Increasing Returns and Economic Growth
A Sectoral Approach with respect to Greek Regions

by
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I. Introduction

Ever since Lord Kaldor suggested that the statistical relationship between the rate of growth of labour productivity and that of output (also known as the "Verdoorn's Law") is an indication of substantial increasing returns to scale, it has been surrounded by considerable debate.

Verdoorn's Law is an indispensable element of Kaldor's 1970-growth model, in which he highlights the importance of the manufacturing sector in the process of economic development. Many attempts have been made to test the validity of this Law.

The empirical literature on Verdoorn's Law includes studies with respect to various countries, time periods and data used. In general, the majority of them provide empirical confirmation of Verdoorn's Law. These studies usually refer to the manufacturing sector and tend to take a narrow view by considering this sector as the only "leading" sector of the economy. However, attention should be drawn to the fact that modern economies can have *more than one* "leading" sector.

This paper has two purposes. The first is to shed some further light on whether or not there are increasing returns to scale for the manufacturing sector using regional cross section data for Greece. McCombie and de Ridder (1984) came to the conclusion that the results from estimating Verdoorn's Law using regional data for the US provide a strong confirmation of the existence of substantial economies of scale in the manufacturing sector. Moreover, in modern economies the service or tertiary sector may also be considered as a "leading" sector. The second purpose of this paper is to test the hypothesis of the existence of economies of scale in the tertiary sector of the economy.

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One such attempt, which is particularly interesting, is by Leon-Ledesma (1998) who tests empirically the Verdoornian relation for the Spanish regions, using the technique panel data analysis. A variant of this approach has been developed in this paper for the growth performance of Greek regions.

The rest of the paper is organised in the following manner. Section II outlines Verdoorn's Law. Section III briefly discusses the data used, while section IV presents the econometric results. Finally, section V is devoted to conclusions and some policy implications.

II. Outline of the model

Verdoorn's Law can be specified in linear form as either:

$$p_{it} = \alpha + \beta q_{it} \qquad (1)$$

where t = 1 ... T refers to a given time period. Thus, p_{it}, q_{it} and e_{it} are the rates of labour productivity, output and employment in region i at time t, respectively. The constant term α stands for the rate of autonomous productivity growth and the slope coefficient, β, is the "Verdoorn coefficient".

The growth of labour productivity can be defined as follows:

$$p = q - e \,. \qquad (2)$$

Having equation (3) in mind equation (1) can be written as follows

$$e_{it} = \alpha^* + \beta^* q_{it} \qquad (3)$$

Equation (3) is a mirror image of equation (1) with $\alpha^* = -\alpha$ and $\beta^* = (1-\beta)$. For estimation purposes equation (3) is preferred to (2). This emerges from the fact that equation (2) does not hold if time is a discrete variable.

Attention should be drawn to the fact that previous studies give a value of β^* around 0.5[1]. This implies that a one percentage point increase in output growth induces an increase in the growth of employment of one-half a percentage point and an equivalent increase in the growth of productivity.

Verdoorn's original model (1949) consists of the following equations[2]:

1. See Kaldor (1967), Stoneman (1979), Hildreth (1989). For a more detailed discussion see McCombie and Thirlwall (1994).
2. See Bairam (1987).

$$Q = E^{\varepsilon} K^{\theta} \quad (4)$$

$$W = \mu (Q / E) \quad (5)$$

$$W = \psi (E / N)^{\varrho} e^{\tau t} \quad (6)$$

$$k = \gamma (Q / K) \quad (7)$$

$$N = N_0 e^{\eta t} \quad (8)$$

Q is the level of manufacturing or industrial output, K is the capital stock with k its growth rate, E is the level of employment, N is the total active population. W is the wage rate, ε and θ are the relevant output elasticities, ϱ is the reciprocal of the elasticity of the labour supply with respect to the wage rate, ψ is a constant, τ and η are the exogenous growth rates of W and N, respectively and γ is the average propensity to invest. Having this in mind, equation (7) describes Harrods warranted rate of growth[3].

Equation (5) describes the demand for labour, while equation (6) and (7) are the labour and capital supply functions. The autonomous growth of total labour force is given by equation (8).

Of particular importance is equation (4). This is nothing more than a production relation. Broadly speaking, it is a static Cobb-Douglas production function.

