	14137.781	18228.439	29999.871	36079.285	43110.449	52840.164	66961.359	75500.672	87592.172	108913.758	126125.016
71.	361	542.907	615.344	671.367	732.146	800.638	916.299	991.457	1111.593	1445.588	1580.655	1814.585	2113.434
72.	362	273.557	542.869	798.708	1334.197	1493.972	1638.903	1974.438	2191.558	2484.107	2553.063	2663.858	2944.753
73.	363	2874.596	3113.847	3417.260	3817.446	3998.308	4566.828	4995.864	5286.963	5653.222	6918.771	7572.351	8234.633
74.	364	1520.210	1619.045	1728.553	1852.187	2029.155	2122.379	2708.890	3177.842	3741.528	4621.186	5389.263	6469.998
75.	365	515.953	562.776	655.565	668.392	837.165	906.861	1033.784	1227.091	1537.139	1746.816	2007.805	3145.279
76.	366	313.883	354.309	389.906	417.603	463.427	470.409	486.666	487.075	490.710	515.669	553.592	572.194
77.	367	1121.651	1385.286	1756.953	2202.757	2402.778	3291.060	3915.962	5290.371	9653.360	10119.371	10948.361	11769.163
78.	368	23.840	48.056	52.474	52.772	53.287	53.365	54.779	65.156	80.954	84.189	107.546	167.284
79.	369	3400.856	4341.885	4804.367	5486.765	6441.771	7242.548	8434.136	11053.880	15282.713	18114.070	21849.818	24674.209
80.	371	2747.549	3820.158	4020.365	4295.698	7037.417	7630.423	8091.459	8416.645	9053.914	10612.185	12371.500	13562.447
81.	373	9290.016	10142.798	12224.750	12986.890	14148.953	17057.473	19713.252	22595.436	26340.088	37096.402	44483.086	51359.523
82.	375	1854.827	2503.241	3173.431	4031.646	4881.802	5760.024	6509.341	7860.932	9923.188	12491.243	15640.810	17881.672
83.	376	1954.485	2639.206	3247.064	3696.642	4603.572	5223.594	6466.843	8469.267	12202.862	19000.621	29010.691	39285.051
84.	377	1267.432	1832.652	2169.459	2509.867	3382.425	4933.863	5577.011	8735.839	9756.633	10391.473	12192.279	13299.563
85.	378	4820.356	6119.423	7515.063	9513.635	10881.386	13128.941	15522.731	19181.004	22155.555	27293.664	32405.980	39209.020
86.	379	21.604	22.397	23.341	24.780	25.858	26.517	80.850	93.614	119.049	173.713	178.327	197.838
87.	381	12660.982	15146.712	19125.838	21649.574	22934.244	24431.729	25532.115	29346.375	34781.156	40605.410	44988.043	56739.305
88.	383	7905.790	9713.954	11711.128	13685.924	14966.837	16156.643	17456.631	18761.598	19614.795	23697.598	27913.266	34670.445
89.	384	1167.103	1652.372	2619.777	3084.122	3565.135	4017.295	4396.416	4902.610	6292.035	7259.186	8416.967	9547.359
90.	389	3649.472	8318.010	9925.585	12892.965	13637.755	14854.449	15777.729	17670.473	19222.574	21247.303	23026.688	32289.131
91.	393	114.334	123.799	124.195	140.741	143.631	153.569	160.390	168.911	171.202	178.097	178.658	195.272
92.	394	327.714	399.309	455.130	548.620	782.855	908.173	1029.042	1286.182	2323.630	2873.350	3554.499	3863.591
93.	396	590.769	635.875	720.831	860.584	980.522	1160.115	1292.484	1524.729	1783.331	1911.786	2058.714	2258.778
94.	397	525.701	747.682	994.253	1301.781	1623.812	2116.998	2527.701	2821.534	3386.584	3605.771	3875.521	4840.822
95.	398	1207.843	1507.268	1689.160	1794.181	1927.108	1997.199	2232.353	3861.544	4199.679	5971.907	7392.131	8549.200
96.	399	596.641	667.799	981.908	1668.366	2208.035	2553.734	3069.995	3322.914	3895.969	4305.838	5213.110	5779.825

REFERENCES

Berndt, E. R., and Fuss, M. A., 1986, "Productivity Measurement with Adjustments for Variations in Capacity Utilization and Other Forms of Contemporary Equilibria", Journal of Econometrics, 33, 7-29.

Christensen, L. R., Cummings, D., and Jorgenson, D. W., 1980, Economic Growth, 1947-73: An International Comparison, in Kendrick, J. W. and Vaccara, B. N., eds., New Developments in Productivity Measurement and Analysis, NBER Studies in Income and Wealth, Vol. 44, Chicago University Press.

