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OUTPUT AND INPUT SUBSIDIES AS A MEANS OF INDUSTRIAL DECENTRALIZATION: THE GREEK CASE

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I. PROLOGUE

DEVELOPMENT planners are concerned with marked characteristics of both advanced and developing economies such as the synchronous soaring of unemployment, industrial concentration, pollution, regional economic stagnation, and of all sorts of congestion difficulties. In myriad studies Keynesian prescriptions have been endorsed by an arsenal of selective incentives to achieve mainly structural changes on aggregate economic levels.

This paper focuses on a proposal concerning the Greek economy: the catastrophic repercussions of industrial concentration in Athens could be resolved by promoting subsidies; indeed, this neglected incentive may be proved able to achieve a simultaneous decentralization and development of background regions spread all over Greece. Straightforward, the subject is a legitimate concern of the Greek administration. Eligibility for granting such subsidies is judged upon business relocation or establishing new plants in the periphery.

Theoretically, subsidy programs have two major characteristics: (a) subsidies are used primarily to alter the use of resources in the private sector of an economy; (b) subsidies seek to achieve their goals by operating through the price mechanism by offering rewards to different groups as inducements to change the private market economic activity. In general, the goals may be classified as follows: higher production and employment, economic growth, optimal income distribution, and efficient use of resources. Hereinafter, the objective of subsidy policy is merely the relocation of a part of the economic activity away from the Athenian metropolis. It is considered that in the absence of attractive incentives, such industrial decentralization would be impossible to be achieved.

The aforesaid problem of congestion is noteworthy with already accumulated problems being unsolvable. The stimulation of new industrial ventures will inevitably create a multi-pole technology strengthening competition and efficient cooperation between physical and human capital. First, though, we pose a few remarks on the Greek economy.

World War II was succeeded by reconstruction in Europe but by a civil war

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in Greece. Industrialization was late in coming to the country and any periodic euphoria in labor absorption had proved to be illusory forcing laborers towards a massive exodus from the country. A dual scarcity in capital and skilled laborers kept the economic horizons unpromising up to the late 1950s. Since then the annual GNP growth rates rank consistently among the highest in the OECD group; a significant change in the composition of the labor force was explained by a drastic deterioration in the agricultural sector from 54 per cent in 1961 to 27 per cent in 1984. The gradual growth of the manufacturing sector was accompanied by an excessive agglomeration in Athens as government and industrial planners failed to forecast the labyrinthic effects. In the mid–1970s, the Greater Athens zone—including the triangle of Athens, Pireaus, Elevsis—provided nearly 65 per cent of the total industrial employment. The rest of the country remained overwhelmingly underindustrialized with cities such as Patras, Volos, Larisa, and Kavala being nearly stagnant in investment and employment.

Athens has been attractive to domestic and international firms for various reasons. She offers Pireaus, the largest port of the country and the second largest port in the Mediterranean, and all financial and bureaucratic facilities nearby. Hence, the industrial elite, very closely associated with the political world of the country, is hesitant to "move out" saving thus expensive transport costs, preserving customer contacts, and fearing lack of skilled workers. Multinational corporations prefer also Athens for her geographic priviledges and the advanced transportation and communication facilities. Significantly, Greece is one of the few countries offering multiple constitutional guarantees to foreign firms, maintains excellent relationship with Arabs and Eastern Europeans, is a member of EEC, and enjoys a political stability since the fall of the military junta in 1973. Also, the opening of the Suez Channel and the chronic disturbances in Beirut and the Middle East as a whole have strengthened Athens's position to provide shelter to foreign firms.

The paper is organized as follows: in Section II we set the foundation of subsidies; in Section III we determine the optimum subsidy as yielded by empirical tests on Greek time-series data, and in Section IV we conclude. Finally, in Appendix three selected tables seem crucial to our argument on centralization.

II. A FOUNDATION OF SUBSIDIES

Just as the rich nations have grown faster than the poorer, so the richer regions tend to grow more rapidly than the poorer regions. Without being an axiom, it appears that poor areas in developing economies exhibit different problems than poor areas in developed countries and obviously call for different solutions. Also, it is pertinent to mention that LDCs carry a limited ability to afford regional aids which do not benefit the total economy quickly. Presently we intend to study subsidy incentives for relocating Greek firms, investigate their economic optimality, and determine the manner they shall be inserted into this economy.

In general, subsidies are negative taxes aiming at various economic and social targets; herein, we are concerned with three subsidy forms proposed to a firm as an incentive for relocating in distressed areas. Subsidies on Labor (LS), Capital

(KS), and Output (QS) are government payments to a firm equal to the difference between the new and the previous marginal labor value product, rate of return on investment, and price per unit of output respectively.

First, LS were introduced by Kaldor [17], elaborated by Frisch [10], and since then widely adopted by numerous economies. Such subsidies lower the price of labor, decrease the price of unskilled relative to skilled workers, or support a firm with a credit equal to a specified percentage of its wage expenditures. LS have been advocated in alternative formulations: Borts and Stein [6] indicate that for a single region, LS are the most efficient development incentive. Borts [5] in a seminal work proves the validity of the aforementioned indication arithmetically. Moreover, Lind and Serck-Hanssen [24] using a CES production function applied to Norwegian data proved that LS are superior to KS or QS. Bhagwati and Srinivasan [4] and Archibald [3] discuss the optimality of LS, while Woodward [36] found that LS create the most jobs per firm and have a favorable cost per new direct job. LS for urban sectors of a LDC have been studied by Hagen [14], for income maintenance by Kesselman [18], and for job-hunting of low-wage laborers by Hamermesh [15]. Kesselman, Williamson, and Berndt [19] have analyzed an employment tax credit (ETC) and a marginal employment tax credit (METC) which channel credits to firms for increasing employment.[1]

