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Jordi Pons-Novell

Elisabet Viladecans-Marsal

Department of Econometrics, Statistics and Spanish Economy

UNIVERSITY OF BARCELONE

Avda. Diagonal, 690

08034- BARCELONE (SPAIN)

E-mail: jpons@eco.ub.es // eli@eco.ub.es

Fax number: + 343 402 18 21

KALDOR'S LAWS AND SPATIAL DEPENDENCE. EVIDENCE FOR THE EUROPEAN REGIONS*

Abstract

In this paper we provide an outline of Kaldor's growth model, and test its relevance to the economic experience of European regions during the period 1984-1992. Kaldor's first law asserts that manufacturing is the engine of economic growth. His second proposition, also known as Verdoorn's law, states that there is a strong positive relation between manufacturing productivity growth and manufacturing output growth. Kaldor’s third law holds that overall productivity growth is positively related to manufacturing output growth, and negatively related to employment in non-manufacturing sectors. The empirical results, corrected for the presence of spatial autocorrelation, indicate that Kaldor's second and third laws are compatible with the economic growth of European regions during the period 1984-1992.

Keywords: Kaldor's laws, growth, productivity, regional economics, spatial autocorrelation.

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1. INTRODUCTION

In the late sixties, Nicholas Kaldor[1] put forward three propositions regarding the causes of economic growth, often referred to as Kaldor's laws. Recently, there has been renewed interest in the study of economic growth, and Kaldor's laws of growth have been subjected to empirical testing by a number of researchers. Some have conducted international comparisons (McCombie, 1983; Thirlwall, 1983 and McCombie and Thirlwall, 1994) while others have studied countries individually - the United Kingdom (Stoneman, 1979), Australia (Whiteman, 1987), Turkey (Bairam, 1991), Greece (Drakopoulos and Theodossiou, 1991) and the United States (Wulwick, 1991 and Atesoglu, 1993). At regional level, McCombie and Ridder (1983) and Bernat (1996) assessed the compatibility of Kaldor's laws with the US economy, and Casetti and Tanaka (1992) evaluated their validity with regard to Japan.

The purpose of this article is to test whether Kaldor's laws hold for the European regions during the period 1984-1992 period, analyzing the three laws at regional level in order to examine the role of externalities in economic growth. In our opinion, the study of the influence of neighbouring regions on an area's growth is of considerable interest. Following the suggestion of Bernat (1996), our empirical analysis uses the Spatial Econometrics technique. The statistical information used is the REGIO data base provided by EUROSTAT for the 74 European regions in the 12 European Union members (EU-12). The spatial detail coincides with the EUROSTAT NUTS I system, extended or reduced according to the information available (see Appendix). The sample period chosen is 1984-1992, a period in which the European economy experienced the various stages that characterize an economic cycle.

The rest of this paper is divided into three sections. In section 2, we briefly comment on Neoclassical and post-Keynesian conceptions of economic growth and present the equations used in our assessment of Kaldor's laws in the context of European regions. Next, in section 3, we apply the Spatial Econometrics technique in order to carry out the analysis, and briefly survey its main features. In section 4, the empirical evidence is presented and, finally, the results are summarized and their implications briefly discussed.

2. KALDOR'S LAWS AND ECONOMIC GROWTH

The study of Keynes' theory of economic growth is limited by the core of Keynesian work centred as it was on the short-term determination of employment and income. Authors such as Kaldor, Kalecki, Pasinetti or Robinson were all influenced by Keynes; they represent the post-Keynesian tradition in economic growth analysis, although it was Harrod (1939) who first developed a full theoretical growth model.

Two different schools have attempted to correct the limitations of Harrod's model: the Neoclassical economists and the post-Keynesians. The Neoclassical school - based on the work of Solow (1956) - considers that economic growth depends on the quantity and quality of primary inputs and on the efficiency of their use. Therefore, this focus assigns a major role to supply factors in the explanation of economic growth. In its simpler version, output is considered a multiplicative function of capital and labour, and of a residual factor that includes technical progress, considered as an exogenous factor.