Christensen, L. R., and Jorgenson, D. W., 1969, "The Measurement of U.S. Real Capital Input, 1929-1967", Review of Income and Wealth, 15, 292-320.

Christensen, L. R., and Jorgenson, D. W., 1970, "U.S. Real Product and Real Factor Input, 1929-1967", Review of Income and Wealth, 16, 19-50.

Denison, E.F., 1969, Some Major Issues in Productivity Analysis: An Examination of Estimates by Jorgenson and Griliches, Survey of Current Business,Part II, 49(5), 1-28.

Denison, E.F., 1974, Accounting for U.S. Economic Growth, 1929-1969, Washington D.C., Brookings Institution.

Diewert, W. E., 1976, "Exact and Superlative Index Numbers", Journal of Econometrics, 4, 4, 115-145.

Diewert, W. E., 1980, "Capital and the Theory of Productivity Analysis", American Economic Review, 79(5), 260-267.

Diewert, W. E., 1986, "Index Numbers", Discussion Paper No. 86-33, Department of Economics, University of British Columbia.

Diewert, W. E., 1989, "The Measurement of Productivity", Discussion Paper No. 89-04, Department of Economics, University of British Columbia.

Diewert, W. E., 1992, "Fisher Ideal Output, Input, and Productivity Indexes Revisited", Journal of Productivity Analysis, 3, 211-248.

Fare, R., and Chambers, R., 1991, Hicks Neutrality and Multiple Outputs, mimeographed.

Farrell, M. J., 1957, "The Measurement of Productive Efficiency", Journal of the Royal Statistical Society, Series A, 120(3), 253-281.

Georganta, Z., 1992, "Errors of Measurement in Output Deflators: The Manufacturing Sector of Greece", Annals of the University of Macedonia (in Greek).

Georganta, Z., 1993, "Total Factor Productivity in the Greek Agricultural Sector", Discussion Paper, Athens, KEPE.

Grosskopf, S., 1993, Efficiency and Productivity, in Fried, H.O. et al. eds., The Measurement of Productive Efficiency Techniques and Applications, Oxford University Press, 160-194.

Hauer, J. H., and Yee, J., 1992, "Morrison's Measure of Capacity Utilization, A Critique", Journal of Econometrics, 52, 403-406.

Hulten, C. R., 1986, "Productivity Change and Capacity Utilization, and the Sources of Efficiency Growth", Journal of Econometrics, 33, 31-50.

Hulten, C. R. (1990), Measurement of Capital, in Berndt, E. R., and Triplett, J. E., eds., Fifty Years of Economic Measurement, 119-152, NBER, Studies in Income and Wealth, 54.

Harper, M. J., and Gullickson, W. (1989), "Cost Function Models and Accounting for Growth in U. S. Manufacturing 1949-1986", Paper presented at the NBER Summer Institute.

Jorgenson, D. W., and Griliches, Z., 1967, "The Explanation of Productivity Change", Review of Economic Studies, 34, 249-283.

Jorgenson, D. W., and Griliches, Z., 1972, Issues in Growth Accounting: A Reply to Edward F. Dennison, Survey of Current Businesses, 55, 5, Part ii, 65-94.

Kendrick,J.,1961,Productivity Trends in the United States,Princeton University Press, NBER.

Levhari, E., Kleiman, E., and Halevi, N., 1966, "The Relationship between two Measures of Total Productivity, Review of Economics and Statistics, 48(3), 345-47.

Mark, J. A., and Waldorf, W. H., 1983, "Multifactor Productivity: A New BLS Measure", Monthly Labor Review, December, 3-15.

Morrison, C.J., 1986, "Productivity Measurement with Non-static Expectations and Varying Capacity Utilization: An Integrated Approach", Journal of Econometrics, 33, 51-74.

Morrison, C., and Diewert, W. E., 1990, "New Techniques in the Measurement of Multifactor Productivity", Journal of Productivity Analysis, 1(4), 267-286.

Skountzos, T., and Mattheou, G., 1991, "Measurement of the Capital Stock of the Greek Economy", Internal Document, Athens, KEPE.

Solow, R., 1957, "Technical Change and the Aggregate Production Function", Review of Economics and Statistics, 39(3), 213-320.

Theil, H., 1967, Economics and Information Theory, North Holland.

Thirtle, C., and Bottomley, P., 1992, "Total Factor Productivity in UK Agriculture, 1967-90, Journal of Agricultural Economics, 43, 3, 381-400.

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