

Petrakos, George C.; Zikos, Spyros E.

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# The Decline of Greek Industrial Growth, 1963-1983

by George C. Petrakos\* and Spyros E. Zikos\*\*

## 1. Introduction

The performance of Greek manufacturing in the rapidly changing environment of the last three decades has been the subject of discussion among economists and policy makers over recent years. The basic feature of this period has been the retardation in the growth rates of output from an average of 11.85 % in the period 1964-1973 to an average of 2.08 % in the period 1974-1983. As Table 1 shows, this retardation coexisted with a moderate decline in the growth rates of capital, a sharp decline in the growth rates of employment and a rapid increase in the capital intensity of production. This significant change in the record of industrial growth has prompted researchers to examine the determinants of technological progress and the ability of Greek industry to substitute resources in the production process.

The general approach used has been the employment of production functions in estimating efficiency growth and the constant elasticity of substitution (CES) either for industry as a whole or for each industrial branch separately.

Lianos (1976), using data for the period 1958-1969, computed technical progress for Greek industry as a whole and found that capital efficiency grew in that period twice as fast as the efficiency of labor and that technical progress was labor saving. He also estimated the annual rate of change of total factor productivity to be about 4 percent. In another paper Kindis (1978) derived the elasticities of substitution and the nature of technical progress for 18 industrial sectors in the period 1958-1973, by estimating a linear equation of the first order conditions pertaining to a postulated cost minimizing behavior on the part of the firms:

$$(1) \quad \log(K/L) = c + \sigma \log(w/r) + gt + e$$

where  $g = (1 - \sigma)(\lambda - \mu)$  and  $\lambda, \mu$  the labor and capital embodied technological progress respectively. He found  $\sigma$  in most sectors to be below unity although his estimates are relatively high compared to international figures. He also

\* Athens University of Economics and Business, Greece.

\*\* University of Macedonia, Greece.

Table 1

Growth Rates of Greek Industrial Output, Capital and Labor for the Period 1963-1983

| Year | $g_y$  | $g_k$ | $g_l$ | K/L Ratio<br>(1963 = 1.00) |
|------|--------|-------|-------|----------------------------|
| 1964 | 12.08  | 8.23  | 3.75  | 1.04                       |
| 1965 | 10.73  | 14.61 | 1.60  | 1.17                       |
| 1966 | 7.75   | 10.09 | -0.25 | 1.29                       |
| 1967 | 8.22   | 5.18  | 0.07  | 1.36                       |
| 1968 | 11.22  | 2.74  | -2.15 | 1.43                       |
| 1969 | 14.73  | 4.08  | 1.40  | 1.47                       |
| 1970 | 17.05  | 9.59  | 4.25  | 1.54                       |
| 1971 | 10.68  | 10.96 | 4.84  | 1.63                       |
| 1972 | 4.85   | 15.10 | 6.11  | 1.78                       |
| 1973 | 21.24  | 9.57  | 5.77  | 1.84                       |
| 1974 | -2.25  | 10.28 | -3.17 | 2.10                       |
| 1975 | 4.10   | 6.81  | 3.23  | 2.17                       |
| 1976 | 9.28   | 5.86  | 3.88  | 2.21                       |
| 1977 | 1.57   | 3.62  | 0.68  | 2.28                       |
| 1978 | 6.40   | 2.32  | 6.32  | 2.19                       |
| 1979 | 6.18   | 3.88  | -0.99 | 2.30                       |
| 1980 | 0.05   | 5.05  | -1.00 | 2.44                       |
| 1981 | -0.005 | 6.36  | 0.42  | 2.58                       |
| 1982 | -2.14  | 0.11  | -3.91 | 2.69                       |
| 1983 | -2.34  | 0.22  | -2.81 | 2.78                       |

verified that in Greek manufacturing technical progress is predominantly labor-saving and attributed that to minimum wage legislation, to special policies that kept capital prices artificially low and to foreign trade regulations that subsidized the importation of capital-intensive technology.

Similarly, Panas (1986), in a more recent paper, estimated a linear form of the first order conditions, resulting from a profit maximizing behavior assuming perfectly competitive markets and a CES production function:

$$(2) \quad \theta Y/\theta L = (b_0 e^{\lambda t})^{-\rho} (Y/L)^{1+\rho} = w$$

$$(3) \quad \theta Y/\theta K = (a_0 e^{\mu t})^{-\rho} (Y/K)^{1+\rho} = r$$

where  $\lambda, \mu$  are the labor and capital augmenting parameters and  $\rho$  is equal to the ratio  $(1-\sigma)/\sigma$  where  $\sigma$  is the constant elasticity of substitution. He uses a seemingly unrelated regressors (SURE) technique in estimating equations (2) and (3) for each branch of the Greek manufacturing industry and obtains branch values for the elasticity of substitution and the coefficients of embodied technological progress. Panas's values of  $\sigma$  are in most sectors less than unity but greater in general than those found by Kindis. He concludes also that technical progress for the Greek manufacturing industry is predominantly capital using, but labor using bias was also present in some branches.

Although existing studies have systematically examined the direction of technical progress bias in Greek industry, documented overcapitalization and discussed some possible factors contributing to it, very little has been said and virtually no empirical evidence has been provided about the factors explaining the impressive retardation in the growth rates of industrial output. Moreover all of them suffer from serious shortcomings that raise questions about the validity of their conclusions.