In his original model Verdoorn claims that a fast rate of output growth generates opportunities for greater division and specialisation of labour and, hence, it is possible to obtain gains in productivity. However, of particular importance is the fact that productivity gains can be stimulated by a number of factors associated with the growth of output. Indeed, Kaldor (1966) put emphasis on a *dynamic relationship* between the rate of change of output and of productivity due to technological progress, new discoveries, learning by doing, etc. Once this knowledge is introduced, Verdoorn's Law is not just a reflection of micro economies of scale, but, more importantly, an indication of macro-economies of scale and technical progress induced by output growth and capital accumulation. In other words, the relation between the rate of growth of output per man and the rate of capital per man, i.e. *Kaldor's technical progress function*.

It follows that the Verdoorn coefficient cannot properly be interpreted as a measure of returns to scale unless the contribution of capital stock growth is

3. We are grateful to an anonynous referee for this point.

explicitly included in the Verdoorn equation or there is some evidence that its omission does not bias the coefficient.

If a measure or a proxy of the rate of growth of the capital stock is available, then equation (2) becomes:

$$e_{it} = \alpha^* + \beta^* q_{it} + \gamma k_{it} . \qquad (9)$$

where k_{it} is the growth rate of the capital stock .

Solving equation (9) with respect to q_{it} and rearranging one can obtain,

$$q_{it} = -\frac{\alpha^*}{\beta^*} + \frac{1}{\beta^*} e_{it} - \frac{\gamma}{\beta^*} k_{it} \qquad (9.1)$$

The degree of returns to scale can be obtained by the sum of the coefficients of e_{it} and k_{it}. Thus,

$$v = \frac{(1-\gamma)}{\beta^*} . \qquad (10)$$

The model to be estimated consists of the following two equations:

$$e^j_{it} = \alpha^*_1 + \beta^*_1 q^j_{it} + u_t \qquad (11)$$

$$e^j_{it} = \alpha^*_2 + \beta^*_2 q^j_{it} + \gamma k^j_{it} + u_t \qquad (12)$$

where i = 1 ... N refers to the 13 administrative Greek regions (N = 13) and j = a,m,s denotes each sector of the economy, i.e. agricultural, manufacturing and service sector, respectively. The term u_t stands for the disturbance term of the regression.

III. The data

The data used for estimation purposes are a pool of the average growth rates of output and employment between 1974-1978, 1979-1983, 1984-1988 and 1989-1994 for each of the 13 administrative Greek regions. The reason for the use of panel data is that it permits the control of unobservable heterogeneity between regions. The growth of output (q) can be expressed as the gross value-added at factor cost in each sector, while the growth of employment (e) is the number of employed population in each sector. These data were obtained from various publications of EUROSTAT, publications from the Greek Centre of Economic Research and annual surveys from the National Statistical Agency of Greece. The data are regionally disaggregated by the National Statistical

Agency of Greece. Deflators were provided by the same official source.

Problems arise with the third variable, the growth of the capital stock (k). Regionally disaggregated estimates of the capital stock are not available from official sources. Following Kaldor, the gross investment-output ratio (I/Q) can be used as a proxy for the growth of the capital stock.

Since net investment (i.e. gross investment less scrapings) is definitional equal to the increase in the capital stock, ΔK, the relationship between the k and I/Q is given by (McCombie and Thirlwall, 1994, p. 177):

$$k=\frac{\Delta K}{K}=\frac{I}{Q}\frac{Q}{K}$$

It also has to be assumed that the capital-output ratio does not differ greatly between regions. This assumption stands in marked contrast to the Keynesian analysis. However, the Keynesian approach to economic growth is a demand-orientated approach. As McCombie points out a demand-orientated approach suggests that the growth of capital is determined by the growth of output (McCombie 1986, p. 1223).

It is little wonder that Kaldor in his seminal paper points out

> "It is as sensible-or perhaps more sensible-to say that capital accumulation results from economic development as it is a cause of development. Anyhow, the two proceed side by side. Accumulation is largely financed out of business profits; the growth of demand, in turn, is largely responsible for providing both the inducements to invest capital in industry and also the means of financing it."
>
> (Kaldor 1970, p. 339)

Regional data on investment in the three sectors of the economy and rates of depreciation were obtained from annual surveys of the National Statistical Agency of Greece.