In the case LS are offered to workers who would otherwise remain idle, the per-hour wage subsidy θ is

$$\theta = s(Z-W), \qquad Z>W, \quad 0<s<1 \tag{1}$$

where s is the subsidy rate, Z and W are the desired and market wage rates, respectively.[2] LS are effective only for wage rates where $Z>W$ yielding a leftward kink of the S_L at the level of the desired wage rate (Figure 1). If per-hour LS are W_1W_2, the post-subsidy equilibrium yields lower market wage rates ($W_1<W_0$) and higher employment ($L_1>L_0$).[3] The total cost of labor subsidies $\Sigma\theta$ is

$$\Sigma\theta = [s(Z-W_1)L_1]L, \tag{2}$$

where W_1 and L_1 are the post-subsidy equilibrium wage and annual hours values respectively, and L is the number of LS recipients. Thus, the subsidy-inclusive labor market equilibrium depends on three constants: s, Z, and L.

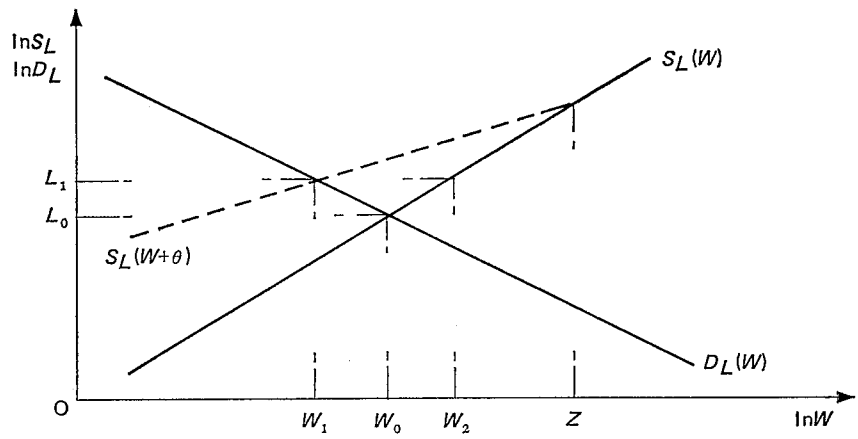
KS provide to eligible firms a competitive advantage over others by promoting the latest vintages of production techniques and altering the production structure

[1] Labor-subsidies may be disbursed to either employers or laborers. Noted distinctions found in the literature (wage-subsidies, employment-subsidies, wage-rate-subsidies, etc.) do not concern us here. Countries, methods of payments, accounts and duration, dates and eligibility are well described by Kopits [21].

[2] The total compensation per-hour is $W+\theta=sZ+(1-s)W$; the supply (S_L) and demand (D_L) for labor services in log-linear form are: $\ln S_L=\ln \alpha_0+\alpha_1 \ln W$ and $\ln D_L=\ln \beta_0-\beta_1 \ln W$ where α_1, β_1 are the respective wage elasticities.

[3] Reversed results apply when S_L is backward-bending. Borts [6] postulated S_L to be perfectly inelastic (fixed factor) and S_K to be perfectly elastic (variable factor) in the depressed area.

Fig. 1



through intensive industrialization. KS are used to operate as a decisive incentive designed to induce firms to open new plants in specified distressed areas or expand existing ones. Popular devices of this sort of subsidies are tax holidays for profits, lowering the capital costs, exemptions from income and property taxes, the grant of accelerated depreciation privileges, low or even free-interest rate loans, low social security contributions, and duty-free imported machinery and equipment.[4]

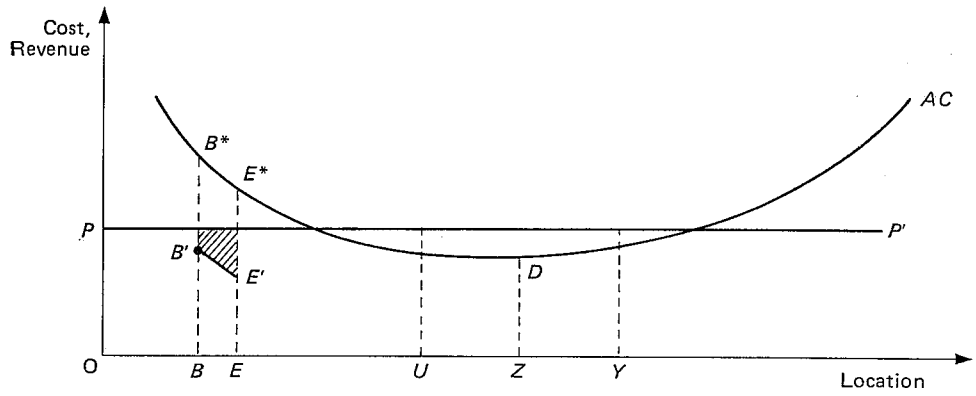
QS are provided to producers in various aid-packages such as floor and support prices, or the difference between the pre-subsidy and post-subsidy price. Consider the following paedagogical fiscal attempt to attract new industry into a depressed area away from the congested metropolitan zone UY (Figure 2). A firm experiences average cost AC with its minimum falling into the relatively optimum site Z of the metropolitan zone which allows a spatial profitability margin UY at price level PP'. If the objective is to attract this firm to distressed area BE, the average cost would be B^*E^* in the absence of any QS. But the provision of QS enables a shift of $B^*E'^*$ below both the price line PP' and the minimum point D of AC at $B'E'$; this deterioration of the AC through QS makes periphery BE profitable.

