Kaldorian Approach to the Economic Growth of Greek Regions[1]

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The present paper reports an attempt to examine the tendencies of regional growth and convergence with respect to Greek regions. It does so by establishing the validity of Kaldor's second Law of growth (or Verdoorn's Law) and tests for regional convergence in the 'conventional' framework introduced by Barro and Sala-i-Martin. The empirical results suggest that regions of Greece converge at an extremely slow rate. This slow rate can be attributed to differences in regional specialisation. Moreover, is established that both the manufacturing and the service sector are subject to increasing returns. Therefore, the service sector should not be considered as a 'passive' sector, but rather as one of the *'leading'* sectors of the Greek economy.

Keywords:

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I. Introduction

A major concern for economists in general, and for development economists in particular, is to find an explanation for the persistent disparities in the level of development between different regions within a country. Broadly speaking the problem at hand is *'why levels of growth differ between regions?'* The question is simple; the answer less so. Traditionally, there are two opposing tendencies to this issue. First, the neo-classical approach based on the concept

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of general equilibrium and second the Post Keynesian approach, as formulated in the disequilibrating models of 'cumulative causation' or 'centre and periphery,' based mainly on the existence of increasing returns.

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, the relation it has been surrounded by considerable debate.

Verdoorn's Law is an indispensable element of Kaldor's[2] 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 includes studies with respect to various countries and regions, both time series and cross section. In general, the majority of them provide empirical confirmation of this relation. 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. With this in mind, it becomes evident that the service sector is typically ignored. The important point to emphasize is that modern economies can have *more than one* leading sector.

This paper has a contribution to make to the existing literature on regional convergence with respect to Greek regions. In particular, this paper has two purposes. The first is to shed some further light on whether or not there are increasing returns to scale in the manufacturing sector using regional panel data for Greece. McCombie and de Ridder (1984) came to the conclusion that the results from estimating Verdoorn's Law using regional data provide a strong confirmation of the existence of substantial economies of scale in the manufacturing sector. But, in modern economies, the service or tertiary sector may also be considered as a 'leading' sector. This hypothesis is also tested in this paper using the Verdoorn relation. The second purpose of this paper is to confront alternative theories with empirical evidence regarding region convergence. In particular, the 'conventional' neo-classical approach to convergence, as outlined by Barro and Sala-i-Martin (1992, 1995) is opposed empirically with the Post-Keynesian view.

The rest of this paper is organized in the following manner.

[2]In particular, see Kaldor (1966, 1967, and 1970).

Section II briefly develops the neo-classical and the Post-Keynesian approaches to regional economic growth and reproduces some of the criticisms that have been levelled against the former approach. The way that new approaches to regional growth map into contrasting ideas regarding the mechanisms of regional growth is then discussed. In particular, the main features of Endogenous Growth Theory and the New Economic Geography are also outlined briefly in this section. Section III specifies the mathematical formulation of Verdoorn's Law together with the conventional neo-classical test for regional convergence. Section III is then followed by a briefly discussion of the data used, while section V presents the econometric results. Finally, in the concluding section we offer a possible explanation for the results we obtain and suggest that might afford an interesting policy conclusion.

II. Why Levels of Growth Differ Between Regions?

In this section we shall discuss some of the theories that have been put forward to explain regional growth and convergence. The models belonging to the neo-classical and Post-Keynesian tradition are outlined first, followed by a discussion of the more recent approaches by the Endogenous Growth Theory and New Economic Geography.