In the first place, all studies utilize capital stock data instead of capital in use, introducing cyclical fluctuations into their model. That implies an error measurement of the independent variables and generally results in biased and inefficient estimates of the elasticity of substitution and the factor augmentation parameters. Lianos (1976) and Kindis (1978) recognize the problem and its consequences but because of lack of available information about the degree of capital utilization, are unable to correct it. A similar problem may also exist for available labor statistics to the extent that labor input is considered in the short run a semi-fixed factor of production.

Secondly, estimating first-order condition equations of a profit maximizing or a cost minimizing behavior, instead of estimating directly the production function itself, requires perfectly competitive markets and marginal product factor pricing, assumptions that are largely unrealistic in a small country manufacturing especially at the industry level. In several cases an industrial branch is dominated by a small number of large firms and the equivalent number of usually strong labor unions so that income distribution is more like-

ly to be the outcome of collective bargaining and the market structure may have very little in common with perfect competition. In addition a regression of the log of average factor productivity to the log of factor prices and time does not provide any estimates of the share of each factor in the formation of output, let alone the fact that the way of capital prices measurement is suspect.

Third, the problematic, in any case, estimates of CES in previous studies, are well above international figures<sup>1</sup>, offering a very poor explanation of the Greek industrial record.

Finally, existing studies have confined themselves strictly to within the analytical framework of pure economic theory and are therefore unable to quantify and evaluate the impact of other non-economic influences on industrial activity.

The purpose of this paper is to remove the deficiencies of previous studies and develop a model that will test for the effects of other socio-political and international factors that may have contributed along with the economic ones to the decline of Greek industrial growth in the late 70s and the 80s. In the next part of the paper we set the theoretical framework of our discussion, examining in addition to economic factors, the impact of changes in the domestic political and international environment on the performance of Greek industries. In part 3 we specify the structure of the model and present the variables and the data used in estimation. In part 4 we derive and discuss the empirical estimates and in the last part we present the conclusions and discuss the policy implications of our model.

## 2. Political Factors, International Economic Environment and Economic Performance of Greek Manufacturing Industries

The most appropriate method utilized in the literature to estimate sources of growth of industrial output is a standard CES constant-returns-to-scale production function of the general form:

$$(1) \quad Y_{it} = \lambda_i e^{G_i(t)} [\delta_i K_{it}^{-\rho} + (1-\delta_i) L_{it}^{-\rho}]^{-1/\rho}$$

where  $i$  indicates industrial branches,  $t$  indicates time period,  $\delta_i$  is the share of capital in the output of industry  $i$ ,  $1-\delta_i$  is the share of labor in the output of industry  $i$ ,  $\rho_i = (1-\sigma_i)/\sigma_i$  where  $\sigma_i$  is the CES of industry  $i$  and  $G_i(t)$  indicates efficiency growth<sup>2</sup> for each industry.

<sup>1</sup> Ferguson and Moroney (1969) for United States and Woodfield (1973) for New Zealand, have estimated CES using time-series data. Most of their estimates are closer to zero than one and in any case they are significantly lower than those of Panas (1986) and Lianos (1976)

<sup>2</sup> We use the terms efficiency growth, economic and productive efficiency, total factor productivity and technological progress interchangeably as they all denote any contribution to output growth other than that of capital and labor, subject to constant returns to scale.

Most researchers usually feel free to set the component  $G_i(t)$  equal to the linear trend  $g_i$ , postulating a smooth exponential technological progress which in several cases may be a satisfactory approximation especially in countries with a relatively stationary sociopolitical and international economic environment. In the case of Greece however, and we believe in the case of many other countries too, the environment within which the economic agents have been operating has sustained serious changes in more than one parameter, affecting in one way or another economic behavior and the overall performance of manufacturing in the last three decades. The parameters we consider as more important and whose significance we wish to examine here are the existence of democracy and civil liberties in the political system, the membership of Greece in the European Economic Community and the OPEC crisis. Considering also the size of the public sector in Greece we wish to examine the existence of a political business cycle for industrial output.

(a) *Democracy and Economic Efficiency.* We claim that democratic regimes allow for a more efficient allocation and use of productive resources than authoritarian ones. In democracy the centers of power are more easily accessible and their activities can be checked to a certain degree by various social groups and private citizens. Freedom of expression, pluralistic institutions and a system of direct or indirect representation at all levels of power constitute the minimum conditions for creativity and efficiency to be present. On the other hand, authoritarian regimes derive their authority not from the people but from the various mechanisms of command. Power and control centers are highly concentrated and serve a political, economic or racial cast at the expense of the society. All kinds of restrictions may be imposed on social and economic activities, and free movement of labor, capital or other productive resources may not be allowed everywhere. These rigidities along with the crucial psychological factor they imply, generate an environment that does not facilitate the most efficient utilization of productive resources. Greece in the last three decades has experienced several types of political regimes from a right-wing military dictatorship to a socialist one. In a period of 21 years it experienced the ruling of four political parties, a military coup and a longlived caretaking government.

(b) *Greece in the European Economic Community: The impact on manufacturing.* The entrance of Greece into the EEC changed dramatically the international environment within which domestic industry was accustomed to operating. Import substitution policies implemented in the 50s, 60s and 70s created a strong protective environment for manufacturing that facilitated a rapid growth for a number of branches, especially the traditional ones. The reduction or abolition of tariffs, quotas and other forms of protection associated with full membership in the Community increased competition for Greek firms at home; at the same time however the opening of the huge European

market to domestic products created opportunities for export-oriented firms to expand their activities abroad.