The choice for the optimum subsidy—the one to achieve the most desired economic impact—is problematic. In order to reach this choice and conclude whether or not a subsidy program as a fiscal instrument is better than doing nothing, we adopt a few basic assumptions under a static framework: (i) while the supply of capital is perfectly elastic, the corresponding for labor is considered to be alternatively elastic and inelastic;[5] (ii) the marginal products of the cost-

[4] The weak points of *KS* consist of conflicts of interest (e.g., discrimination, weakening the bargaining power of unions, etc.), the issue of unnecessary subsidies, and mainly the provision of subsidies (read: grants) under personal fraud and political corruption.

[5] This has been recommended by a referee of this journal. Policy implications regarding elasticities of labor and capital as appear subsequently are also due to this source.

Fig. 2



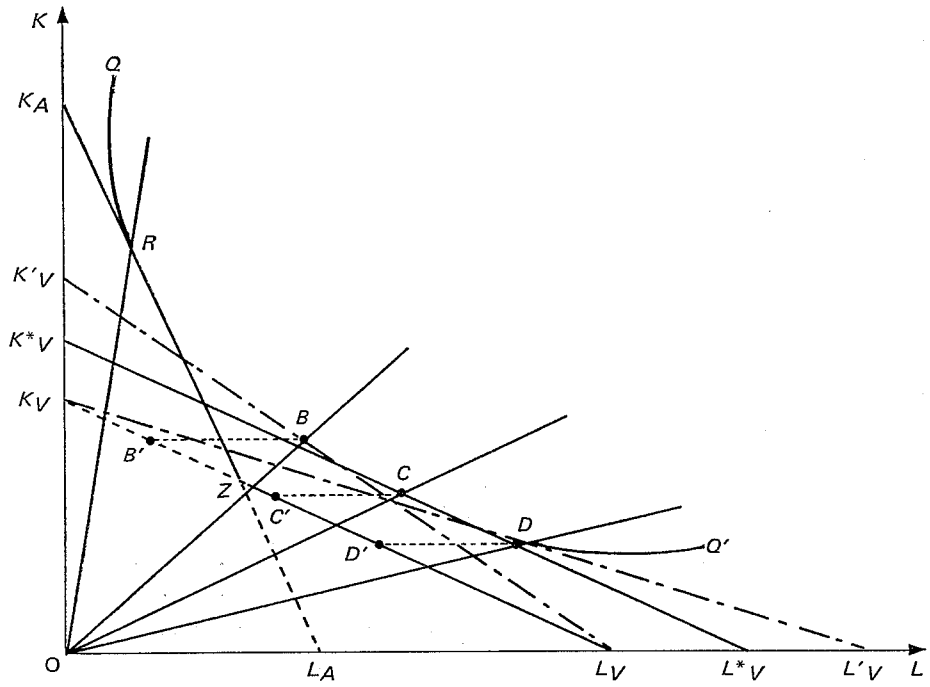
minimizing firm are positive and isoquants are strictly convex; (iii) due to diseconomies of scale the average cost curve of the firm is U-shaped; (iv) the elasticity of substitution between the primary factors of capital and labor σ_{KL} must be greater than zero indicating that substitution possibilities in the production process indeed exist; (v) firms face a perfectly elastic demand for their product regardless of location; (vi) the production function must be homothetic wherein homotheticity is interpreted as a monotonic transformation of a homogeneous function of degree one which relabels isoquants in an order without shifting their shape and allows σ_{ij} to maintain its original value. Considering duality between production and cost functions,[6] under homotheticity, a firm's output is independent of factor prices and depends only on the applied technology ϕ. Thus the ratios of total, average, and marginal costs of producing at any two output levels is independent of factor prices; viz., changes in factor prices due to KS or LS do not influence the cost-minimizing output across regions and this is at the heart of why one region is preferred to another.[7] A production function $\phi[\varphi(.)]$ is homothetic if $\varphi(.)$ is linearly homogeneous in (.) and if ϕ is a non-decreasing function with $\phi(0)=0$ and $\phi(\varphi)\to\infty$ as $\varphi\to\infty$.

Axiomatically, regional subsidies aim to induce core industries to expand to a minimum level at which investment in periphery become profitable. We examine how KS, LS, and QS make a firm indifferent between two areas considering always the aforementioned assumptions on the elasticities of factor supply. It is expected that external economies, agglomeration effects, indigenous savings, spillover activities, and product diversification in the periphery will force the differences between regions to minimize.

[6] See, [25] [32] [35].

[7] The social costs of subsidies is not the transfer payment to receivers but the potential loss of output by moving a firm to the depressed area. It is, also, considered that unlimited financial resources are available for subsidization.

Fig. 3

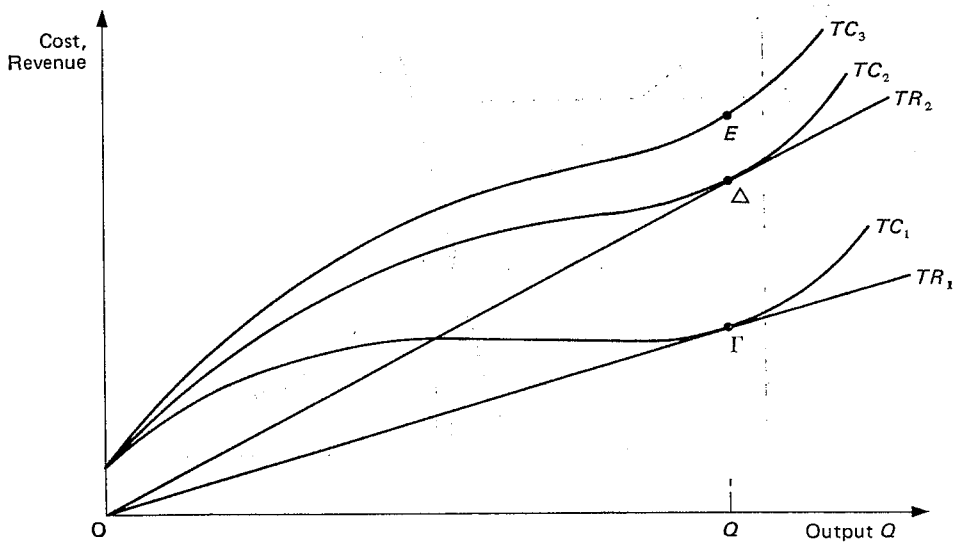


Returning to the Greek case, consider Athens (A) and Volos (V) to represent the advanced and depressed regions respectively. The issue of whether emphasis should be given to the output or the employment level depends on the circumstances: there may be no conflict of interest if establishments with high L/K ratios also yield increased Q/K ratios.

