Regional policy and investment behaviour: The case of Greece, 1971-1982

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LOURI H. (1989) Regional policy and investment behaviour: the case of Greece, 1971–1982, *Reg. Studies* **23**, 231–239. The present paper reports an attempt to evaluate the relative effects of regional policy on investment in Greek manufacturing industry during 1971–82. A generalized neoclassical model of investment behaviour is used allowing for separate estimates of the effects of different policy instruments. Both regional investment incentives and infrastructure expenditures were found to exert a significant influence on capital formation. Simulations with alternative policy combinations showed that if incentives were accompanied by more equally distributed infrastructure expenditures the cost of the policy would be the same but its effects would be enhanced: an equal amount of investment would be created with a fairer regional distribution.

Regional policy Investment Incentives Greece Manufacturing

LOURI H. (1989) La politique régionale et le comportement d'investissement: étude de cas de la Grèce de 1971 à 1982, *Reg. Studies* **23**, 231–239. Cet article fait un compte-rendu d'une tentative d'évaluer les effets relatifs de la politique régionale sur l'investissement dans l'industrie manufacturière grècque de 1971 à 1982. On se sert d'un modèle néo-classique généralisé du comportement d'investissement qui tient compte des estimations indépendantes des effets des divers instruments de politique. Il s'est avéré que les incitations financières et les dépenses d'équipement ont influé sensiblement sur la formation du capital. Des simulations élaborées à partir d'autres combinaisons de politique ont montré que si les incitations étaient assorties de dépenses d'équipement mieux réparties le coût de la politique ne changerait pas mais ses effets seraient accrues: un montant égal d'investissement serait créé, dont une distribution régionale plus équitable.

Politique régionale Investissement
Incitations Grèce Fabrication

LOURI H. (1989) Regionalpolitik und Investierungsverhalten: dargestellt am Fall Griechenlands im Zeitraum, 1971–1982, *Reg. Studies* **23**, 231–239. Der vorliegende Aufsatz beschreibt einen Versuch, die relativen Auswirkungen der Regionalpolitik auf Investierungen in der Fertigungsindustrie Griechenlands im Zeitraum 1971–1982. Es wird dazu ein verallgemeinertes, neo-klassiches Modell des Investierungsverhaltens angewandt, das gestrennte Schätzungen der Auswirkungen verschiedener Instrumente dieser Politik gestattet. Es stellte sich heraus, dass sowohl regionale Investierungsanreize wie Infrastrukturausgaben einen bedeutsamen Einfluss auf die Kapitalbildung ausüben. Simulationen mit alternativen Kombinationen politischer Verfahren zeigten, dass, sofern Anreize von gleichmässiger verteilten Infrastruktur-ausgaben begleitet wären, die Kosten der Politik die gleichen bleiben, die Auswirkungen jedoch verbessert würden: bei gleichem Investierungsbetrag würde eine gerechtere regionale Verteilung erreicht.

Regionalpolitik Investierung Anreize
Griechenland Fertigungsindustrie

INTRODUCTION

The purpose of this paper is to evaluate the relative effects of regional policy on investment in Greek manufacturing industry in the 1971–82 period. Regional policy was aimed at attracting firms to the periphery. It used two main instruments, namely the provision of infrastructure and investment incentives, which worked through creating a better environment for firms and reducing the cost of capital respectively. The beginning of the period is determined by the first systematic shaping of an incentive policy for regional development with legislative decree 1078 in 1971. The end is determined by changes in the investment environment in Greece after 1981 by the newly elected socialist government.

When examining investment across the regions of a national economy locational preferences are critical. Therefore, it is necessary to identify the way in which such preferences are shaped. Industrial investment cannot normally locate absolutely anywhere. It needs an organized urban centre which will provide labour and other services, hence the importance of available infrastructure. Urbanization is a prerequisite for industrialization, although after an initial stage the two proceed hand in hand (RICHARDSON, 1978).

Production (from which demand for investment is derived) is affected by the degrees of urbanization economies available. These economies are the result of the general level of economic activity internal to a city. They reflect advantages available to firms when operating in a larger urban environment where there is a larger overall labour market and a larger public and private service sector (HENDERSON, 1986; LOURI, 1988). Firms take differences in such economies into account and choose their location accordingly. Consequently, the assumptions underlying a regional production function should also refer to interregional differential shifts caused by urbanization economies and affecting locational preferences. Thus, in a regional context and following the neoclassical tradition it is: (1) expected demand for the goods to be produced in the region; (2) the rental cost of capital as differentiated by region; and (3) urbanization economies available in the region that determine investment.

In the next section of the paper, a generalized neoclassical model of regional investment is introduced. The data used for the estimation of the model is presented in the third section and, following this, the effects of policy measures on investment are estimated and discussed. Using these estimations, simulations of alternative policies are then performed. The relative merits of each policy are evaluated as far as fixed capital formation is concerned. Conclusions about the relative performance of the policy implemented are drawn in the final section.