Therefore the net impact of EEC membership on the Greek manufacturing depends on the ability of each industry to adjust to the new conditions, the intensity of competition in the unified market and the existence of comparative advantages in domestic production.

(c) *The OPEC oil crisis and economic efficiency in Greek manufacturing.* The OPEC oil crisis that led to an international recession in the 70s and the early 80s could not leave Greek manufacturing, which is heavily dependent on oil imports, unaffected. The abrupt increase in the price of oil besides the negative effects on demand, output and the employment of non-oil exporting countries, resulted in a change in the relative price of energy, which rendered the existing factor allocation and production technologies inefficient.

Therefore it is an open question whether, and to what extent, manufacturing branches in Greece have been able to alleviate the impact of the oil-price shock, seek out alternative energy sources and implement energy-saving technologies. Inability to adjust to the new condition, we claim, contributes to the decline of economic efficiency and the retardation of output growth rates.

### 3. Model Specification and the Measurement of Variables

(a) *The model.* The discussion above indicates that it would be more appropriate in the case of Greece to allow the economic efficiency factor to be affected by changes in the socio-political and international environment. Therefore we set the component  $G_i(t)$  as in equation (4):

$$(4) \quad G_i(t) = g_i t + b_{1i} DEM_t + b_{2i} PBC_t + b_{3i} EEC_t + b_{4i} OPEC_t$$

where  $t$  ranges from 1963 to 1983,  $DEM_t$  measures the level of democracy in that period,  $EEC_t$  indicates EEC membership,  $OPEC_t$  represents the oil crisis and  $PBC_t$  is the political business cycle. Equation (4) can also be written as:

$$(5) \quad G_i(t) = g_i t + \sum_{k=1}^4 \{b_{ki} W_{kt}\}$$

and therefore the production function in (3) takes the form:

$$(6) \quad Y_{it} = \lambda_i e^{g_i t + \sum_{k=1}^4 \{b_{ki} W_{kt}\}} [\delta_i K_{it}^{-e} + (1 - \delta) L_{it}^{-e}]^{-1/e}$$

This form allows us to estimate values of factor shares and the constant elasticity of substitution by major industry and also evaluate the extent to which domestic political and international environment changes have affected the performance of Greek manufacturing.

In order to be able to estimate (6) as a system of equations for major industries, we choose to take a linear approximation suggested by Kmenta (1967):

$$(6) \ln(Y_{it}/L_{it}) = \ln \lambda_i + g_i t + \sum_{k=1}^4 b_{ki} W_{it} + \delta_i \ln(K_{it}^*/L_{it}) + a_i \ln(K_{it}^*/L_{it})^2$$

where  $i = 1, 2, \dots, N$  is the number of industries and

$$a_i = -2\varrho_i/\delta_i(1-\delta_i).$$

The variable  $K_{it}^*$  is given by:

$$(7) K_{it}^* = K_{it} e^{\overline{\ln K_{it} - \ln L_{it}}}$$

where  $K_{it}$  is the capital stock in use at time period  $t$  in industry  $i$  and:

$$(8) \overline{\ln K_{it} - \ln L_{it}} = \frac{\sum_{t=1}^T (\ln K_{it} - \ln L_{it})}{T}.$$

This transformation, which has been suggested by Shalk (1976) and Nikolaou (1980), is necessary in order to minimize the deviation of the linear approximation of CES from its nonlinear form. It is known that the linear approximation becomes closer to the real CES function when the factor ratio  $K/L$  fluctuates around unity (Shalk (1976), pp 104-106). Taking the logarithm of  $K_{it}^*$  in (7) and subtracting from both sides the logarithm of  $L_{it}^*$  we get:

$$(8) \ln(K_{it}^*/L_{it}) = \ln(K_{it}/L_{it}) - \overline{\ln(K_{it}/L_{it})}$$

which fluctuates around zero implying that the ratio  $K/L$  takes values around unity. Another advantage of the transformation in (7) is that it produces estimates of  $\delta$  and  $\varrho$  that do not depend on the measurement unit of the variables and are therefore comparable to the estimates of other studies (Nikolaou (1980), pp 110-112).

*Measurement of Variables.* A major disadvantage of all previous studies is that they carry out their estimation of CES using existing capital stock instead of capital stock in use, introducing an error-in-measurement and resulting in biased and inefficient estimates. To avoid this problem we use the capital utilization rates  $R_{kit}$  estimated by Petrakos and Zikos (1990) for all manufacturing branches in the period 1963-1983. The method utilized, which has also been used by Krengel (1970) and Zikos (1987) estimates  $R_{kit}$  from the maximum deviation of the average productivity of capital ( $APK_{it}$ ) from its linear trend:

$$(9) R_{kit} = APK_{it} / (A\hat{P}K_{it} + e_{imax})$$

where:  $APK_{it} = a_{i0} + a_{i1}t + e_{it} \quad i=1, 2, \dots, N \quad t=1, \dots, T$   
 $e_{imax} = \max(APK_{it} - A\hat{P}K_{it})$

and therefore capital stock in use is found by multiplying the rate of capital utilization ( $R_{kit}$ ) by the actual stock ( $k_{it}$ ):

$$(10) K_{it} = R_{kit} k_{it}.$$

A similar problem however to that described for capital utilization may also exist for labor employment. A significant number of employees in manufacturing such as skilled workers, middle level personnel and managers have gone through extensive on-the-job training and possess human capital that cannot be replaced without a cost to firms. Therefore they are considered a semi-fixed factor of production and experience shows that firms hesitate to discharge them along unskilled labor in a recession. As a result hired labor may not be fully utilized during the business cycle and available labor statistics for manufacturing may not be used in estimating the parameters of the production function. Especially for Greek industrial statistics this problem becomes more apparent since the available employment data provides information only about the average annual number of employees but not for the actual man-hours spent at work.