Post-Keynesian authors reject the Neoclassical conception of economic growth, arguing that the aggregate production function - the basic theoretical framework of the Neoclassical approach - is incorrect. They do not accept capital as a homogeneous production factor, or the existence of perfect markets, and they also reject the distribution theory underpinning Solow's work. Challenging the Neoclassical conception, post-Keynesians postulate the importance of capital accumulation, price formation, income distribution and technical change to the dynamics of economic growth. They also attribute an important role to the profits rate in economic dynamics. Nonetheless, there are deep-rooted differences in the models proposed by the authors of this school. In fact, three main lines of research can be identified, each given the name of tis most important proponent: Robinson, Kalecki and Kaldor.

According to the third focus - Kaldor's, dating from 1966 - the demand side of the economy is the key to the differentiated behaviour of economic systems. This focus is very far from the Neoclassical tradition, which stressed the role of supply factors, but incorporates an endogenous conception of technical progress that is of great importance in the evolution of productivity[2]. In this focus, an expansion of demand favours future economic growth by increasing the use of productive capacity and by encouraging investment**.** Demand expands as a result of the technical progress brought about by returns to scale[3]. Kaldor uses this conception of growth, based on the work of Verdoorn (1949), and explains economic growth by dynamic economies of scale associated with technical progress, and the process of "learning by doing" derived from the level of specialization attached to output expansion[4].

Concluding, Kaldor's model predicts the following virtuous circle: growth in demand increases productivity, and rising productivity induces an increase in competitiveness that leads to an additional increase in demand. Kaldor tested this process with the aid of his three growth laws.

Kaldor’s first law asserts that manufacturing is the engine of economic growth. In consequence, there is a positive relation between growth of the Gross Domestic Product (GDP) and the output growth of manufacturing:

$$[1] \qquad Q_i = \alpha_1 + \beta_1 QM_i + u1_i \qquad \beta_1 > 0$$

where Q_i and QM_i are the growth rate of GDP and the manufacturing growth rate between the years 1984 and 1992. Note that expression [1] presents a spurious relation between the two variables analyzed, given that manufacturing product is an important part of an economy’s total GDP. In order to correct this problem, Thirlwall (1983) re-formulated this first law as follows:

$$[2] \qquad Q_i = \alpha_2 + \beta_2 (QM_i - QNM_i) + u2_i \qquad \beta_2 > 0$$

where QNM_i is non-industrial GDP growth. The implication of this second formulation is a positive relation between total product growth of a given area and the differential growth between industrial and non-industrial production. The significance that Kaldor assigns to the role of industrial production in economic growth is not difficult to justify. If it is accepted that differences in economic growth depend on productivity, it can be argued that the industrial sector can experience higher productivity increases (increasing returns to scale) than other productive sectors, because the industrial sector can incorporate technological progress more easily and, therefore, induce growth in the overall economy.

Kaldor's second law is also known as Verdoorn's law, since it is based on an observation made by the latter to the Italian economy (Verdoorn, 1949). Verdoorn claimed that there was a positive relation between labour productivity growth in the industrial sector and total industrial output growth:

[3] $PM_i = \alpha_3 + \beta_3 QM_i + u3_i$ $\beta_3>0$

where PM_i indicates industrial productivity growth. This second law could be explained by the fact that an increase in industrial production - which is partly justified in Kaldor's exposition by the dynamism of exports - causes an increase in productivity. The expansion of industrial production, which shows increasing returns to scale, originates a fall in production costs which, at the same time, leads to a surplus that can be reinvested in the same sector. This reinvestment involves an increase in capital stock, with the natural consequence of an increase in industrial productivity.