A. The Neo-Classical and the Post-Keynesian Approaches

In neo-classical theory, regional differences in levels of per capita income are supposed to converge in the long run, mainly through trade and factor mobility. The neo-classical approach depends critically upon the restrictive and unrealistic assumptions of perfect competition. We can note Richardson's comments on this point:

> '...the background assumptions of neo-classical growth theory are inapplicable to the regional economy.... Perfect competition cannot be assumed in regional economic analysis since space itself and the existence of transport costs limits competition; oligopoly, pure monopoly or monopolistic competition are much more appropriate market structures. Indeed, *if we adopt neo-classical models in their pure unadulterated form there would be no such field as regional economics*.' (1973, p. 22) [Emphasis added]

Using the aggregate production function, which exhibits constant returns to scale, the neo-classical paradigm predicts that regional per capita incomes will finally converge. Convergence is brought about mainly through the free movement of factors of production. The argument runs as follows. Labour will migrate from poor regions to the prosperous regions, while capital will move from rich regions to poor regions. To the neo-classical economists the diffusion of innovations and technology is a meaningless topic. Technical progress, under the assumption of perfect competition, is available to all or at least, 'plays a reinforcing role which accentuates the effects of investment and labour force growth' (Borts and Stein 1964, p.8)[3]. This suggests that the process of regional growth, in the neo-classical spirit is a *static* equilibrium process.

Nevertheless, several criticisms have been raised against the predictions, which this model has yielded because of various drawbacks underlying these predictions. First, the neo-classical approach is very supply orientated. This approach can be criticised on the grounds that it cannot provide a satisfactory answer to the question why the growth rates of capital, labour and technical progress differ over time or between regions within a country. This is mainly because the sources of growth are treated as exogenous. Second, the use of the production function to explain growth performance is very aggregative. The essence of this aggregation is that the various sectors of the economy are assumed to have the same characteristics in production. This steams from the assumptions, which characterize perfect competition. But, as mentioned above, this assumption is unrealistic, when the primary concern is on regional economics. Third, the neo-classical approach makes the implicit assumption of constant returns to scale. This approach arises from the overriding emphasis on treating the economy as a whole. This assumption is also unrealistic. It is impossible to understand the growth and development process (and divisions between rich and poor regions within a country) without taking a *sectoral* approach. The sectoral approach involves a distinction between sectors with increasing returns on the one hand and sectors with diminishing returns activities on the other.

Kaldor, as an answer to the neo-classical approach, articulates

[3]In other words, technology is treated as a public good.

three fundamental growth 'laws,' stressing the importance of industrialisation to the development process. In particular, Kaldor formulated them in a series of influential papers, published mostly in the 1970s.

These growth 'laws' are the following (Thirlwall, 1983):

First Law: There exists a strong positive relation between the growth of manufacturing output and the growth of GDP.

Second Law: There is a strong positive relation between the rate of growth of productivity in manufacturing industry and the growth of manufacturing output.

Third Law: The faster the growth of manufacturing output, the faster the rate of labour transference from non-manufacturing to manufacturing, so that overall productivity growth is positively related to the growth of output and employment in manufacturing and negatively associated with the growth of employment outside manufacturing.

Kaldor's first law stresses the importance of industrialisation in the development process. That is, the faster manufacturing output grows, the faster the GDP grows. What is the intuition behind this argument? There are two main explanations for this. The first is wherever industrial production and employment expand, labour resources are drawn from other sectors which have open or disguised unemployment, so that the labour transference to manufacturing does not cause a diminution in the output of these sectors and therefore productivity growth increases outside manufacturing (McCombie and Thirlwall 1994, p. 166).

The second explanation is rooted in the existence of increasing returns in the manufacturing sector, in the static and dynamic form. Before any progress can be made, it is necessary to understand exactly what is meant by static and dynamic returns to scale. Thirlwall emphasises this point.

> Static returns relate to the size and scale of production units and are a characteristic largely of manufacturing where in the process of doubling the linear dimensions of equipment, the surface increases by the square and the volume by the cube. Dynamic economies refer to increasing returns brought about by 'induced' technical progress, learning by doing, external economies in production, and so on. Because economies of scale result from increased product differentiation, new processes, new subsidiary industries, and so on, it was Young's contention that they cannot be discerned adequately by observing the effects of variations in the size

> of an *individual* firm or of a *particular* industry. Economies of scale and increasing returns derive from general industrial expansion, which should be seen as an interrelated whole or as an interaction *between* activities [emphasis in the original] (Thirlwall 1983, p. 349).