THE MODEL OF INVESTMENT BEHAVIOUR

A relationship describing investment behaviour should be derived from the production function of the industry and not be imposed as a maintained hypothesis in an *ad hoc* way. A regional production function should take explicit account of urbanization economies. LOURI, 1985, found that such economies are significantly affected by the provision of infrastructure.[1] Such a function controlling for the role of location in production is necessary in order to estimate the effects of a policy differentiated across regions.

If the product and capital markets are perfectly competitive and if the production function has constant returns to scale, a constant elasticity of substitution between capital and labour, and is subject to an external (Hicks neutral) shift factor due to urbanization economies, then optimum capital stock ($K^\star$) is:[2]

$$K^\star = b^\sigma N^\theta (c/p)^{-\sigma} Q \qquad (3)$$

where: Q = output
c = the rental cost of capital
p = the product price
b = the capital coefficient in the production function
N = urban population
θ = the degree of urbanization economies
σ = the elasticity of substitution.

Following the generalized neoclassical theory (FELDSTEIN and FLEMMING, 1971) the rental cost of capital is given by:

$$c = q^\gamma (r + \delta - \dot{q}/q)^\varepsilon (1 - J)^\lambda/(1 - u)^\mu \qquad (4)$$

where: q = the price of capital goods
$\dot{q}/q$ = the rate of change
r = the long-run interest
δ = the depreciation rate
J = the present value of investment incentives applied on q
u = the corporate tax rate.

In order to (partly) avoid investment decisions based on equation (3), current values of Q are replaced by expectations about Q given by short-distributed lags:

$$\hat{Q}_t = (1 + h)^\varrho \pi_{i=0}^{\infty} (1 + h_{t-i})^{\varrho_i} Q_t \qquad (5)$$

where: h = the long-term output growth rate
h_{t-i} = growth rate in year $t-i$
$\hat{Q}_t$ = expected or planned level of output in year t
$\Sigma\varrho_i + \varrho = 1$.

The availability of internally generated funds, being a less expensive source of funds than borrowing or new capital issues, is also thought to affect investment decisions by reducing c (FELDSTEIN and FLEMMING, 1971). We approximated internal funds by the opportunity cost of retained earnings in terms of foregone dividends, T. In our case $T = (1 - u_y)/(1 - u)$ (LOURI, 1985), where u_y is the personal income tax rate found by PATSOURATIS, 1980, to be on average equal to u. If $u_y = u$, $T = 1$, i.e. the tax system is neutral between retentions and dividends. Therefore, the availability of internal funds does not affect c. But the (effective) tax rate in the denominator of T is not always a constant equal to u because reinvested profits are not taxed in many cases depending on, for example, the sector, the region and the cost of investment. So, if we name the tax rate in the denominator u_i (for retained and reinvested profits), $0 < u_i < u$. If $u_i = u$, $T = 1$ and c is not influenced. If $u_i = 0$, $T = (1 - u_y) \simeq (1 - u)$ and the tax system favours retention. Thus, the term $(1 - u)$, already included in c to count for the positive effect of taxation on it, may also pick up the negative effect of (cheaper) internal funds on c. Actually, the lower the T, the cheaper the internal funds will be and so the lower the rental cost. Therefore, the corporate income tax rate, u, may be exerting a two-way influence on investment through c. On the one hand it may reduce investment by increasing the cost of capital and on the other it may increase investment by making firms plough back more profits when there are tax allowances for profits to be reinvested. This case will be depicted by a negative coefficient of $(1 - u)$.[3]

Following the assumptions and the theory adopted in this section, the equation giving desired investment in Greek manufacturing industry may be derived from:

$I_t = K_t^* - (1 - \delta)K_{t-1}$ as:

$$I_t = CN_t^{\theta}\{(q/p)^{\gamma}\,(r + \delta - \dot{q}/q)^{\varepsilon}\,(1 - J)^{\lambda}\,(1 - u)^{-\mu}\}^{-\sigma}\,\hat{Q}_t - (1 - \delta)K_{t-1} \quad (6)$$

DATA

Although infrastructure is the same, incentives are different for each of the twenty sectors of manufacturing industry and for different investment goods, namely buildings and machinery, within the same region. Also, the response of each sector to the available incentives and to urbanization economies, through which infrastructure affects investment, varies and occurs with a different time lag. Therefore, it was decided that separate estimates for each sector and type of investment would provide a more faithful picture of real relationships than aggregate estimates. Two equations had to be estimated for each sector. In order to do so, it was additionally assumed that buildings and machinery are separable in production and have proportional returns (BERNANKE, 1983).