We use the same technique here to obtain estimates of the rate of labor utilization ( $R_{lit}$ ) which, multiplied by the employment figure given by statistics ( $l_{it}$ ) produces the real employment figure ( $L_{it}$ ):

(12)  $L_{it} = R_{lit} l_{it}.$

In quantifying  $DEM_t$  we work in a similar way to Gastil (1981) who created a seven point cross-country index of democracy and civil liberties. We separate the 1963-1983 period into six subperiods according to which political party was in power and rate them from 1 for the most democratic to 5 for the least democratic. This method intends to produce comparable standards rather than absolute:

$$(13) DEM_t = \begin{cases} 4 & t = 1963 \text{ (Right-wing conservative party)} \\ 2 & 1964 \leq t \leq 1965 \text{ (Moderate centrist party)} \\ 4 & t = 1966 \text{ (Conservative government)} \\ 5 & 1967 \leq t \leq 1974 \text{ (Right-wing military junta)} \\ 3 & 1975 \leq t \leq 1981 \text{ (Cristian-democratic party)} \\ 1 & 1982 \leq t \leq 1983 \text{ (Socialist party)} \end{cases}$$

Although we admit that every effort to evaluate — let alone to quantify — recent periods of Greek political history with respect to democracy and civil liberties is not free from personal judgments, we believe that most people will find the scale and the rating appropriate. We regret that an index similar to that developed by Gastil (1981) in his cross-country study is not available for Greece, yet the issue of democracy and economic performance is of too great importance to be ignored by empirical studies. As a final note in this however sensitive effort, we ask the attention of the reader that the rating is not attached to the political parties in power, but to the political rights and civil liberties available in each period (which may or may not be the outcome of the parties' policy).

In order to measure the impact of Greek membership in the European Economic community on the performance of manufacturing we construct the index  $EEC_t$  given in equation (14):

$$(14) EEC_t = \begin{cases} 0 & 1963 \leq t \leq 1976 \\ 1 & 1977 \leq t \leq 1980 \\ (t+1) - 1980 & 1981 \leq t \leq 1983 \end{cases}$$

This index intends to capture the net effect of the gradual elimination of protectionism for Greek manufacturing industries in domestic markets and the reduction by Community members of their restrictions on Greek exports. Similar indices have also been used by other studies, for example Gomulka (1977) used an analogous index in his study of Soviet industrial growth. In the period 1963-1976 Greece was not a member of the Community and therefore  $EEC_t$  is zero. The membership treaty was signed in 1977 and became effective in 1981.  $EEC_t$  is 1 in the period 1977-1980 since Greek firms are in a transitory stage where they are anticipating the effects of the upcoming implementation of the treaty, may be attempting to adjust their policies, but they have felt no sign yet of these effects. From 1981  $EEC_t$  becomes a linear trend variable since the markets for manufacturing open gradually, tariffs and quotas decline and protectionism becomes weaker for both sides. Of course alternative methods of measuring  $EEC_t$  may be suggested such as the terms of trade or the export-import ratio by industry. We choose not to employ these methods because they are not free from other influences such as domestic inflation, exchange rates or international price variations that have no direct relation to the membership of Greece in the European Community. By measuring  $EEC_t$  as in (14), we get a simple index that is free from those influences and also serves the basis purpose at hand.

$OPEC_t$  is a dummy variable defined in equation (15):

$$(15) \quad OPEC_t = \begin{cases} 0 & 1963 \leq t \leq 1973 \\ 1 & 1974 \leq t \leq 1983 \end{cases}$$

that intends to capture the oil-crisis effects on the performance of the Greek industries.

Finally,  $PBC_t$  is a dummy variable defined in equation (16):

$$(16) \quad PBC_t = \begin{cases} 2 & \text{if } t = 1963, 1964, 1965, 1974, 1977, 1981 \\ 1 & \text{otherwise} \end{cases}$$

where 1963, 1965, 1974, 1977, 1981 were election years. This variable will test for the existence of a political business cycle, that is, for the impact on industrial activity of the ability of political parties in power to use the state mechanism and the public coffers, in their effort to be reelected.