We compare the size of LS, KS, and QS in a quadrant where output is held constant and inflows of capital K and labor L are shown along the vertical and horizontal axes respectively (Figure 3). All costs—business costs and value of government subsidies—are estimated in labor units for convenience; the former is determined by the intersection of the firm's initial isocost with the L-axis and the latter is shown by the horizontal distance between the original isocost and the tangency point of the isoquant QQ' and the subsidized isocost. The cost to the firm in money terms and the monetary value of the subsidy can be calculated by multiplying the respective labor units by labor's initial price in the region receiving the subsidy.

If K_AL_A and K_VL_V are the corresponding isocosts for regions A and V, and K_AZL_V is the production iso-outlay, then based on microfoundations, production equilibrium is determined by the tangency between isoquant QQ' (whose convex portion is deleted in order to avoid cluttering the diagram) and the iso-outlay. Currently the firm is located in region A where the K-intensive technology is

Fig. 4



indicated by expansion path OR with production equilibrium at point R. We, now study the market repercussions of the recommended three alternative subsidies (LS, KS, QS) expecting that at least one of them shall be suitable and permit a site relocation of the firm into depressed region V.

Imposition of LS causes a shift of V's isocost to $K_VL'_V$; this outward rotation around point K_V allows isocost $K_VL'_V$ to become tangent to isoquant QQ' at point D along the labor-intensive ray OD.[8] LS are shown by the horizontal distance $D'D$ and the total cost of production—private plus subsidy—is $(OL_V+D'D)$.

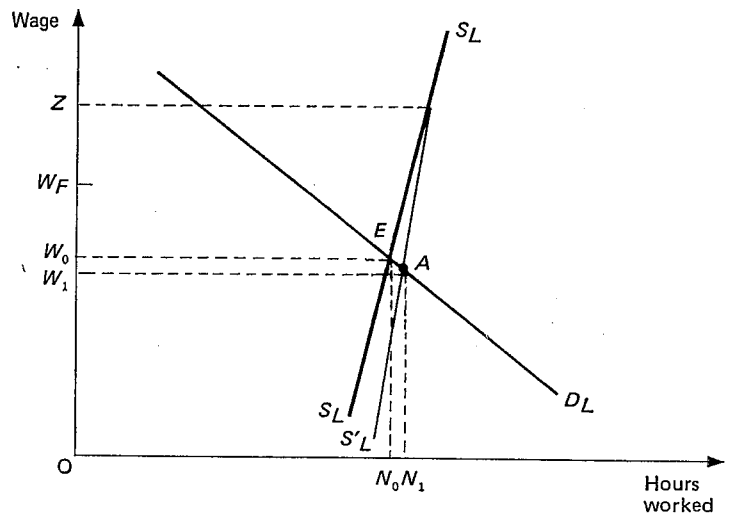
KS allow V's isocost to rotate around point L_V to $L_VK'_V$ making it tangent to isoquant QQ' (not shown) at point B. KS are equal to $B'B$ and the total cost of production is $(OL_V+B'B)$. Finally, the grant of QS does not alter the wage/rental ratio and, therefore, the original isocost K_VL_V shifts to its parallel post-subsidy isocost $K^*_VL^*_V$; the cost of QS is equal to $C'C$ and total cost of product is $(OL_V+C'C)$.

The aforesaid may be shown under a different but relevant framework. Information yielded in Figure 3 are explicitly shown in Figure 4 where TC_1 represents the total cost of expansion path OR of Figure 3 (site A). Considering fixed costs, TC_2 indicates the total costs along expansion path OC under QS and TC_3 shows the total cost under either KS or LS. Apparently, $TC_3>TC_2$ since $C'C<B'B$ or $C'C<D'D$ as shown in Figure 3. Being consistent with the earlier analysis, the firm produces in Athens (point Γ, Figure 4) with zero economic profits at output level Q.

Since QS yield a higher price per unit produced, the slope of the total revenue

[8] The elimination of the convex segment of isoquant QQ' by no means implies that the subsequent equilibria points D, C, and B are arbitrary.

Fig. 5



curve increases from TR_1 to TR_2 tangent to TC_2 at point Δ. The homothetic translogarithmic production function—utilized in Section 3—allows the firm to relable isoquants, to maintain constant optimal scale without changing the original shape, and to produce output Q with a subsidy equal ΓΔ. Similarly, the firm being subject to an input subsidy ΓE, becomes indifferent in producing output Q in either site A or V; it is again self-evidenced that input subsidies are more expensive than QS to the government ($\Gamma\Delta<\Gamma E$ in Figure 4 and $C'C<B'B$; $C'C<D'D$ in Figure 3).

Where output is constant, subsidizing an input causes the firm both to change its location and to increase its use of the subsidized input. The sensitivity of the labor supply (elasticity ε_s) is important for the determination of the efficacy of the LS in raising workers' incomes and employment. Here, we analyze with the help of appropriate diagrams the effects of the three subsidy policies in the case of inelastic supply of labor ($0<\varepsilon_s\leqslant 0.3$).