Information about capital and ouptut was obtained from the published annual accounts of Greek corporations[4]. Information about available incentives and their award rates was acquired from the relevant legal documents (laws, decrees, etc.) published in the *Government Gazette*. The small number of observations has been a serious problem. We examine the 1971–82 period as explained earlier; hence there are only eleven annual observations. The regional breakdown in three broad areas (Attica, Macedonia and the Rest of Greece) was imposed by the way our data were collected and classified. Since the data at hand were not enough for either a time-series or a cross-section study alone, we decided to pool the observations by sector keeping in mind the problems related to the interpretation of the estimates. Thus, thirty-three observations became available for most sectors[5].

Because of the data limitations covering an eleven-year period for three regions, we used only two short-term growth rates for Q, namely those of present and past years, and different long-term rates for each region.[6] Q was approximated by sales (net of labour expenses) as in many investment studies (BESNER, 1978). Both capital and output data were deflated to represent values at constant 1970 prices. The rental cost of capital in real terms is given by:

$$c/p = (q/p)^{\gamma}\,(r + \delta - \dot{q}/q)^{\varepsilon}\,(1 - J)^{\lambda}\,(1 - u)^{-\mu} \quad (7)$$

where: q = the price index of capital goods constructed by the National Accounts of Greece.

This index is different for buildings and machinery and refers specifically to such goods used only by the manufacturing sector. The base year of the index is 1970. As an approximation of p we used the wholesale price index for each of the twenty manufacturing sectors with $p_{1970} = 100$. The wholesale price indices are published in the Statistical Yearbooks of Greece.

For r we used the lending rate for long-term loans available to manufacturing industry for investment purposes only, published in the *Monthly Bulletins* of the Bank of Greece; δ is the rate allowed for regular depreciation purposes by the tax authorities. The rate of change of capital goods prices, $\dot{q}/q$, should be as expected by the investors and not the actual one. Most investment studies have ignored this term. That might have been acceptable for periods of low inflation, but it is not suitable to recent experience (FELDSTEIN and SUMMERS, 1978; BOSWORTH, 1982). An adaptive expectations model was used to formulate the expected rate of capital changes, $\widehat{\dot{q}/q}$.[7]

The computation of the present value of investment incentives, J, has been complicated; J may include up to four different investment incentives offered simultaneously. The major incentives available in the 1971–81 period are five: increased depreciation allowance (IDA); tax allowance (TA); investment grant (IG); interest rate subsidy (IRS); and interest-free loan (IFL). They are awarded at different rates depending on the time, the place, the sector and the type of capital good. Some are mutually exclusive. In this case, assuming that firms behave rationally, we adopt the combination with the highest present value. The present value of the incentive package available to rational investors is:

$$\begin{aligned} J = {} & [IG/(1 + v)] + [(zIRS/v)\,\{1 - 1/(1 + v)^t\}] \\ & + [u(1 - IG)\,\{DA\,(1 + IDA)/v\} \\ & \{1 - (1 + v)^s\}] + [uTA/(1 + v)] \\ & + [IFL/(1 + r) - 0{\cdot}10\,IFL/\{r(1 + r)\} \\ & \{1 - 1/(1 + r)^{11}\}] \end{aligned} \quad (8)$$

where: t = 10 for 1971–80 and 8 for 1981
v = the short-term lending interest rate used as the ordinary rate of discount
z = the percentage of investment cost eligible for IRS
s = $1/DA(1 + IDA)$ i.e. the fiscal life-time of an asset
DA = the normal depreciation rate
u = the final tax rate paid by corporations (for a more detailed derivation of J see LOURI, 1985).

Urban population is population residing in cities of more than 10,000 inhabitants as reported by the National Statistical Service of Greece in the Statistical Yearbooks (1971–1981).

ESTIMATION RESULTS

Empirical work using mostly quarterly data has showed that desired capital in year t, $K_t^\star$, is not realized completely within the same year, but is subject to lags. So actual capital, K_t, consists of the realized part of presently desired capital, $w_0 K_t^\star$, plus the backlog of completed projects in previous years:

$$K_t = \Sigma_{j=0}^{\infty} w_j K_{t-j}^\star$$

The reasons for such lags are many. LUND, 1971, discusses lags that are inherent in the investment process; in addition, costs of adjustment are believed to have an effect on the lag structure and finally there may be technological reasons for lags (NICKELL, 1978).