*Sources of Data.* Manufacturing branches output data for the period 1963-1983 is taken in 1970 and current prices from the National Accounts Statistics. Capital stock data by branch in 1975 prices is taken from Handrinos (forthcoming). To obtain real output in 1975 prices, we construct a price index for all manufacturing branches using 1975 as a base year. Employment data for manufacturing branches is taken from the National Statistics Service Industrial Censuses and the Annual Employment Surveys. For 1979,

Table 2

**Major Industries Used for the Estimation of the Production Function**

| Major Industries | ISIC Counterparts | Description                       |
|------------------|-------------------|-----------------------------------|
| 1                | 20,21,22          | Food, Beverages, Tobacco          |
| 2                | 23,24             | Textiles, Clothing/Footwear       |
| 3                | 25,26             | Wood/Cork, Furniture              |
| 4                | 27,28             | Paper, Printing/Publishing        |
| 5                | 30,31,32          | Rubber/Plastic, Chemicals, Petrol |
| 6                | 33                | Non-metallic                      |
| 7                | 34,35             | Basic Metal, Metal Products       |
| 8                | 36,37             | Machinery, Electrical             |
| 9                | 29,39             | Leather, Miscellaneous            |

where data is not available, we estimate employment as a linear interpolation of the years 1978 and 1980 using the participation rates of „small” and „large” industry for each branch. The same method is employed for the years where „small” industry employment data is not available.

#### 4. Model Estimation and Data

We carry out our estimation of the production function in (6) aggregating production activities in 9 major industries as shown in table 2, including all branches of Greek manufacturing except transport equipment (39) for which available statistics are not reliable<sup>3</sup>.

For convenience, we rewrite here the production function of equation (6), setting  $\ln(Y_{it}/L_{it})=y_{it}$ ,  $\ln(K_{it}/L_{it})=k_{it}$ ,  $\ln\lambda_i = \gamma_i$  and introduce the stochastic term  $e_{it}$ . We also substitute  $DEM_t$  and  $PBC_t$  with their natural logarithms postulating: (a) that improvements in the democracy and civil rights record result in a gradually diminishing rather than a constant improvement in economic performance and (b) that economic agents adapt expectations and therefore elections do not have the same impact on economic activity over time. We also restrict the coefficients  $b_{1i}$  of  $DEM_t$  and  $b_{2i}$  of  $PBC_t$  to take the same values for all industries since it is reasonable to assume that the impact of these two variables are the same for the entire manufacturing sector (and perhaps for the entire economy).

The system of equations to be estimated for the 9 major industries of Greek manufacturing is given by (17):

$$(17) \quad y_{it} = \gamma_i + g_i t + b_1 DEM_t + b_2 PBC_t + b_3 EEC_t + b_4 OPEC_t + \delta_i k_{it} + a_i k_{it}^2 + e_{it}$$

where:  $i = 1, 2, \dots, 9$  (major industries) and  
 $t = 1, 2, \dots, 21$  (the time period 1963-1983).

<sup>3</sup> Kindis (1978) has also excluded this branch from his analysis for the same reasons.

The simultaneous estimation of the block of equations for the 9 major industries of (17) is a typical situation where the Seemingly Unrelated Regressors (SURE) technique proposed by Zellner (1962) should be applied. In general, we cannot rule out the possibility that the residuals of the equations are contemporaneously correlated, since random effects on the output of one industry may be associated with those of another and therefore the off-diagonal elements of the Variance-Covariance matrix  $E\{e_{N \times T} e'_{T \times N}\}_{N \times N}$  may be non-zero. In that case the use of OLS for each major industry separately results to inefficient estimators of the production function parameters.

Equation (17) was estimated for the 9 major industries of Greek manufacturing using the Seemingly Unrelated Regressors technique and the results are given in Table 3. Examining the estimated parameters we can make the following remarks:

- (i) The „net” coefficient of technological progress  $g_i$  is positive and significant — except in industry 3 — ranging from an annual rate of 1 to 6 percent for all industries.
- (ii) The estimated share of capital in output  $\delta_i$  is positive and significant for all industries — except 5 — and ranges between 22 and 66 percent according to the intensity of capital in each industry.
- (iii) The estimated constant elasticity of substitution  $\sigma_i$  is significantly smaller than unity in all industries — except 7 (basic metal, metal products) — where its value is quite higher than one. The abnormality of industry 5 (plastic, chemicals, petroleum) which appears with a negative CES value, may be attributed to the abrupt increase of 600% in the capital stock series of the petroleum industry in 1972, due to the Prinos oil-production project in Thasos. It simply denotes the difficulty of the model to fit a discontinuous data series, which may also explain why industry 5 was the only one with an insignificant  $\delta_i$  coefficient.
- (iv) The coefficient of the  $DEM_i$  index  $b_1$  is negative and significant indicating that deficiencies in the political rights and civil liberties record ceteris paribus result in a reduction of the overall performance of manufacturing.
- (v) The coefficient  $b_2$  is positive and significant, providing evidence for the existence of a — frequently alleged — political business cycle, which seems to increase industrial output in election years by an average rate of about 2%.
- (vi) Coefficient  $b_{3i}$ , which captures the impact of EEC membership on industrial output, is nega-