1. *LS.* In the established literature (viz., Hamermesh [16], Cain and Watts [8], and the plethora of references cited in Killingsworth [20]), ε_s is inelastic ranging between 0.1 and 0.3. If the LS program target wage is set at level Z (Figure 5), and the subsidy rate s at 50 per cent, the implications are: at any pre-subsidy wage rate, say W_0, the subsidy-inclusive wage of the worker will be W_0 plus 50 per cent of the target wage–market wage rate differential. Hence, the subsidy inclusive wage will equal $W_0+0.5\ (Z-W_0)$ or W_F.

Adopting a downward sloping demand for labor curve D_L and the inelastic supply of labor curve S_LS_L we conclude that: (a) the market-wage rate is bid down at W_1 as shown by the intersection of D_L and the post-subsidy supply curve S'_LS_L at point A; (b) hours worked marginally increase from N_0 to N_1; under inelastic supply of labor, LS would *not* have a large employment effect although

Fig. 6

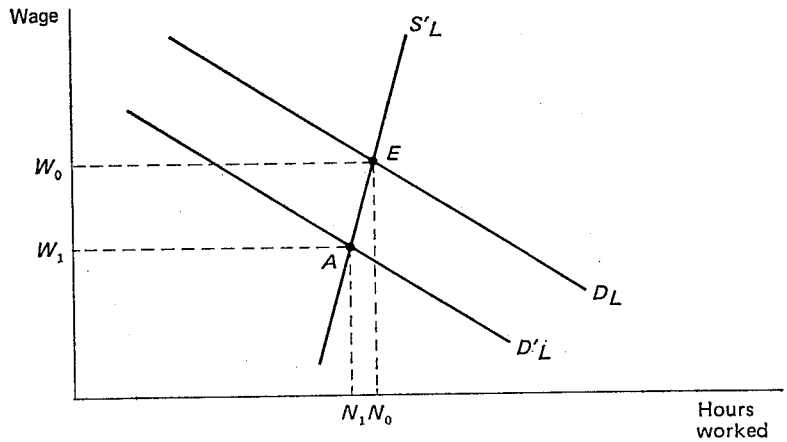
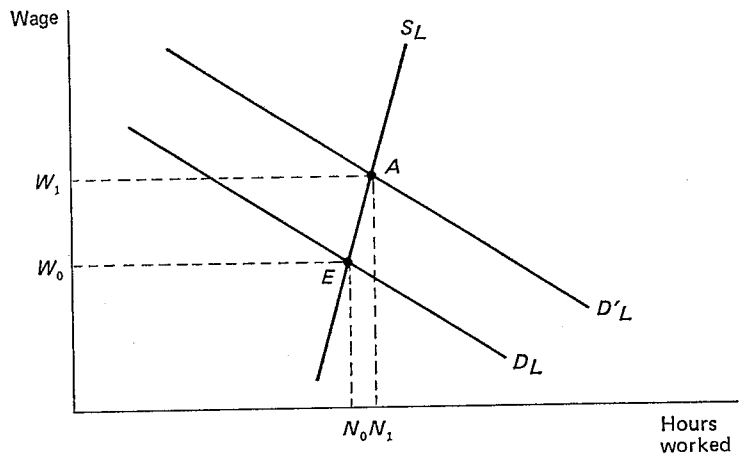


Fig. 7



wages are augmented by the amount of the subsidy; (c) post-subsidy renumeration: apparently, workers' annual subsidy-inclusive renumeration exceeds presubsidy earnings.

2. *KS*. Since in Greek periphery there is no abundance especially of skilled labor, KS will be consistent with the needs of the stagnant areas. If substitution possibilities in the Greek production process exist ($\sigma_{KL}>0$), then the relative price of K decreases through KS in Greek periphery, and relatively more K will be employed. This may cause a downward shift of the D_L to D'_L (Figure 6) allowing thus a small decrease in hours worked but a drastic drop in wages. However, if the output effect dominates the substitution effect, employment may increase; if the two effects are equal to each other, employment remains unaffected.

3. *QS*. Obviously, QS make a firm just indifferent between two locations given that the firm materializes equal profits in both areas. If the firm receives QS it effectively receives a higher price for each unit of output. Thus, the demand for labor increases (from D_L to D'_L in Figure 7) granted that L is a normal input. QS lead to both higher wages and hours worked.

In a pathbreaking work, Borts [5] postulated that it is economically preferred to promote any subsidization rather than doing nothing. His elaborations were heavily concentrated on the values of the elasticity of input substitution as being the primary determinant of choosing the optimum subsidy.[9] More specifically, if α and β are the labor and capital income shares ($\alpha+\beta=1$), σ is the elasticity of factor substitution, r is the pre-subsidy competitive rate of return on capital, and P is the percentage change in output price, then γ_L, γ_K, and γ_Q stand for the social rate of return for LS, KS, and QS respectively.

First, under enacted LS

$$\gamma_L=\frac{r}{\beta}\{1+P(1-\sigma)\}, \tag{3}$$

if $\sigma\geqq 1$, then $\gamma_L>r$ implies that LS are worthwhile.[10]

Second, with KS it is

$$\gamma_K=\frac{r}{\beta}\left[1+\frac{P}{\beta}(1-\alpha+\alpha\sigma)\right], \tag{4}$$

if $P>\dfrac{-\alpha\beta}{1-\alpha+\alpha\sigma}$ then $\gamma_K>r$ and use of KS should be preferred than doing nothing.[11]

[9] Differences in hypotheses between Borts's work and our analysis exist: Borts assumes that capital is variable and labor is constant; we assume that the supply of capital is elastic and the supply of labor is alternatively elastic and inelastic. Also, Borts has formulated his analysis in terms of a "rate of return" approach while we express all costs in terms of labor units. Borts formulated his analysis in terms of the rate of return since "it has been successfully used in the water resource field and it is a useful tool in regional economics.... [It] permits a comparison between sacrifices and gains in national product resulting from development programs." We already mentioned in the introductory explanation of Figure 3 that throughout our analysis it is *convenient* to measure the firm's costs and the value of government subsidies in units of labor. This is an advantage for our case since the monetary cost to the firm and the monetary value of the subsidy can be easily calculated by multiplying the respective labor unit by labor's initial price in the region receiving the subsidy.