If one has long series of quarterly data, it is feasible to estimate at least some of the w's. For example, BEAN, 1981, estimated a five quarter lag between the decision to invest and realization in UK manufacturing industry for 1957–77; HALL and JORGENSON, 1971, estimated a seven-quarter lag for manufacturing investment in equipment and eight-quarter lag for investment in structures in the 1929–65 period in the USA. In our case, with eleven annual observations for three regions, extensive experimentation on the lag structure was not possible. Therefore, we assumed that $K_t^\star$ was realized completely within year t, but it was planned earlier. $K_t^\star$ was determined by plans made in previous years on the basis of actual prices and expectations about output and urbanization economies in year t ruling by the time the plans were drawn. With an investment function as expressed by equation (6) we experimented with different rental costs of capital. Actually, we tried $(c/p)_t$, $(c/p)_{t-1}$, $(c/p)_{t-2}$ following the results of previous research establishing lags of one to two years. Investment was better explained by $(c/p)_{t-1}$ in the case of machinery and $(c/p)_{t-2}$ in the case of buildings. That was much as expected, since most previous research examining the response of investment to c/p concluded that buildings were slower to realize than machinery, the realization period of the first being closer to two years and of the second to one year. Thus, a one-year lag for investment in machinery and a two-year lag for investment in buildings were adopted.

The non-linear form of equation (6) made it difficult to estimate investment. Following FELDSTEIN and FLEMMING, 1971, we log-linearized it by transferring the net capital stock to the left-hand side (*LHS*):

$$I_t + (1 - \delta)K_{t-1} = C\, N^{\theta}\, (c/p)_{t-i}^{-\sigma}\, \hat{Q}_t \qquad (9)$$

Actually, since the elasticity of $K^\star$ with respect to Q, E_{KQ}, is equal to unity from our constant returns to scale CES production function, we should move Q to the LHS of equation (9) too. But since time-series estimate short-run or behavioural elasticity which may differ from the long-run unitary one, we decided to leave Q_t on the RHS and estimate its coefficient from the data. We thought that firms may react hesitantly to changes in expected demand because their expectations are only rough approximations of real future demand. Taking into consideration sudden changes in tastes, technology, competitive import prices and other risk-increasing factors may urge the firms to behave more cautiously. On the other hand, firms may be very optimistic or even discount for changes in expected demand of more than one year in the future, perhaps due to lumpiness of investment goods. So, $E_{KQ} \gtrless 1$ depending on observed short-run behaviour of firms. The function we finally estimated is in a log-linearized form:

$$\begin{aligned}\log[I_t + (1-\delta)K_{t-1}] = {} & a_0 + a_1 \log\hat{Q}_t + a_2 \log N_t \\ & + a_3 \log(1-J)_{t-1} + a_4 \log(r + \delta - \widehat{\dot{q}/q})_{t-i} \\ & + a_5 \log(1-u)_{t-i} + a_6 \log(q/p)_{t-1} \qquad (10)\end{aligned}$$

where $i = 1$ for investment in machinery and $i = 2$ for investment in buildings.

The estimates of equation (10) when only significant variables are taken into account are presented in Tables 1 and 2. We believe that by dropping the (systematically) insignificant variables and keeping only the significant ones for our estimations we improve the stability of our estimates (reducing the variance) without seriously affecting their magnitude. We also facilitate the reader by sparing him 120 insignificant coefficients and 280 t-statistics. Both urbanization economies and incentive policy were found to have a significant impact on investment behaviour.[8]

More specifically, the elasticity of $K^\star$ with respect to urbanization economies was significant in the majority of sectors. Equation (10) was also estimated without N. The performance of the equation became much worse giving lower R^2, F, DW and higher SERs. In some sectors different components of c/p, though not to be significant if N was not taken into account, became significant when adding N to the explanatory variables. The effect of N was strong[9] and similar in all sectors and for both investment types.[10]

It is interesting to note that sectors 31–39, where incentives had a weak effect (for half of them incentives were not significant), respond closely to N. It seems that intermediate and capital goods-producing sectors take the existence of urbanization economies into account more than price effects. It may be that such economies reflect the supply of a specialized labour force existing in urbanized centres which has been found (KOTTIS, 1980) to be an important location factor for such firms. For policy-makers this response could mean that investment in 'heavy industry' is more influenced by infrastructure expenditures (partly increasing N) than by price reductions.

What looks strange is the negative effect of urbanization economies in sectors 20, 25 and 31 for

Table 1. Estimated elasticities of desired capital (machinery) with respect to output, urban population, incentives, rate of return, corporate tax and own price