Table 3

SURE Parameter Estimates for the Greek Industries Production Function in the Period 1963-1983

| Major Industry (i) | Parameters          |                  |                 |                    |         |            |                   |                 |                   |                   | $\bar{R}_i^2$ | DW <sub>i</sub> |
|--------------------|---------------------|------------------|-----------------|--------------------|---------|------------|-------------------|-----------------|-------------------|-------------------|---------------|-----------------|
|                    | $\gamma_i$          | $g_i$            | $\delta_i$      | $a_i$              | $e_i$   | $\sigma_i$ | $b_1$             | $b_2$           | $b_{3i}$          | $b_{4i}$          |               |                 |
| 1                  | -2.1179<br>(-44.63) | .0469<br>(11.12) | .2408<br>(1.82) | -.6792<br>(-3.52)  | 7.4304  | .1186      | -.0124<br>(-1.88) | .0197<br>(3.26) | -.0217<br>(-2.00) | -.0447<br>(-2.24) | 99.38         | 1.72            |
| 2                  | -2.0908<br>(-41.20) | .0470<br>(10.29) | .3606<br>(4.89) | -.5833<br>(-5.45)  | 5.0596  | .1650      | -.0124<br>(-1.88) | .0197<br>(3.26) | -.0720<br>(-5.87) | -.0514<br>(-1.78) | 99.36         | 2.26            |
| 3                  | -1.8683<br>(-15.63) | -.0062<br>(-.60) | .4918<br>(3.61) | -.9301<br>(-6.10)  | 7.4428  | .1184      | -.0124<br>(-1.88) | .0197<br>(3.26) | .0276<br>(1.03)   | -.0983<br>(-2.12) | 90.45         | 1.88            |
| 4                  | -1.5018<br>(-37.69) | .0183<br>(4.15)  | .3909<br>(4.75) | -.6149<br>(-4.59)  | 5.1651  | .1622      | -.0124<br>(-1.88) | .0197<br>(3.26) | .0089<br>(.69)    | -.0407<br>(-1.54) | 97.61         | 1.39            |
| 5                  | -1.6072<br>(-25.10) | .0685<br>(8.11)  | .5755<br>(1.24) | 2.0539<br>(1.78)   | -16.814 | -.0632     | -.0124<br>(-1.88) | .0197<br>(3.26) | -.1156<br>(-4.40) | -.1344<br>(-1.94) | 90.81         | 1.47            |
| 6                  | -1.9759<br>(-14.13) | .0395<br>(3.06)  | .3979<br>(1.80) | -.1107<br>(-1.05)  | .9241   | .5197      | -.0124<br>(-1.88) | .0197<br>(3.26) | -.0347<br>(-2.29) | -.3269<br>(-1.11) | 99.28         | 2.00            |
| 7                  | -1.8131<br>(-36.16) | .0320<br>(5.00)  | .6640<br>(8.96) | .0656<br>(.80)     | -.5880  | 2.4275     | -.0124<br>(-1.88) | .0197<br>(3.26) | -.0981<br>(-5.93) | -.0394<br>(-.92)  | 97.49         | 2.04            |
| 8                  | -1.7841<br>(-46.49) | .0174<br>(4.69)  | .2283<br>(3.56) | -.7141<br>(-11.03) | 8.1065  | .1090      | -.0124<br>(-1.88) | .0197<br>(3.26) | .0262<br>(3.20)   | -.0525<br>(-3.01) | 98.89         | 2.14            |
| 9                  | -2.2083<br>(-35.87) | .0343<br>(4.80)  | .6233<br>(4.44) | -.2787<br>(-.86)   | 2.3739  | .2960      | -.0124<br>(-1.88) | .0197<br>(3.26) | -.1121<br>(-5.07) | -.0284<br>(-.54)  | 92.19         | 1.02            |

Note: t-statistics are in parentheses.

tive and significant for 6 out of 9 major industries indicating that firms in these industries have been unable to adjust in the new conditions and face difficulties in competing with their European counterparts. The findings provide evidence that *ceteris paribus* EEC membership has resulted for these 6 industries in an annual reduction of output ranging from 2 to 11 percent. The impact of EEC membership is found to be insignificant in major industries 3 and 4 (wood-furniture, paper-printing) and is also found to be positive and significant in industry 8 (machinery/electrical). A possible explanation for the positive impact on the latter one is that firms in industry 8 have been actively engaged in subcontracting practices with European firms and also that several European firms have expanded their operations in Greece aiming at the expanding domestic market.

- (vii) The impact of the oil-crisis on economic performance, captured by the coefficients  $b_{4i}$ , is negative and significant in 5 industries causing an annual decline in output ranging from 4 to 13 percent. The impact is also negative but insignificant in the remaining 4 industries.
- (viii) The adjusted coefficients of determination  $\bar{R}^2$  for each equation are quite high and also there are no signs of serially correlated residuals since the DW-statistics are well above the critical value  $d_L$ , which for  $N=21$  and  $k=8$  is 0,474.

The results of the estimation provide empirical evidence for a number of factors that have contributed to the decline of Greek industrial growth in the last two decades. First the especially low elasticities of substitution found in most industries outline the limits of a development strategy that has been based on extensive capital accumulation. Indeed, post-war industrialization in Greece was based on a policy of artificially low — mostly negative — interest rates aiming to assist the transformation of the economy from a primarily agrarian to a modern industrial one. If we think of CES as a measure of the rate at which diminishing returns set in as one factor of production is increased relative to another, then the magnitude of our estimates provides an explanation of the declining growth record of Greek manufacturing. A CES significantly smaller than unity implies an eventual difficulty in increasing industrial output by primarily incrementing the stock of capital because diminishing returns set in strongly and rapidly. In other words, capital augmentation not followed by analogous increases in employment or improvements in the quality of labor, eventually has a diminishing effect on output because factor substitution in the production process of most industries is very limited. Our estimates of CES are in a better position to explain the record of Greek industrial growth than those found by Lianos (1976) and Panas (1986) which tend to be equal to or even greater than unity.