Impressively, Milliman in his comment on Borts's work questions the following: "In general I have no quarrel with these conclusions. The analysis is well-done and tightly reasoned. Some theorists might have wished that Borts had formulated his analysis in terms of *net social returns* rather than using a *rate of return* approach..." [27, p. 223].

[10] For $\sigma>1$ it is considered that $P<0$; proofs are readily available in [5, Appendix].

[11] If $\sigma=1$, then $P>-\alpha\beta$ and for given (negative) values of P and α, the larger the σ the less profitable the *KS*. In contrary, under *LS*, profitability rises with σ. Moreover, a casual comparison between γ_L and γ_K yields that *LS* are preferred to *KS* unless $\sigma_{KL}=0$ (fixed coefficients) where $\gamma_L=\gamma_K$. One should keep in mind always the differences in assumptions in Borts's and our model.

Third, QS incentives yield

$$\gamma_Q=\frac{r}{\beta}(1+P), \tag{5}$$

where in $\gamma_Q>r$ if the percentage drop in price P is less than α. From equation (3) it is obvious that if $\sigma=0$, LS=QS.

Overall, the conclusions are straightforward:

1. Input subsidies, viz., KS and LS increase the utilization of the corresponding subsidized input.
2. If labor supply is elastic, the recommended policy is QS since under a limited budget, QS are the cheapest to the government—$C'C$ falls short of either $B'B$ or $D'D$ (Figure 3).
3. If labor supply is inelastic and the adopted subsidy does not reduce the price of output, the recommended policy is KS.
4. If labor supply is inelastic and the subsidy does reduce the price of output, the recommended policy according to Borts is LS and according to our model is KS.
5. Every individual subsidy as a fiscal tool is preferred than doing nothing.

III. EMPIRICAL EVIDENCE AND THE ROLE OF SUBSIDIES

In this section we investigate whether or not substitution possibilities between the primary inputs of K and L exist in the aggregate Greek economy;[12] hence, we estimate the elasticity of substitution between K and L (σ_{KL}) using annual time-series data, 1953–81. We then relate our results with the development policy of subsidization. Apparently, the fundamental question is, are alternative subsidies capable to affect the ratio of input utilization?

More specifically, we disaggregate Greek output between consumption goods Y_C and investment Y_I, both produced by three inputs: Capital K, Labor L, akin to Imports M which have been considered a factor of production.[13] We use a two-output, three-input translogarithmic cost function approach whereas the value of final output is associated with the value of factors of production for each period by the following accounting identify:[14]

[12] If substitution possibilities at the aggregate level exist, it is not necessary that this holds on regional basis.

[13] See, [7] [1].

[14] Detailed calculations, data and their sources are not shown in the sake of saving space; all, though, are available on request. The data are expressed in millions of current Drachmae (Dr.) where appropriate. To calculate the total cost Z we add back the value of imports M into GDP net of non-factor costs: $Z=\text{GDP}+M-T_i+S$ where $T_i=$indirect taxes, $S=$subsidies (Source: [30]). Consumption consists of expenses on non-durables and services by households, government, and exports (Sources: [33] [30]). Investment figures Y_I were treated as residuals between Z and Y_C. For calculation purposes the output shares $R_C=Y_C/Z$ and $R_I=Y_I/Z$ were normalized to 1.00 in base year 1953.

Data involving the three factors of production are: The wage bill (Source: [12]);

$$P_C Y_C + P_I Y_I = W_K K + W_L L + W_M M, \tag{6}$$

where P_i, W_j are the prices of the ith good and jth factor of production respectively. The translog cost specification is expressed as

$$\begin{aligned} \ln Z = \alpha_0 + \sum_i \alpha_i \ln Y_i + \sum_j \beta_j \ln W_j + \frac{1}{2} \sum_i \sum_r \delta_{ir} \ln Y_r \\ + \frac{1}{2} \sum_j \sum_s \gamma_{js} \ln W_j \ln W_s + \sum_i \sum_j \rho_{ij} \ln Y_i \ln W_j, \end{aligned} \tag{7}$$

where Z=total cost, i, r=C, I; j, s=K, L, M; $\delta_{ir}=\delta_{ri}$; $\gamma_{js}=\gamma_{sj}$; and $\rho_{ij}=\rho_{ji}$. The parameters of equation (7) are estimated by the cost shares of labor S_L, imports S_M, and capital S_K:

$$\begin{aligned} S_L &\equiv \frac{\partial \ln Z}{\partial \ln W_L} = \beta_L + \gamma_{LL} \ln \frac{W_L}{W_K} + \gamma_{LM} \ln \frac{W_M}{W_K} + \rho_{CL} \ln \frac{Y_C}{Y_I}, \\ S_M &\equiv \frac{\partial \ln Z}{\partial \ln W_M} = \beta_M + \gamma_{MM} \ln \frac{W_M}{W_K} + \gamma_{LM} \ln \frac{W_L}{W_K} + \rho_{CM} \ln \frac{Y_C}{Y_I}, \\ S_K &\equiv \frac{\partial \ln Z}{\partial \ln W_K} = 1 - S_L - S_M, \end{aligned} \tag{8}$$

and the revenue shares of consumption R_C and investment R_I:

$$\begin{aligned} R_C &\equiv \frac{\partial \ln Z}{\partial \ln Y_C} = \alpha_C + \delta_{CC} \ln \frac{Y_C}{Y_I} + \rho_{CL} \ln \frac{W_L}{W_K} + \rho_{CM} \ln \frac{W_M}{W_K}, \\ R_I &\equiv \frac{\partial \ln Z}{\partial \ln Y_I} = 1 - R_C. \end{aligned} \tag{9}$$

These estimations are derived by applying Shephard's [32] Lemma, viz., partial logarithmic differentiation of the cost and revenue shares with respect to total cost.[15] A series of tests follows the estimation of the translog parameters.