Sector	a_0	a_1	a_2	a_3	a_4	a_5	a_6	$\bar{R}^2$	DW
20 Food	9.55	0·61	−0·38	−0·13	—	−2·55	—	0·94	1.44
21 Beverages	−5·74	1·37	—	−0·40	—	—	—	0·95	1·57
22 Tobacco	—	0·26	0·58	−0·35	—	−1·35	—	0·90	0·72
23 Textiles	−4·71	0·48	0·79	−0·45	—	−1·54	—	0·95	1·17
24 Clothing and footwear	−6·63	1·03	0·36	—	—	—	—	0·87	1·27
25 Wood and cork	11·15	0·43	−0·28	−0·44	—	—	−1·55	0·90	1·07
26 Furniture	−10·47	1·25	0·42	−1·34	—	—	—	0·97	1·46
27 Paper	−14·88	0·98	1·25	−1·17	—	5·52	—	0·80	1·00
28 Printing and publishing	−17·32	0·42	1·67	−0·58	—	—	−1·15	0·98	2·54
29 Leather and fur products	−11·16	0·69	0·99	−0·38	—	—	—	0·78	0·84w
30 Rubber and plastic products	−2·40	1·18	—	−0·22	—	—	—	0·70	1·94
31 Chemical industries	19·69	1·31	−1·74	—	−0·25*	—	—	0·83	1·09
32 Petroleum and coal refining	—	—	0·94	—	—	—	−0·32	0·36	0·99
33 Non-metallic minerals	—	0·75	0·26	−0·29	—	—	—	0·99†	1·26
34 Basic metal industries	−11·63	0·60	1·43	−0·53	—	4·82	—	0·75	1·28
35 Fabricated metal products	—	0·97	—	−0·61	—	—	—	0·84	1·54
36 Machinery	−1·74	0·31	0·61	—	—	−2·70	—	0·99†	0·97
37 Electrical machinery	—	0·33	0·55	−0·88	—	—	—	0·99††	1·10
38 Transport equipment	−0·90	0·07*	0·89	—	—	−3·07	—	0·99†	1·76
39 Miscellaneous industries	−16·72	0·14	1·68	—	—	−3·67	—	0·96	0·80

Notes: * means that the estimated coefficient is significant at 90% certainty level, while all the rest are significant at 95%.
† next to $\bar{R}^2$ denotes the number of iterations to which the estimation has been subjected in order to correct for serial correlation as explained in note 8.
w next to DW means that the first iteration did not improve the results; therefore, the initial estimation is adopted. For thirty observations and five explanatory variables the critical values of d are d_l = 0·88 and d_u = 1·61 at 1% significance level.

Table 2. Estimated elasticities of desired capital (buildings) with respect to output, urban population, incentives, rate of return, corporate tax and own price

Sector	a_0	a_1	a_2	a_3	a_4	a_5	a_6	$\bar{R}^2$	DW
20 Food	—	0·96	—	−0·29	—	—	—	0·99†	1.79
21 Beverages	—	0·92	—	−0·58	—	—	—	0·91	1·01
22 Tobacco	—	0·27	0·45	−0·59	—	−3·13	—	0·85	1·51
23 Textiles	−5·96	0·54	0·82	−0·55	—	—	—	0·90	1·76
24 Clothing and footwear	−16·12	1·19	0·86	−0·39	—	—	—	0·89	1·31
25 Wood and cork	4·79	0·21	0·20	−0·54	—	−2·95	—	0·59	1·04
26 Furniture	−46·99	0·60	3·63	−3·48	—	5·56	—	0·98†	1·35
27 Paper	−0·41	0·98	—	−1·24	—	—	—	0·99†	1·15
28 Printing and publishing	−51·28	—	4·33	−2·43	—	—	—	0·99	1·87
29 Leather and fur products	−4·75	0·74	0·47	−0·37	—	—	—	0·87	1·22
30 Rubber and plastic products	—	0·93	—	−0·38	—	—	—	0·86	1·22
31 Chemical industries	12·93	1·12	−1·06	—	—	—	—	0·84	1·05w
32 Petroleum and coal refining	−18·48	0·10	2·01	—	—	—	—	0·89	1·16
33 Non-metallic minerals	10·92	0·63	−0·44	—	—	—	—	0·85	0·83w
34 Basic metal industries	−6·41	0·90	0·64	−0·91	—	4·13	—	0·62	0·95
35 Fabricated metal products	−3·66	0·80	0·37	−0·70	—	—	—	0·85	1·18
36 Machinery	−10·63	0·42	1·04	—	—	−4·71	—	0·97	0·93w
37 Electrical machinery	−13·08	0·14	1·62	−0·77	—	—	—	0·91	1·00w
38 Transport equipment	−16·53	0·22	1·64	—	—	−5·06	—	0·87	0·81w
39 Miscellaneous industries	−5.22	0·27	0·60	—	—	−8·18	—	0·88	1·69

Notes: † next to $\bar{R}^2$ denotes the number of iterations to which the estimation has been subjected in order to correct for serial correlation as explained in note 11.
w next to DW means that the first iteration did not improve the results; therefore, the initial estimation is adopted. For thirty observations and four explanatory variables the critical values of d are d_l = 0·88 and d_u = 1·61 at 1% significance level.