Second, this model allows us to empirically evaluate important factors of the socio-political and international environment within which Greek industry has been operating during the period of examination. The evidence provided suggests that deficiencies in the political rights and civil liberties record, that were unfortunately present in the recent political history of Greece, had a dragging effect on the performance of the manufacturing sector. This is attributed to restrictions imposed on various aspects of social and economic activities by the state control mechanism and also to the public disobedience, unrest or even open conflict that they imply. The evidence also suggests that changes in the international environment had a negative effect on Greek manufacturing. Most industries have been unable to adjust their technologies in the post-OPEC era of international energy prices and have found it difficult to face competition in the Common European market. The result of this failure has been significant, in magnitude, reduction of productive efficiency and a consequent retardation in the output growth rates. The independent effects of these „external” political and international factors along with overcapitalization in the face of a near-Leontief type production technology, have been the prime factors explaining the record of Greek manufacturing in the last two decades.

Most previous studies have confirmed the existence of a capital-using bias for most branches of Greek manufacturing, mainly attributing it to the importation of a capital embodied technology from developed countries. Since we use more recent data and our model is based on a different estimation method, it would be interesting to examine here whether technological progress is capital embodied, labor embodied or disembodied.

In order to do that, we subtract from the technological progress factor  $G_i(t)$  the „explained” part which has been attributed to the effects of the political and international factors and add the residuals of the estimated regressions, getting a „net” growth performance factor  $N_{it}$ :

$$(18) \quad N_{it} = G_i(t) - [b_1 DEM_t + b_2 PBC_t + b_3 EEC_t + b_4 OPEC_t] + e_{it}$$

This factor, which measures the component of efficiency progress that is independent from the political and international environment factors, is regressed on labor and capital:

$$(19) \quad N_{it} = h_0 + h_1 K_{it} + h_2 L_{it} + u_{it}$$

in order to capture the indirect effects of the production factors on output growth<sup>4</sup>. Equation (19) was initially estimated with the use of Ordinary Least Squares (OLS) for the 9 major industries of Greek manufacturing in the period 1963-1983. Since however the DW-statistics for most industries were in the acceptance or inconclusive regions, we

<sup>4</sup> A method similar to that has been used by Balasa and Bertrand (1970) in a study comparing the performance of Eastern and Western European countries.



Table 4

GLS Parameter Estimates for Equation (19)

| Major Industry (i) | Parameter Estimates |                    |                      |                | DW <sub>i</sub> | R <sub>i</sub> <sup>2</sup> |
|--------------------|---------------------|--------------------|----------------------|----------------|-----------------|-----------------------------|
|                    | h <sub>0i</sub>     | h <sub>1i</sub>    | h <sub>2i</sub>      | q <sub>i</sub> |                 |                             |
| 1                  | .760*<br>(5.69)     | .00003*<br>(10.11) | -.00001*<br>(-7.66)  | .67<br>(5.75)  | 1.41            | .99                         |
| 2                  | 2.328*<br>(2.62)    | .000003<br>(.72)   | -.000004*<br>(-3.61) | .96<br>(40.81) | 2.57            | .98                         |
| 3                  | .273*<br>(3.23)     | -.000007<br>(-.65) | -.000006*<br>(-3.05) | .64<br>(3.35)  | 1.89            | .66                         |
| 4                  | .193*<br>(1.77)     | .00009*<br>(5.27)  | -.00002*<br>(-2.76)  | .54<br>(2.58)  | 1.86            | .93                         |
| 5                  | 3.950<br>(.71)      | .00001<br>(.44)    | -.00001<br>(-.76)    | .97<br>(19.53) | 2.03            | .94                         |
| 6                  | .564*<br>(7.97)     | .00004*<br>(7.52)  | -.00002*<br>(-6.90)  | .65<br>(4.68)  | 1.90            | .98                         |
| 7                  | .064<br>(.43)       | .00003*<br>(4.64)  | -.000005<br>(-1.06)  | -.20<br>(-.86) | 1.94            | .97                         |
| 8                  | .051<br>(1.03)      | .00004*<br>(7.93)  | -.000003*<br>(-1.74) | .21<br>(.79)   | 2.08            | .94                         |
| 9                  | -.200<br>(-1.44)    | .00004*<br>(4.10)  | -.000004<br>(-.26)   | .18<br>(.74)   | 1.75            | .92                         |

reestimated each equation in (19) with the use of Generalized Least Squares (GLS) assuming that the residuals  $u_{it}$  follow a first-order autoregressive process:  $u_{it} = \rho u_{it-1} + v_{it}$ , where  $v_{it}$  is a normally distributed error term. The results of the estimation are given in Table 4 (the stars indicate rejection of the Null hypothesis at the 5% level). We observe that the constant term estimate is positive and significant in 5 out of 9 major industries, the estimated coefficient of capital is positive and significant in 6 industries and the coefficient of labor is negative and significant in 6 industries also.

The evidence provided by this simple test suggests that technological progress, both disembodied and capital embodied, was present in Greek industries during the period of examination. A tendency appears for consumer and intermediate goods industries to experience a mainly disembodied technological progress, while capital goods industries tend to experience a mainly capital embodied progress.

Disembodied progress basically reflects organizational and institutional changes that improve the operation of the markets and the quality of public services, reduce bureaucracy and the cost of transactions and facilitate a more efficient utilization of productive resources and time.