The Allen-Uzawa partial elasticities of input substitution σ_{js} are estimated by

$$\sigma_{js} = \frac{Z \cdot Z_{js}}{Z_j Z_s}, \qquad j, s = K, L, M \tag{10}$$

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the labor force L was obtained from [29]; the price index of capital services was estimated by

$$W_K = r_t q_{t-1} + dq_t - (q_t - q_{t-1})$$

where r_t=long-term rate of interest used as a proxy for the opportunity cost of capital; q_t=implicit price deflator of domestic capital formation; d=average annual depreciation rate, and $q_t - q_{t-1}$=capital gains during the year. (Sources—r_t: [11]; and q_t: [34]).

[15] In order to represent the technology exactly, the cost function must be "well-behaved"; neoclassical theory requires:

a. Linear homogeneity in factor prices: $\sum_j \beta_j = 1$; $\sum_j \gamma_{js} = \sum_s \gamma_{js} = 0$; $\sum_j \sum_s \gamma_{js} = 0$; $\sum_j \rho_{ij} = 0$;

b. Monotonicity in input prices: $\partial \ln Z / \partial \ln W_i > 0$;

c. Concavity in input prices: The Hessian matrix of second partial derivative with respect to factor prices must be negative semidefinite.

Where $Z_j=\frac{\partial Z}{\partial W_j}$, $Z_{js}=\frac{\partial^2 Z}{\partial W_j \partial W_s}$.

For our case, equation (10) becomes

$$\sigma_{KL}=\frac{(\gamma_{LL}+\gamma_{LM})}{S_K S_L}+1. \tag{10'}$$

If $\sigma_{KL}>0$, K and L are substitutes and if $\sigma_{KL}<0$, the two inputs are complements. In order to verify the estimates of σ_{KL} [equation (10')] we also estimate the cross-price elasticities of input-demand,

$$\eta_{ij}=\frac{S_i S_j+\gamma_{ij}}{S_i}, \qquad i, j=K, L, M;\ i\neq j \tag{11}$$

as follows:

$$\eta_{LK}=\sigma_{LK}\cdot S_K, \qquad \eta_{KL}=\sigma_{KL}\cdot S_L,$$

where apparently $\eta_{LK}\neq\eta_{KL}$. If σ_{LK} $(=\sigma_{KL})$ are positive the pair-wise elasticities of substitution are positive with the inputs of K and L being substitutes; the reverse holds for negative values of η_{ij} $(i, j=K, L)$. To obtain further information, the own-price elasticities of input demand are calculated as

$$\eta_j=\frac{S_j^2-S_j+\gamma_{jj}}{S_j}, \qquad j=K, L, M. \tag{12}$$

Finally, we test whether input-output (I-O) separability exists; if it does, we conclude that changes in the composition of output do not affect the cost minimizing input-mix. This is a very significant concept for the present analysis; the test is carried out by setting the interaction terms (input-output) equal to zero:[16] $\rho_{CL}=\rho_{CK}=0$.

In brief, the results are:[17] annual values of σ_{KL} cluster around 0.985 without significant fluctuations during the entire sample period and thus substitution possibilities between K and L indeed exist. Henceforth, a decrease in the relative price of K to L will lead to the employment of relatively more K. Thus, if the relative price of K decreases through KS—presumably in the Greek periphery where K is more expensive—relatively more K will be employed and the productivity of L will increase. This substitutability is also verified by the positive signs of both η_{KL} (with an average value of 0.45) and η_{LK} (with values clustering around 0.36).

The own-price elasticities of input-demand η_L and η_K yield values negative

[16] In a transformation function $H(Y, \varphi)=0$ where Y=output and φ=inputs, if I-O separability exists then $-f(Y)+g(\varphi)=0$ and the cost function may be written as $Z(Y, W)=\lambda(Y)\delta(W)$. Thus $\ln Z(Y, W)=\ln\lambda(Y)+\delta(W)$ and the cost function Z will have no interaction terms between outputs and inputs prices $(\rho_{CL}=\rho_{CK}=0)$. Thus, the marginal rate of transformation between C and I is independent of the input composition, and the marginal rate of substitution between pairs of factors is independent of the composition of content.

[17] Complete tables with annual estimates, 1953–81, are available on request.

and inelastic signaling a certain input demand rigidity ($\eta_L \cong -0.52$ and $\eta_K \cong -0.62$) especially for the labor force.[18] Finally, based on a X^2-distribution, I-0 separability is tested by $\lambda = \hat{L}_\omega / \hat{L}_\Omega$ where $\hat{L}_\omega$ and $\hat{L}_\Omega$ stand for values of the constrained and unconstrained likelihood functions respectively. The calculated X^2-statistic with two degrees of freedom (two restrictions: $\rho_{CL} = \rho_{CK} = 0$) is 1.008 which is well below the $\alpha = 0.05$ critical level of 5.991. We conclude that Greek technology is separable between inputs and outputs and consequently changes in the composition of output do not have any effect on the cost minimizing input mix at given factor prices. This separability is very important for the Greek case. We endorse KS to Greek decision-makers and this incentive shall increase the K-intensity of the production process thus altering the input-mix; this change in the input-mix, though, will not alter the output-composition.