Furthermore, economies of scale may be either internal or external. Internal economies may arise within firms on account of engineering or managerial considerations; external economies may be obtained by the geographical concentration of activities, so that services and other facilities may be shared in common (Chisholm 1990, p. 72).

All of these considerations are relevant for the way in which we view regions and their economic growth. Perhaps the main point of relevance is the following. Kaldor's second growth law (Verdoorn's Law) deals with the positive relation between the rate of growth of productivity in manufacturing industry and the growth of manufacturing output. In the present context, two features are of particular relevance. First, Verdoorn's Law indicates the industrial sector as the leading sector of the economy or 'the engine of growth.' This argument arises from the overriding emphasis on the sectoral approach to the growth process. The manufacturing sector is subject to a faster growth of productivity, whilst the remaining sectors are 'passive' responding to the growth of the former. This, according to Kaldor, indicates the *dual nature* of modern economies. But beyond this, the second important feature of the Verdoorn's Law is that it provides a base or a fundamental element of the cumulative causation models. Indeed, through the Verdoorn effect, the industrial growth can result in a cumulative process through the concentration of economic activities. In the context of regional economies, scale economies are of crucial importance. Due to the existence of increasing returns to scale, captured in the Verdoorn relation, growth rates not only differ among regions, but are also perpetuated. Internal and external economies of scale result in a *geographical concentration* of economic activities. This fact intersects with the Keynesian emphasis on disequilibrium processes, giving scale economies considerable status as an important mechanism, allied with multipliers and the Verdoorn effect, creating a *cumulative* growth processes.

The Verdoorn effect, therefore, provides a mechanism whereby a region, which grows faster than other regions will obtain

productivity, or quality advantage, which will probably mean that it will continue to grow more rapidly, reinforcing the disequilibrium effects (Chisholm, 1990). Kaldor recognised the importance of increasing returns to scale in determining regional growth rates. Kaldor offers a broader definition of increasing returns and the function of Verdoorn law in the context of cumulative causation models. A quotation from Kaldor gives a clear picture of his ideas:

> [increasing returns to scale] are not just the economies of large-scale production, commonly considered, but the cumulative advantages accruing from the growth of industry itself- the development of skill and know-how; the opportunities for easy communication of ideas and experience; the opportunity of ever-increasing differentiation of processes and of specialisation in human activities. [...] One aspect of this [the Verdoorn's Law] is that as communication between different regions becomes more intensified (with improvements in transport and in marketing organisation), the region that is initially more developed industrially may gain from the progressive opening of trade at the expense of the less developed region whose development will be inhibited by it (Kaldor 1970, pp. 315-6).

B. Endogenous Growth and New Economic Geography

In recent years, doubts have crept in the validity of the traditional neoclassical and the Post-Keynesian model. The 1980s and 1990s have seen the earlier growth models augmented by a new generation of growth theories. Research on economic growth has diverted into a new context provided by an entirely new strand: the *New* or *Endogenous Growth Theory*. According to Armstrong and Taylor (2001), this has given a welcome fillip to what had become a rather sterile debate between supporters of neo-classical and post-Keynesian views of regional growth.

Endogenous growth theory is build upon the premise that long-run growth in per capita output depends on *investment decisions*, rather than unexplained or exogenous improvements in technology, which are *generated within* the growth process. Thus, endogenous growth theory moves towards an explanation for the *causes* of technological progress.

This concept of technological progress has led to the development of endogenous growth models, which put strong emphasis on the dictum that technology is created *intentionally*. Following the spirit of this approach, progress in technology is the outcome of *human*

capital formation and activities relating to the research and education and is incorporated into capital, defined in 'broad' terms. From this perspective endogenous growth models with 'broad' capital may deem as an extension of the neo-classical model. However, in the context of endogenous broad capital technological progress is no longer determined exogenously but it is an inherent element of the mechanisms of the economic system. In particular, the endogenous broad capital model modifies the traditional neo-classical production function in such a way to include *externalities* to investment.