The time period chosen is of particular importance. The period 1974 to 1994 is characterised by several structural changes that took place in Greece. In particular, the Greek economy experienced such a rapid rate of growth that it transformed itself from an agricultural economy into a market economy with a significant industrial base and a high per capita income (Drakopoulos and Theodossiou 1991, p. 1683). This affected the growth performance of Greek regions to a considerable extent.

IV. Empirical results

The regression results obtained testing equation (11) are shown in table 1.

Table 1
The Verdoorn Law:
Greek pooled regional data, 1974-1994

	Constant	q^m	R^2	SD
Manufacturing sector	-0.82	0.56	0.56	0.35
	(-3.98)	(8.09)		
Service sector	0.81	0.47	0.49	0.32
	(3.68)	(2.27)		

Note: Figures in parentheses are t values and SD is the standard deviation of the regression.

As may be seen from table 1 the Verdoorn coefficient obtained from Kaldor's specification for the manufacturing sector, in terms of size and R^2 is satisfactory and in line with the findings of other studies. Since as a rule of thumb, a coefficient is statistically significant if the t-value is greater than two we can conclude that the coefficient of q^m variable is statistically significant.

The value of the coefficient indicates the validity of Verdoorn's Law with respect to the Greek regions. Moreover, the results provide empirical confirmation of the thesis that the manufacturing sector is subject to increasing returns.

More importantly, the value of the Verdoorn coefficient is not only statistical significant for the service sector but also gives support to the view that this sector is also *subject to increasing returns*. This is mainly because in modern economies activities related to services are intensive in technology and productivity gains (especially in the information technology such as hardware and software). This should not be very surprising, considering the importance of the tertiary sector in the process of economic development.

The contribution of capital stock is now introduced.

Table 2 reports the results for equation (12), while table 3 shows the degree of increasing returns obtained from the three methods.

Table 2
The Verdoorn Law:
Greek pooled regional data, Manufacturing sector 1974-1994

	Constant	q^m	k^m	R^2	SD
OLS	-0.044	0.55	-0.20	0.76	0.26
	(-0.22)	(10.7)	(-6.27)		
Fixed effects		0.51	-0.18	0.97	0.16
		(3.9)	(-6.3)		
Random effects	-0.048	0.54	-0.19	0.75	0.24
	(-0.2)	(6.8)	(-7.2)		
Hausman test					
fixed vs random effects	$\chi^2(2) = 0.19$				

Note: Figures in parentheses are t values and SD is the standard deviation of the regression.

Table 3:
Estimates of returns to scale (v)

	OLS	Fixed effects	Random effects
V	2.181	2.313	2.203
Wald $\chi^2(1)$	30.401	16.162	14.583
(p-value)	(0.0000)	(0.0000)	(0.0013)

The important point to note is that the coefficient on the q variable is not only statistically significant at the usual levels but is also similar to that obtained by other relevant studies[4]. The negative coefficient on k indicates the fact that employment falls as the capital stock increases due to substitution of capital for labour. However, the value of the Verdoorn coefficient is not different from the coefficient obtained without the variable of the growth of capital stock. This indicates that investment has a substantial impact on output confirming, thus, the Keynesian approach to economic growth.

Estimates obtained by the three methods show little variation in the coefficients. This could be due to the existence of small unobservable differences between the regions that may have otherwise biased the levels

4. See for example McCombie and deRidder (1984), Leon - Ledesma (1998), inter alias.

estimations obtained in the OLS and random effects models. The values of v indicates the existence of substantial increasing returns to scale, since they are all greater than two, which is confirmed by the Wald test. Once again this reinforces the validity of the thesis that the manufacturing sector is subject to substantial increasing returns.

Estimates for the service sector are presented in table 4. The degrees of returns to scale obtained using the estimated coefficients are in table 5.

Table 4

The Verdoorn Law:

Greek pooled regional data, Service sector 1974-1994

	Constant	q^s	k^s	R^2	SD
OLS	-0.92	0.66	-0.20	0.93	0.14
	(-2.76)	(24.04)	(-11.61)		
Fixed effects		0.47	-0.19	0.92	0.14
		(4.20)	(-7.79)		
Random effects	-0.13	0.62	-0.20	0.93	0.14
	(-0.73)	(10.68)	(-9.37)		
Hausman test					
fixed vs random effects	$\chi^2(2) = 2.67$				

Note: Figures in parentheses are t values and SD is the standard deviation of the regression.