IV. EPILOGUE

The industrial congestion in the Athenian triangle has been recognized as an economic weakness and a more widespread industrial base is being sought by establishing appropriate zones throughout the country. By retaining the firm in heavily industrialized zones, the possibilities of increasing investment returns are deteriorating over time.

In the light of empirical evidence based on Greek time-series data, 1953–81, input substitution possibilities exist and we propose KS to increase the K/L ratio, diminish some growth barriers, utilize local multipliers, and experience positive externalities, with income redistribution effects. The empirically found input-output separability allows the following interpretation: subsidies, by altering the relative price of inputs, cannot become a bottleneck or a vector of rigidities in Greek production. Henceforth, the recommended KS are able to make a firm indifferent in relocating or establishing its new plant in Greek periphery, raise labor productivity—which is among the lowest in the OECD group—and generate an economic metamorphosis in the country. Another implication we derived is that changes in the cost-minimizing input-mix (increased K/L ratio as caused by KS) do not affect the composition of output.

Borts's theoretical buildup on alternative subsidies suggests that LS are worthwhile if $\sigma_{KL} > 1$, if the recommended subsidy reduces the output price, and LS profitability increases positively with σ_{KL}. These postulates do not apply in the Greek case: since the labor supply is *inelastic,* the recommended subsidy does not reduce output price; $\sigma_{KL} < 1$ throughout the twenty-nine annual observations, and the optimum subsidy is KS. Our endorsement is in accord with Borts's calculations where the smaller the σ_{KL}, the more profitable the KS.

These empirical findings along with the proposed KS are not necessarily the ultimate corrective steps for all ills in the Greek economy. They may safely

[18] To satisfy microeconomic foundations, the sum of the cross-price elasticities η_{ij} must be equal to the negative sum of the own-price elasticities of demand η_i.

regarded, though, as adequate for her industrial decentralization which may be just one healthy step to resist the strong antagonism mainly from EEC partners.

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APPENDIX

Since the early 1950s sporadic measures have been adopted by the Greek government through the Institute of Economic and Industrial Studies, the Regional Public Investment Program, and the Council of Greek Industrialists. It is unclear to us whether these steps have been consistent and noncontradictory with production needs and factor endowments. According to Cottis [9] the 80 per cent of firms in less developed regions cannot find business experts, the 73 per cent cannot find skilled workers, and 20 per cent find it hard to attract even unskilled workers. Appropriate references are found in Poulopoulos [31], Koutsoumaris [22], Michalakis [26], and Apostolakis [2]. Characteristically, Lianos [23] insists that scarcity of skilled labor and not shortage of capital is the main barrier to foster economic expansion in Greece. In order to support our argument we report in the following three tables uncommented observations of selected years.

APPENDIX TABLE I

INDUSTRIAL ESTABLISHMENTS AND EMPLOYMENT: SELECTED YEARS

Location	1958		1963		1969		1973		1978	
	Number	%	Number	%	Number	%	Number	%	Number	%
Industrial establishments										
Athens	25,709	23.5	34,262	28.0	40,956	32.8	42.907	35.4	47,332	36.7
Salonica	7,831	7.2	9,382	7.7	12,707	10.2	11,277	9.3	13,432	10.4
Rest	75,696	69.3	78,688	64.3	70,988	57.0	67,173	55.3	68,224	53.0
Total	109,236	100.0	122,332	100.0	124,651	100.0	121,357	100.0	128,988	100.0
Average annual employment										
Athens	171,227	41.4	220,672	46.8	233,779	46.6	279,824	46.3	281,821	42.0
Salonica	40,687	9.8	46,531	9.9	59,282	11.8	70,539	11.7	93,567	14.0
Rest	201,733	48.8	204,361	43.3	208,461	41.6	253,679	42.0	296,108	44.0
Total	413,647	100.0	471,564	100.0	501,522	100.0	604,042	100.0	671,496	100.0

Source: OECD, *Economic Survey, Greece,* various issues.

APPENDIX TABLE II

ESTIMATES ON ECONOMIC MAGNITUDES OF INDUSTRIAL ACTIVITY: LARGE-SCALE FIRMS, 1968 AND 1969

	Greece, Total		Athens	
	1968	1969	1968	1969
No. of establishment	6,417	6,356	3,422	3,409
Gross prod. value	69,821,981	79,681,825	33,159,568	38,313,328
Value added	25,296,991	30,513,939	13,531,021	16,212,916
Remunerated personnel	219,504	224,106	126,846	128,764
Annual labor remuneration	9,637,915	10,705,669	5,768,131	6,384,508

Source: Greece, Ministry of Coordination, *Statistical Yearbook,* various issues.
Note: Values are in thousand of current drachmae.

APPENDIX TABLE III

VALUE OF NEW ESTABLISHMENTS, REPAIRS, AND EXTENSIONS

Year	Establ. in General			Value			(Thereof) Manufacturing		
	Greece Total	Athens	Salonica	Greece Total	Athens	Salonica	Greece Total	Athens	Salonica
1965	20,079	9,046	3,362	2,157,563	1,128,717	252,230	396,435	194,150	59,878
1966	19,801	8,481	2,638	2,401,040	1,025,830	320,817	534,166	161,308	96,614
1967	17,642	6,684	2,084	2,409,169	1,036,399	231,759	450,408	186,198	21,757
1968	19,839	7,517	2,117	3,408,725	1,394,017	296,962	634,719	222,441	21,713
1969	20,799	8,501	2,277	4,243,982	1,472,978	261,360	975,767	254,728	115,689

Source: Same as Appendix Table II.
Note: Values are in thousand of current drachmae.