The notion of externalities, especially in Arrow's sense[4], is the cornerstone of the endogenous growth theory. Romer (1986) claims that externalities due to investment in capital stock are generated through '*knowledge spillovers*' and '*learning by doing*' effects. It these *externalities* that make technology a 'public' good and, thus, technological progress is generated within the system as an outcome of the growth process. Romer developed the most instructive model in this category in series of influential papers, published mainly in the late 1980s and early 1990s.[5] Romer argues that technology is a non-rival input; that is, its exploitation by one firm does not rule out its exploitation by another. In his formal model the important feature is the distinction between the rival component of knowledge and the non-rival technological component. Hence, the treatment of knowledge as a non-rival good provides an explanation for knowledge spillovers. A central tenet of Romer's thesis is that firms can patent technological inventions and innovations, which gives them the exclusive right to produce new goods. In turn, these innovations create new 'general' knowledge, which is freely available to all firms. Romer's (1990) model explicitly describes the contribution of the research sector, which generates endogenous innovations.

Nevertheless, the best application of the notion of externalities can be found in the recent models that explain the rise and success of new industrial districts[6] and to the models of *New*

[4]Kaldor (1957) and Arrow (1962) are considered to be the 'progenitors' of endogenous growth theory. See McCombie and Thirlwall (1997).

[5]See Romer (1986, 1990, 1990a, 1993, and 1994).

[6]This approach usually pays attention to specific regional case studies, which allow for a detailed analysis of the complex interacting forces that determine the evolution of a local system, by combining economic, social

Economic Geography.

Krugman's view of economic geography is, as Martin and Sunley (1996) point out, non-equilibrium one. In Krugman's world, an automatic process of spatial equilibrium with equal factor payments does not exist. The uneven balance across space is attributed to similar mechanisms as in Kaldor's model, namely the operation of *dynamic increasing returns*, which provide comparative advantages to a selected number of localities. Krugman argues that once an initial regional advantage is established it may become cumulative through backward and forward linkages, which 'lock in' regions to a given growth pattern. Krugman does not deny the relevance of its theory to Kaldorian approach and acknowledged this by mentioning that

> 'this clear dependence on history is the most convincing evidence available that we live in an economy closer to Kaldor's vision of a dynamic world driven by cumulative processes than the standard constant returns model' (Krugman 1991, pp. 9-10).

III. The Model

The primary purpose of this section is to articulate the mathematical framework upon which the empirical analysis will be conducted. In particular, the specification of Verdoorn's law and the neo-classical expression for regional convergence are discussed.

A. Specification of Verdoorn's Law

Moving away from the above abstract considerations, so as to get closer to the complications of the empirical verification, account has to be taken of the specification of Verdoorn's Law. Verdoorn's Law can be specified in linear form as either:

$$p_{i,t} = \alpha + \beta q_{i,t} \qquad \text{or} \tag{1}$$

$$e_{i,t} = \alpha^* + \beta^* q_{i,t} \tag{2}$$

where $p_{i,t}$, $q_{i,t}$ and $e_{i,t}$ are the rates of growth of labour productivity,

and cultural factors. See for example Harrison (1992), Storper (1992), Markusen (1996), and Acs (2000).

output and employment in region i at time t, respectively. The constant term a stands for the rate of autonomous productivity growth and the slope coefficient, β, is the Verdoorn coefficient. Since $p_{i,t}=q_{i,t}-e_{i,t}$, it follows that $\alpha*=-\alpha$ and $\beta*=(1-\beta)$.

Estimates of the Verdoorn coefficient using equation (1) or (2) give a value of around 0.5. This coefficient 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. In his original model Verdoorn (1949) 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. 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 macroeconomies of scale and technical progress induced by output growth and capital accumulation.

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*. Dixon and Thirlwall (1975) set up this argument by specifying the technical progress function in linear form as

$$r=d+\pi(m) \tag{3.1}$$

where r is the rate of growth of output per man, m stands for the rate of growth of capital per man and d is the rate of disembodied technical progress.