equipment and 31 and 33 for structures. For instance, when N increases by 1%, machinery of chemical industries (31) decreases by 1·7% and structures by 1%. We believe that this follows the fact that chemical firms are not now allowed to locate near urban centres due to environmental regulations. A safety distance is kept for new firms, while old ones are not allowed to expand. We also believe that the negative coefficients of N in food (20) and wood manufacturing (25) industries as well as in non-metallic minerals (33) pick up not the effect of urbanization economies but rather the effect of the location of resources. Both sectors are primarily resource oriented, so that as N increases, investment looks as if it is decreasing, while the true story may be that as urban centres grow, more remote resources have to be exploited forcing such industries to locate far away from rapidly urbanizing regions. The general effect of N as estimated from our data seems to be strong with twenty-eight cases out of forty showing a positive effect with an average elasticity of 0·6 for machinery and 1·0 for structures.

We also estimated equation (10) with a composite rental cost, c/p, instead of its four separate components. The estimated elasticity of $K^\star$ with respect to c/p had interchanging signs and was insignificant in most cases. This could be interpeted as an indication that the cost of capital had no effect on new capital formation, i.e. prices do not matter. But having estimated equation (10) as well, it is obvious that the non-significant estimates can be attributed to the unnecessary restriction imposed.

As can be seen in Tables 1 and 2, firms react differently to the separate components of c, the most important among them by far being the investment incentives. Constraining $\gamma + \varepsilon + \lambda - \mu = 1$, and letting a_3 estimate σ, may seriously underestimate the effects of policy. It should be stressed that the differences among the elasticities of $K^\star$ with respect to the components of c may reflect suboptimal behaviour by firms. As FELDSTEIN and FLEMMING, 1971, argued, this helps to bridge the gap between Jorgenson and his followers who presented cross-section evidence that σ is approximately one, and Eisner and others who estimated that the elasticity of $K^\star$ with respect to c/p is lower. Even if technology is Cobb-Douglas, the behavioural (short-run) elasticity with respect to the observed variables may be different from one.

The elasticity of $K^\star$ with respect to investment incentives is found to be significant in fourteen out of twenty sectors for both buildings and machinery. Sectors 20–30 show a much better general fit and a stronger response to incentives than sectors 31–39. From the latter nine sectors incentives are important only in four for equipment and three for machinery. One explanation could be that investment in these sectors is lumpier, being subject to indivisibilities, and therefore more expensive. For such large investment, prices are less important than expected demand or urbanization economies. Also, since investment is larger than average it can additionally benefit from special aids offered to projects of more than Drs 150 million (£600,000 in 1988) independent of location.

The own price, q/p, elasticity appears to be almost insignificant. Probably, observed variation of q/p has not been large, q and p following a similar pattern of change, thus leaving investors rather indifferent to this variable.

The effect of corporate tax rate on capital formation is found to be significant in eight sectors for both buildings and machinery. Its sign is positive in five cases for buildings denoting a 'liquidity' effect, while it is negative in sectors 26, 28 and 34 where apparently investors are more interested in its 'profitability' or capital cost increasing effect. Corporate taxation influences investment in machinery positively in six cases, while only sectors 27 and 34 respond negatively. It may be that sectors responding negatively to a change in taxation have not enough profits to enjoy large tax allowances, so it is only the increase in capital cost that is taken into account.

The required net rate of return, $(r + \delta - \widehat{\dot{q}/q})$, is found not to exercise any important influence on investment behaviour. It showed a very small variation and had even a positive but still insignificant estimated coefficient when the expected rate of price changes, $\widehat{\dot{q}/q}$, was not taken into account. It seems that its changes are too small to affect significantly investment behaviour.

Expected output, $\hat{Q}$, has been the most consistant factor in influencing investment behaviour. It has a strong and significant effect in nineteen sectors for both buildings and machinery.

What is of importance for policy-makers is that incentive policy does not seem capable of restructuring Greek industry in favour of capital goods producing sectors as was expected. Price reductions often tried through the award of higher investment incentives are less important for these sectors than urbanization economies. It also seems that in order to affect the investment decisions of firms, it is primarily expected demand for their product that must be increased (e.g. through state purchases) because this is the factor they mostly take into account.

SIMULATIONS OF ALTERNATIVE POLICIES

This section attempts an evaluation of the relative effects on capital formation of regional policy (ARMSTRONG and TAYLOR, 1985) implemented since 1971 in Greece. Using the estimated coefficients as given in Tables 1 and 2, simulations of the actual and alternative policies are performed and their effectiveness in stimulating investment is assessed. The simulations take into account only the direct effects of the policy measures. The indirect effects through changes in output, prices or urban population are ignored.