On the other hand, the effects on productive efficiency of new, mainly imported, technologies implemented in the production process, is expressed through the coefficient  $h_1$  of capital. The negative indirect effect of employment on output growth, may be attributed to insufficient human capital invested in manufacturing and highlights the growing quality gap that exists between the capital mainly imported from advanced economies, and the endogenously determined labor force. This reinforces the increasing difficulty of capital and labor to cooperate in the production process. Our results offer a better insight to the nature of technological progress than those found by Panas (1986), who suggested a negative capital augmenting and a positive labor augmenting parameter for most industries. On the other hand, we are closer to the findings of Kintis (1978), who supported that technological progress in Greek manufacturing is predominantly capital embodied, although our method of estimation is less restrictive and allows for embodied and disembodied technological progress to coexist<sup>5</sup>.

<sup>5</sup> Since our estimates in equation (19) are associated with very similar coefficients of determination (see Table 3) and standard errors of estimate, the use of the residuals  $e_{it}$  in the computation of  $N_{it}$  should not be expected to lead to an error in measurement problem.

## 5. Policy Implications and Conclusions

The crucial question following the diagnosis of the factors contributing to the decline of Greek industrial growth, is that of policy intervention. Given the results of the model and assuming that the proceeding analysis is sound in both theoretical and methodological grounds, what options are available to policy makers in order to overturn existing trends of industrial output?

In the first place, it is important to realize that with the capital-labor ratio trend unlikely to be reversed and the capital technology to a large extent exogenously determined, the only feasible policy to overcome the barrier of a low CES and the current stagnation in industrial output is to seriously invest in human capital. This requires a long-run strategy, which can take advantage of the existing EEC-subsidized educational and other scientific programmes, that will promote job training and seminars for professionals, businessmen, and employees, introducing them to the use of the new, advanced technologies of production, management and marketing<sup>6</sup>. A major reform in the educational system at the higher and highest level is also necessary and should be directed towards new scientific fields, greater autonomy for academic institutions and closer cooperation with research centers and industries. This however requires a generous increase in public spending for education which as a percentage of GNP is the lowest in Europe and explains to a certain degree the level and the quality of human capital.

Second, our results indicate that institutional reforms may be necessary for the improvement of the productive efficiency of manufacturing. Such kinds of reforms may be suggested to include the decentralization and simplification of the decision making process in the public sector, the modernization of the banking system and the elimination of certain rigidities in the labor market. As far as the public sector is concerned it is a common belief in Greece that it requires another philosophy and a generous amount of „glasnost” and restructuring in order for firms and private citizens to minimize time and frictional costs in their transactions with its agencies. The existence of a political business cycle in industrial output provides some evidence of the way the state mechanism has been used in the recent past and may be helpful in explaining the accumulation of a tremendous public sector debt over the last two decades.

Third, given the importance of democratic institutions for the efficient allocation of resources, efforts should be made towards the development of modern conflict resolution mechanisms. Their task would be to establish and expand channels of communication between social classes and economic groups that would facilitate a discussion and negotiation process about issue of income distribution and burden sharing, and intervene to minimize social conflict, disorder and friction. A „social contract for development”, a

moratorium among economic and political interest groups appears today to be absolutely necessary for the exodus from the ongoing industrial crisis. The recent achievement of a two-years economic agreement between the Greek labor unions association and the association of Greek manufacturers was a first step in the right direction.

Finally, given the impact of the OPEC crisis on industrial output, the recent efforts to seek alternative energy source should be continued and intensified with an emphasis given to the renewable ones, especially for the isolated from the mainland Greek islands.

The purpose of this paper has been to investigate the factors contributing to the retardation of the industrial output growth rates. We have estimated constant-returns-to-scale CES production functions for 9 major industries of Greek manufacturing using the Seemingly Unrelated Regressors (SURE) technique for the period 1963-1983. The major advantage of this model compared to previous work is that: (i) it introduces the political and international environment as a determinant of productive efficiency; (ii) it directly estimates production functions and shares of capital and labor in output, instead of relying on first-order-conditions functions, ambiguous measure of capital prices and the relatively strong assumptions about the market structure they require; (iii) it adjusts actual capital stock and labor figures with their capacity utilization rates removing cyclical fluctuations and an error in measurement problem.

Our results indicate that the major contributors to the decline of Greek industrial growth rates have been the barrier of the low elasticities of substitution for most industries, the deficiencies in the political freedom and civil liberties record in the recent past, the difficulties of Greek industries to compete in the common European market, the OPEC oil crisis and the lack of sufficient human capital investment in manufacturing.

It is unfortunate that to this date capital stock data is not available for the period after 1983, since that would give us the opportunity to expand the model in a crucial period for Greek industry and also test for its ability to predict. Although our analytical framework incorporates and examines a number of economic and non-economic factors, certain issues that may also be important in understanding the record of industrial growth have not been examined here. Some of these, dealing with the size of the firms and the discussion on Small Scale Enterprises (SSE) and flexible specialization, the size and the structure of the markets and the spatial allocation of industry, require a cautious examination for Greek industry and should be the subject for further research.

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<sup>6</sup> A recent study by Petrakos and Zikos (1991) found that over 95% of the entrepreneurs and managers in a central Greece province ignore the use of computers and of course do not have one in their firm.

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