Together with the associated assumption that d and m are functions of the rate of growth of output, equation (3.1) can be written as

$$r=r_a+\pi\lambda(g) \tag{3.2}$$

where g is the rate of growth of output, r_a is the rate of autonomous productivity growth and λ is the Verdoorn coefficient.

The autonomous rate of productivity is determined by the autonomous rate of disembodied progress, the autonomous rate of capital accumulation per worker and to the extent to which

technical progress is embodied in capital accumulation. The Verdoorn coefficient is determined by the rate of induced disembodied technical progress, the degree to which capital accumulation is induced by growth and the extent to which technical progress is embodied in capital accumulation (Dixon and Thirlwall, 1975, p. 209). The importance of this can be stated quite succinctly. The process of growth can be regarded *endogenous* to an economic system.

From the discussion above, 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 explicitly included in the Verdoorn equation.[7] If a measure or a proxy of the rate of growth of the capital stock is available, then equation (2) becomes:

$$e_{i,t} = \alpha^* + \beta^* q_{i,t} + \gamma k_{i,t} \tag{4}$$

where $k_{i,t}$ is the growth rate of the capital stock.

The degree of returns to scale obtained from equation (4) is:

$$\nu = \frac{(1-\gamma)}{\beta^*} \tag{5}$$

Thus, Verdoorn's Law is expressed in terms of the following regression equations:

$$e^j_{i,t} = \alpha_1^* + \beta_1^* q^j_{i,t} + u_{i,t} \tag{6}$$

$$e^j_{i,t} = \alpha_2^* + \beta_2^* q^j_{i,t} + \gamma k^j_{i,t} + u_{i,t} \tag{7}$$

where the subscripts i and j refer to the 13 administrative Greek regions and each sector of economy (agricultural, manufacturing and services), respectively.

B. Convergence from the neo-classical perspective

During the last 20 years there has been a proliferation of studies investigating the issue of whether the process of economic

[7]Or there is some evidence that its omission does not bias the coefficient.

development is fundamentally *convergent* or *divergent* in nature. Convergence might be thought as a decline in inequalities across economies in *levels* of per capita income through time. In his seminal paper Baumol (1986) examines the hypothesis of convergence, expressed in terms of a regression equation as follows:

$$y_{i,T}-y_{i,0}=a+by_{i,0}+u_{i,T} \tag{8}$$

where $y_{i,T}$ and $y_{i,0}$ are the natural logarithms of per capita income during the terminal and initial time, respectively. The terms a and $u_{i,T}$ stand for the constant and the error term of the regression, respectively, while the subscript i indexes the economies included in the regression.

Of critical importance is the coefficient of the initial level of output per worker. Since the left-hand side of equation (8) measures, in essence, the growth rate during the time interval T and 0, if economies with higher initial levels of per capita output grow slowly, then this implies a negative value of b and *vice versa*. As Romer (1996) notes, a value for b of -1 corresponds to perfect convergence: higher initial income on average lowers subsequent growth one-for-one, and so output per person in the terminal year is uncorrelated with its value in the initial year. If the value of the convergence coefficient turns out to be zero, then this is an indication that the convergence hypothesis does not hold. Growth is, thus, uncorrelated with initial income and economies included in the data set may even exhibit divergence. In this context the term 'divergence' is used in the sense that the gap between rich and poor economies has increase during the period under question. Barro and Sala-i-Martin (1992) argue that the convergence coefficient b is expressed as follows:

$$b=-(1-e^{-\beta t}) \tag{9}$$

where the term β indicates the speed at which economies approach their steady-state value of output per worker. The condition expressed by equation (9) implies that the convergence coefficient is bounded to the sign of the parameter β. Since $b<0$ implies convergence then the parameter β should be positive. In other words, if $\beta>0$ then this is an indication of convergence and *vice versa*.