Four different combinations of policy measures are considered. Policy P1 assumes that incentives and urban population keep their actual values. Policy P2 assumes that incentives remain the same, but urban population, N, grows everywhere at the rate of total population. In the 1971–81 period, N was increasing by 1·5% p.a. in Attica, 2·3% in Macedonia and 2·5% in the Rest of Greece, while total population was growing by 1·5% p.a. Policy P3 assumes that incentives are abolished everywhere, while urban population remains the same. Finally, policy P4 assumes that infrastructure policy acts in such a way as to let Attica grow at the national rate. Migrants go instead to the urban centres of the other two regions. Macedonia would then have to grow at 2·9% p.a. and the Rest of Greece at 3·1%. The distribution of infrastructure in 1982 implied by P1, P2 and P4 and using an estimated elasticity of 1·28 with respect to population (LOURI, 1985) is for Attica 47%, 49% and 45%, for Macedonia 24%, 23% and 25% and for the Rest 29%, 28% and 30% respectively.

Investment in the 1972–82 period is shown in Table 3. It is the difference between fixed capital in 1972 as given by the data and fixed capital in 1982 as predicted by the simulations of the four alternative policies. We have already noticed that the twenty manufacturing sectors can be divided in two groups according to their responses to the different policy instruments: sectors 20–29 are more responsive to incentives, while sectors 30–39 are more responsive to expected demand and urbanization economies. Therefore, the simulation results are presented for the whole of manufacturing industry and these two groups separately. Incentives accounted for 43% of investment in machinery and 34% of investment in buildings, or 45% of investment in sectors 20–29 and 38% of investment in sectors 30–39.

P4 appears to give superior results combining an equal amount of investment with P1 but more equally distributed. Policy-makers could have made regional investment policy more effective if they had co-ordinated better the available instruments, namely public infrastructure expenditures and investment incentives. P4 would have been possible if infrastructure allocated to Attica had been 2% lower and the difference had been distributed equally to the other two regions[11]. With higher urbanization economies and lower capital cost, remote regions would become more attractive. Lower capital cost alone cannot be very effective if infrastructure is lacking, implying non-availability of specialized labour and facilities necessary for industry to locate in a region.

CONCLUSIONS

This paper has used a generalized neoclassical investment function to evaluate the relative effects of regional policy measures on investment in Greek

Table 3. Investment in manufacturing industry 1972–1982 (%)

a. *Machinery sectors*	Region	P1	P2	P3	P4	R2	R3	R4
20–29	Greece	100	100	100	100	92	61	99
	Attica	44	45	49	42	94	87	94
	Macedonia	21	22	27	22	94	80	105
	Rest	35	33	24	36	89	42	105
30–39	Greece	100	100	100	100	86	52	101
	Attica	28	28	36	24	86	66	86
	Macedonia	31	34	49	32	94	83	103
	Rest	41	38	15	44	81	19	108
20–39	Greece	100	100	100	100	89	57	100
	Attica	37	37	43	33	91	67	91
	Macedonia	26	27	37	27	94	82	103
	Rest	37	36	20	40	85	30	106
b. *Buildings sectors*								
20–29	Greece	100	100	100	100	94	49	99
	Attica	40	50	51	37	93	63	93
	Macedonia	25	25	28	26	94	55	103
	Rest	35	35	21	37	94	28	103
30–39	Greece	100	100	100	100	93	71	100
	Attica	37	38	47	35	94	88	95
	Macedonia	38	39	46	38	98	87	101
	Rest	25	23	7	27	84	20	107
20–39	Greece	100	100	100	100	93	66	100
	Attica	39	39	48	36	94	76	94
	Macedonia	31	32	39	32	96	75	102
	Rest	30	29	13	32	90	24	104

Notes: Investment in 1972–82 is the difference between fixed capital in 1972 as given by the data and fixed capital in 1982 as predicted by the simulations of the four alternative policies.

Columns Pi, $i = 1, 2, 3, 4$, show the distribution of investment associated with each policy, i, among the three regions, See text for details of policies.

Columns Ri, $i = 2, 3, 4$, show the ratio of investment under policy i over investment under (actual) policy 1. Alternatively, they show how much more or less investment is created by each policy relative to the actual one.

manufacturing industry. Both instruments of policy were found to have a significant effect on investment behaviour. Investment incentives were more important for the consumer goods producing sectors, while urbanization economies (partly due to infrastructure expenditures as allocated by the government) influenced capital goods producing sectors more significantly. Both results should be treated with some caution due to information constraints which forced us to pool the data with all the subsequent econometric problems.

Simulations with the estimated investment equations showed that by implementing the actual policy in the 1970s, part of the effect on investment of regional incentives was eroded by the unequal infrastructure policy. On the basis of this limited evaluation there seems to be a need in Greece for reviewing the contradictory regional policy followed up to now, if the pursuit of more equitable regional development is to be continued.