Table 5

Estimates of returns to scale (v)

	OLS	Fixed effects	Random effects
V	1.81	2.53	1.93
Wald $\chi^2(1)$	11.46	23.24	27.58
(p-value)	(0.0007)	(0.0000)	(0.0013)

As may be seen from table 4, the results obtained using data for the service sector indicate that this sector is also subject to increasing returns. As in the manufacturing sector, all the calculated values of v are significant greater than unity at the 99 % confidence level. So the null hypothesis of constant returns to scale is rejected for the case of the service sector.

Attention should be drawn to the fact that available data on service sector tend to underestimate the contribution of this sector because a lot of service activities related to industrial production are counted in the manufacturing sector. However, the values of returns to scale indicate that the data used may not be subject to this bias. Quantitatively, the most important effect is that the value of v obtained for the service sector using the fixed effects model is statistically significant and greater than two, which stresses the importance of the service sector in determining the growth of output. The large degree of returns to scale can also be considered as the result of economy- wide technical progress.

Finally, the results obtained for the agricultural sector are reported in table 6.

Table 6
The Verdoorn Law:
Greek pooled regional data, Agriculture sector 1974-1994

	Constant	q^a	k^a	R^2	SD
OLS	-1.56	-0.019		0.18	0.21
(without the inclusion of the k^a variable)	(2.1)	(0.41)			
OLS	1.30	0.16	-0.17	0.21	0.49
(with the inclusion of the k^a variable)	(3.91)	(1.91)	(-2.98)		

Note: Figures in parentheses are t values and SD is the standard deviation of the regression.

The estimations obtained and the diagnostic tests, for both specifications, give a very low goodness of fit. However, these results for the agricultural sector should not be surprising.

Of particular importance is the fact that development involves a continued fall in the share of the “primary” sector (agriculture, mining, etc) in total output and employment and a continued rise in the share of “secondary” (industry, construction, etc) and “tertiary” (services, banking, etc) sectors.

Kaldor suggests that in the agricultural sector there is no relationship between employment of resources and output obtained, thus permitting the transfer from agriculture to the manufacturing sector. Consequently, Kaldor’s view of the agricultural sector as a “passive” sector receives considerable support in the case of Greece.

V. Conclusions

The results obtained in the previous section give considerable support to the thesis that Verdoorn's Law holds in the case of Greek regions. Indeed, there is overwhelming support for the hypothesis of increasing returns to scale in the manufacturing sector. However, the manufacturing sector can not be considered as the only leading sector of the economy. As the results indicate, the service or tertiary sector is also subject to considerable increasing returns to scale. As already mentioned, during the last ten years Greece has been able to incorporate advanced technology in the service sector. This fact may explain, to a certain extent, the increasing returns in this sector. This, in turn, addresses an interesting question in the debate of deindustrialisation: to what extent service activities have an autonomous existence and to what extent they are vertically integrated with the process of manufacturing, since the demand for most services is derived from the demand for manufacturing output. However, several regions of Greece were able to grow due to a shift from agriculture to tertiary activities, mainly tourism. In this respect we can consider the existence of service activities as autonomous. This implies that the service sector cannot be considered as a "passive" sector, but rather as one of the *"leading"* sectors of the Greek economy.

The main conclusion is the importance of tertiary or service sector for regional economic growth, providing support to the sectoral approach to economic growth. The neo-classical production function approach to the measurement of economic growth is very aggregative. It treats all the sectors of the economy as if they have the same production or growth characteristics. Nicholas Kaldor has argued in many of his writings that it is impossible to understand the growth and development process without taking a *sectoral approach*, distinguishing between increasing returns activities on the one hand and diminishing returns activities on the other. Consequently, the main thrust of economic policy as far as regional economic development is concerned, should be aimed to encouraging private and public investment (mainly infrastructure) in sectors which are subject to increasing returns to scale. Furthermore, provision of regional infrastructure should be oriented not only to the "traditional" activities, such as transportation and communication systems, but also to the development of educational and research institutes in poor regions, in order to enhance indigenous human capital and local talents.

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Abstract

This paper is a consideration of the implications of the *macro phenomenon of increasing returns* and Verdoorn's Law (or Kaldor's second Law of growth) for regional economic growth with respect to Greek regions during the 1974-1994 period. The empirical results suggest that both the manufacturing and the service sector are subject to increasing returns, so that the service sector should not be considered simply as a "passive" sector, but rather as one of the "*leading*" sectors of the Greek economy.