IV. The Data

The data used for estimation purposes are a pool of the average growth rates of output and employment between 1974 and 1998 for each of the 13 administrative Greek 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 annual surveys from 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. Many of the difficulties of the data availability can be overcome by using a proxy for the growth of capital stock. Following Kaldor (1966) the gross investment/output ratio can be used as a proxy for the growth of the capital stock. 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.

V. Empirical Results

The regression results obtained from testing equation (6) using data for the manufacturing sector are in table 1.

The Verdoorn coefficient obtained for the manufacturing sector, in terms of size and R^2 is satisfactory and in line with the findings of other studies.[8] The estimated 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.

The contribution of the capital stock is now introduced.

The important point to note is that the coefficient on the q variable is not only statistically significant but is also similar to that obtained by other relevant studies.[9] The negative coefficient on

[8]See McCombie (1983), McCombie and deRidder (1984) for the regions of USA. While recent studies by Bernat (1996), Fingelton and McCombie (1998), Novell and Marshal (1999) report similar results for various regional contexts.

TABLE 1

KALDOR'S SECOND LAW OF GROWTH, MANUFACTURING SECTOR

α_1^*	β_1^*	R^2	SD
-0.82(-3.98)	0.56(8.09)	0.65	0.35

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

TABLE 2

KALDOR'S SECOND LAW OF GROWTH-MANUFACTURING SECTOR

	α_2^*	β_2^*	γ	R^2	SD
OLS	-0.044(-0.22)	0.55(10.7)	-0.20(-6.27)	0.76	0.26
Fixed effects		0.51(3.92)	-0.18(-6.31)	0.97	0.16
Random effects	-0.048(-0.20)	0.54(6.84)	-0.19(-7.24)	0.75	0.24

Hausman test: $x^2(2)=0.19$

	OLS	Fixed effects	Random effects
Estimates of returns to scale(ν)	2.181	2.313	2.203
Wald $x^2(1)$	30.401	16.162	14.583
(p-value)	(0.0000)	(0.0000)	(0.0013)

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

k indicates that employment falls as the capital stock increases due to substitution of capital for labour. 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 estimations obtained in the OLS and random effects models. The values of ν indicate the existence of substantial increasing returns to scale, since they are all greater than two, which is confirmed by the Wald test. There can be little doubt that, once again, the results reinforce the validity of the thesis that the manufacturing sector is subject to substantial increasing returns.

So far, the discussion has been in terms of the existence of increasing returns to scale with attention focused on the manu-

[9]See for example a recent study by Leon-Ledesma (2000) for the Spanish regions.

TABLE 3a

KALDOR'S SECOND LAW OF GROWTH, SERVECE SECTOR

α*	β*	R^2	SD
0.81(3.68)	0.47(2.27)	0.49	0.32

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

TABLE 3b

KALDOR'S SECOND LAW OF GROWTH-SERVECE SECTOR

	α2*	β2*	γ	R^2	SD
OLS	-0.92(-2.76)	0.66(24.04)	-0.20(-1.61)	0.93	0.14
Fixed effects		0.47(4.20)	-0.19(-7.79)	0.92	0.12
Random effects	-0.13(-0.73)	0.62(10.68)	-0.20(-9.37)	0.93	0.10

Hausman test: $x^2(2)=2.67$

	OLS	Fixed effects	Random effects
Estimates of returns to scale(ν)	1.81	2.53	1.93
Wald $x^2(1)$	11.46	23.24	27.58
(p-value)	(0.0007)	(0.0000)	(0.0000)

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

facturing sector. Estimates for the service sector are presented in table 3a and 3b.

The value of the Verdoorn coefficient for the service sector gives support to the view that this sector is also *subject to increasing returns.*[10] 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).

Finally, the results obtained for the agricultural sector are reported in table 4.

The diagnostic tests give a very low goodness of fit. The results for the agricultural sector should not be surprising. Kaldor suggests that in the agricultural sector there is no relationship between employment of resources and output obtained, thus permitting the

[10]As in the manufacturing sector, all the calculated values of ν are greater than unity at the 99% confidence level.