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NOTES

1. Louri, 1985, found that the elasticity of urban population with respect to infrastructure expenditures is 1·27. Urban population is assumed to represent urbanization economies as has usually been the case in similar studies (Sveikauskas, 1972; Segal, 1976; Carlino, 1979; Moomaw, 1981; Henderson, 1986). Of course, as one of the referees noticed this interpretation is not the only possibility. Urban population also measures the size of the local market and its effect may reflect the desire of firms to locate near it.
2. According to Nickell, 1978, p. 243, such a formulation of K^* is acceptable only if we assume oligopolistic markets where firms minimize costs and apply average cost pricing.
3. The second effect should have been taken into account by the present value of tax and depreciation allowances as included in J. In a sense, $(1 - u)$ measures the 'liquidity' effect of fiscal incentives. With both tax and depreciation allowance rates fixed if u increases, the cash flow of firms due to allowances will increase. Thus, internal funds for investment will increase driving c down and K^* up. It is possible that this role of fiscal incentives is not fully represented when included in the aggregate present value of all incentives. The rate of such allowances used when calculating J has a very low average value which could well underestimate its real value for specific investment projects.
4. The data were given to us by the Statistical Service of the Confederation of Greek Industries. They are obtained from the published annual accounts of almost all Greek corporations and limited liability companies accounting for more than 90% of fixed capital in manufacturing industry.
5. For some sectors with no representation in a particular area the number of observations declined to twenty-two. There are four such cases, namely tobacco, furniture, printing and miscellaneous industries.
6. Because of the small number of observations it was difficult to estimate the three ϱ's separately. Thus we took the harmonic mean of $(1 + h)(1 + h_t)(\varrho + h_{t-1})$ i.e. we imposed $\varrho = \varrho_0 = \varrho_1 = 0{\cdot}33$. Feldstein and Flemming, 1971, give more detailed information about the nature of short-distributed lags.
7. The model was of the form $\widehat{(\dot{q}/q)}_t = \alpha\ \Sigma_j\ (\dot{q}/q)_{t-j}$, $j = 0, \ldots, \infty$ Because of the limited number of observations (1958–81 period) we truncated the model taking into account only years $t - 1$ and $t - 2$. The results were as follows:

   $$\text{Machinery: } \widehat{(\dot{q}/q)}_t = \underset{(2{\cdot}72)}{0{\cdot}56}\ (\dot{q}/q)_{t-1} + \underset{(2{\cdot}22)}{0{\cdot}47}\ (\dot{q}/q)_{t-2} \qquad \bar{R}^2 = 0{\cdot}44$$

   $$\text{Buildings: } \widehat{(\dot{q}/q)}_t = \underset{(6{\cdot}54)}{0{\cdot}88}\ (\dot{q}/q)_{t-1} \qquad \bar{R}^2 = 0{\cdot}40$$

   Neither of the two constants was significant; t-ratios are shown in parentheses
8. The Durbin-Watson statistic, d, appropriately adjusted (two gaps between the 11th and 12th and the 22nd and 23rd observations) for the pooled data we have (eleven years for three regions), was lower than d_u at the 1% level of significance in almost half the sectors indicating a first-order serial correlation of the residuals. Such a problem may cause the coefficients to be inefficient but unbiased. We corrected for it applying the Cochrane-Orcutt iterative technique. Different correlation coefficients (R) of the error terms were used, since R proved to be different in each region for the same sector. Actually R was often found to be significant in only one or two of the three regions depending on the sector. The different R's indicated a regional misspecification of the error term. Apparently some accidental regional factor was having a persistent autocorrelated influence on investment in the specific region. Since we used time-series for each region (eleven years), it is possible that an autocorrelated region-specific variable was left out. For example, a port or an energy producing state industry could have offerred services to the specific sector increasing each year in an autocorrelated way which was picked up by the error term. We stopped the interations when adjusted $d > d_u$. In most cases where $d_e < d < d_u$ and d were closer to d_u we did not correct because of danger of over-correcting. The results for these sectors are inconclusive. The degrees of freedom were reduced by six after the correction. It should be noticed that it was in sectors producing intermediate and capital goods that the residuals were autocorrelated implying the existence of omitted region-specific explanatory variables (autocorrelated themselves) influencing these lumpy investment projects.
9. N expected is assumed to be equal to N actual because quite accurate forecasts about N are produced often by the National Statistical Service and published in the Greek press.
10. To make certain that the effect attributed to N was really so, and it was not due to any other variable, output for example, we checked for multicollinearity between them. Most of the correlation coefficients between N and any other included variable were very

low. The coefficients between N and Q were the highest with an average value of 0·64. Thus, the role of urbanization economies in influencing investment appears to be important by its own merit.

11. The cost would not have been different because total infrastructure in 1982 under P1 and P4 is estimated to be almost the same.

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