TABLE 4

KALDOR'S SECOND LAW OF GROWTH, AGRICULTURAL SECTOR

α^*	β^*	R^2	SD
1.30(3.91)	0.16(1.51)	0.21	0.49

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

TABLE 5

ESTIMATION OF VERDOORN'S LAW FOR EACH REGION

	α_2^*	β_2^*	γ	R^2	V	p-value
R_1	-0.026 (-0.150)	0.41 (8.523)	0.224 (1.265)	0.75	1.892	(0.001)
R_2	-0.131 (-1.680)	0.58 (7.426)	-0.432 (2.369)	0.77	2.467	(0.000)
R_3	-0.018 (-0.027)	0.43 (3.336)	0.208 (2.125)	0.63	1.841	(0.026)
R_4	-0.656 (-1.357)	0.31 (2.841)	0.607 (1.862)	0.54	1.267	(0.000)
R_5	-0.017 (-1.002)	0.46 (3.259)	0.120 (2.388)	0.79	1.913	(0.008)
R_6	-0.541 (1.881)	0.38 (2.329)	0.474 (1.852)	0.66	1.383	(0.000)
R_7	-0.147 (-1.782)	0.41 (2.386)	0.268 (1.369)	0.47	1.783	(0.000)
R_8	-0.023 (-0.145)	0.52 (6.531)	-0.064 (2.012)	0.51	2.048	(0.003)
R_9	-0.010 (-0.200)	0.67 (9.653)	-0.868 (3.697)	0.88	2.798	(0.000)
R_{10}	-0.766 (1.452)	0.38 (2.469)	0.454 (1.777)	0.62	1.436	(0.000)
R_{11}	-0.532 (1.026)	0.21 (1.935)	0.765 (2.036)	0.50	1.116	(0.108)
R_{12}	-0.046 (1.315)	0.32 (1.652)	0.652 (2.449)	0.43	1.157	(0.006)
R_{13}	-0.403 (1.697)	0.46 (2.001)	0.304 (2.319)	0.65	1.511	(0.011)

Note: Figures in brackets are t-ratios

transfer from agriculture to the manufacturing sector. Therefore, Kaldor's view of the agricultural sector as a 'passive' sector receives considerable support in the case of Greece.

Verdoorn's Law is also estimated using data for *each* of the 13 administrative regions of Greece. Table 5 reports the obtained results in conjunction with estimates of scale economies.

The natural question to consider regards the implication of these results with respect to regional convergence. According to Dixon and Thirlwall (1975) regional *divergence* is the most prominent outcome, provided that the Verdoorn coefficient *varies* between regions. The results clearly indicate that the value of the critical coefficient b varies across regions. As it is evident from table 5, this is the case for the regions of Greece. Colloquially, this indicates that regions of Greece follow a distinct convergence 'path',

TABLE 6

TESTING FOR REGIONAL CONVERGENCE

$\ln y_{i,t} - \ln y_{i,0} = c + (1 - e^{-\beta t}) \ln y_{i,0} + u_{i,t}$

	Regression *without* Regional Dummy Variables	Regression *with* Regional Dummy Variables
Constant	0.36253 (11.1045)	
$\ln y_{i,0}$	-0.0211 (-7.8200)	-0.02521 (-8.5095)
Implied β	0.00355 (7.7368)	0.00425 (8.4013)
R^2	0.230	0.265
AIC	144.6156	139.3149
SBC	142.1158	121.8163

Notes: Figures in brackets are the *t*-ratios. *AIC* and *SBC* denote the Akaike and the Schwartz-Bayesian information criterion, respectively.

in accordance to their industrial specialisation. The degree of increasing returns to scale is around the value of 2 in regions specialised in manufacturing (R_2, R_8, and R_9), while in de-industrialised regions (R_{10} and R_4) the degree hardly exceeds unity. Islands regions (R_6, R_{11}, R_{12}, and R_{13}) do not exhibit considerable increasing returns mainly due to absence of industrial tradition. Indeed, these regions are specialised mainly in agricultural activities. Also, there is a group of regions (*i.e.* R_1, R_3, R_5, and R_7) with a relative high Verdoorn coefficient. It may be argued that these regions are in the process of a successful industrialisation based on a shift from agricultural to services activities. According to the model, which has been elaborated in section III, this is entirely logical. Such variations indicate that regional economic growth is strongly related to the industrial composition and structure of regions, an argument emphasised strongly by Kaldor (1966, 1970) and Dixon and Thirlwall (1975).

The next important step forward is to assess the neo-classical predictions of regional convergence. To this aim, the hypothesis of regional convergence in tested in a Barro and Sala-i-Martin framework. Using *panel-data* for the period 1970-1998, the obtained results are reported in table 6.

The estimated coefficient on the variable of the initial income is turned to be negative indicating, thus, that the initially poor regions grow faster than the initially rich regions. From this perspective it may be argued that regions of Greece follow a process of convergence. However, and this is a point that needs

emphasising, the process of regional convergence is extremely slow. The estimated coefficient implies an annual rate of convergence of 0.355%. The implied rate of convergence is higher compare to that obtained for the 1971-96 period by Siriopoulos and Asteriou (1998). The authors estimate an annual rate of convergence equal to 0.1% using cross-section data. Nevertheless, such results are open to ctritisism from econometric point of view, given the low number of observations. The hypothesis of a very slow process of convergence across the regions of Greece is confirmed in the present paper by the use of panel data.

Furthermore, this hypothesis is also confirmed by estimating the model with the addition of regional dummy variables. As it can be seen from table 6, the annual rate of convergence exceeds that obtained from the version without dummies but is still very low (*i.e.* 0.425%) and the obtained R^2 at similar levels. The interesting point to note is that the *AIC* and *SBC* criteria support the superiority of the model with regional dummy variables over the model without them. It follows that unobservable characteristics of regions, captured by the regional dummy variables, do have an important effect on the process of regional convergence.

VI. Conclusions

The validity of Verdoorn's Law at the regional level of analysis has confirmed for a variety of case studies. For example, recent studies established empirically the validity of Verdoorn's Law in the regions of USA (Bernat, 1992), the Spain regions (Leon-Ledesma, 2000) and the regions of Japan (Casetti and Tanaka, 1992). Despite the important implications for regional growth, Verdoorn's Law and the Kaldorian approach, in general, did not receive much attention with respect to Greek regions. The existing empirical literature on Greek regions relies exclusively on the neo-classical approach. This paper adds to the existing literature by estimating Verdoorn's Law using data referring to the regions of Greece.

Previous sections have documented the validity of the Verdoorn's Law across the regions of Greece. The results provide 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 cannot 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 while this is not the case for agricultural sector. In the long run, which means considering a regional economy over a period of time as opposed to a point in time, some regions of Greece were able to grow due to a shift from agriculture to tertiary activities. 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. The fundamental proposition seems to be that the service sector cannot be considered simply as a passive sector, but rather as one of the *leading* sectors of the Greek economy. The large degree of returns to scale can also be considered as the result of economy- wide technical progress.

Another interesting conclusion refers to the tendencies towards regional convergence or divergence. To the extent that the determinants of Verdoorn coefficient vary between sectors, this coefficient may also vary between regions depending on their sectoral specialisation. The established variation of Verdoorn's coefficient between activities and regions indicates either that Greek regions diverge or converge to a slow rate. The slow process of convergence is also confirmed by the neo-classical approach using extended data sets. From a sectoral point of view, the slow rate of convergence may be attributed to differences in sectoral specialisation across regions. Regions specialised in traditional activities are fall behind from regions that specialised in sectors, which are subject to increasing returns or with a high Verdoorn coefficient.

One final point must be addressed explicitly. 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. As a consequence, the main thrust of economic policy as far as regional economic development is concerned should be aimed at encouraging private and public investment (mainly infrastructure) in sectors that are subject to increasing returns to scale or in sectors with higher Verdoorn coefficients attached to them. 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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