An increase in industrial production produces a transfer of the labour force from the rest of economic sectors toward the industrial sector, and this in turn causes an increase in the productivity of non-industrial sectors. As a result of this, and as a result of the increasing returns to scale in industry, there is a positive relation between the labour factor productivity of the overall economy and manufacturing production. A simple formulation of this observation, known in the literature as Kaldor's third law, is:

[4] $P_i = \alpha_4 + \beta_4 QM_i + u4_i$ $\beta_4>0$

where P_i is the labour productivity growth for all productive sectors. An alternative way to express this law is:

[5] $Q_i = \alpha_5 + \beta_5 EM_i + u5_i$ $\beta_5>0$

where EM_i is employment growth in the industrial sector. Cripps and Tarling (1973) have also proposed different alternative formulations for Kaldor's third law, incorporating the non-industrial employment growth represented by ENM_i into models [4] and [5], and obtaining:

[6] $P_i = \alpha_6 + \beta_6 QM_i + \delta_6 ENM_i + u6_i$ $\beta_6>0$ $\delta_6<0$

[7] $Q_i = \alpha_7 + \beta_7 EM_i + \delta_7 ENM_i + u7_i$ $\beta_7>0$ $\delta_7<0$

Thus, these three laws indicate that the industrial sector and its productivity are the decisive factors in economic growth. This gives rise to the following sequence: an increase in demand and production leads to an increase in productivity, which in turn increases competitiveness and, therefore, demand.

Kaldor’s propositions have received a number of criticisms, both theoretical and empirical, although the applied studies mentioned in the introduction seem to confirm the relation between Kaldor's laws and economic growth for different countries and periods. One of the most important criticisms (see McCombie (1983), Thirlwall (1983), and McCombie and Thirlwall (1994)) questions the direction of causality in Kaldor’s second and third laws, arguing that the direction may in fact be the reverse of what the author proposes. For instance, the second law states that manufacturing productivity growth is an increasing function of manufacturing output growth, although it does not take into account the possibility that the relation could be the other way around, i.e. that rapid productivity growth stimulates demand. Thus it may be that demand can account for the correlations observed (the same observation also applies, to some extent, in the case of Kaldor's third law). This criticism of Kaldor’s laws is important, but the present article seeks only to test Kaldor’s growth model and its relevance to the economic experience of European regions and does not aim to consider its formulation or the direction of causality.

3. SPATIAL ECONOMETRICS

Spatial Econometrics is "*the collection of techniques that treat the peculiarities created by space in the statistical analysis of regional models*” (Anselin, 1988a). It is, therefore, an econometric technique applied to data and models of a spatial nature, that is to say, where the spatial position of the units studied contains extremely useful information for the interpretation of the relations studied. Whether the spatial distribution of the variables is merely random or responds to a pattern of autocorrelation or spatial dependence is an interesting question. A detailed review of this technique, beginning with the pioneering studieds by Cliff and Ord

(1972, 1973) and Paelinck and Klaassen (1979), can be found in Anselin (1988a), Getis and Ord (1992) and Anselin and Florax (1995).

The presence of spatial autocorrelation has important consequences for some of the conclusions obtained by the methodology of classical econometrics, and may indeed invalidate them**.** In the presence of spatial autocorrelation**,** the OLS estimation of the parameters will be non-biased, but inefficient. The inference based on the individual parameters significance tests will be biased and will affect the use of different specification tests such as the heteroscedasticity test (Anselin and Griffith, 1988). Thus, the presence of spatial autocorrelation among the territorial units analyzed requires a specific treatment of space in regional studies.

In order to analyze the presence of spatial autocorrelation in the variables we use the Moran I and Geary C statistics[5] which, under the null hypothesis, consider a random distribution of the variables in space. In order to calculate these statistics it is necessary to specify a contacts matrix (a spatial weights matrix, or a contiguity matrix), W, also well known in the literature as a matrix of interactions, distances or spatial weights. This matrix indicates, for each element in the space, the subset of elements between which a relationship of mutual dependence is possible. The W matrix shows the interactions or spatial dependences between the various territorial units - in our case, the NUTS-I regions. The simplest contact matrix is a binary matrix in which the element w_{ij} takes the value 1 when the territorial units i and j present a common border and 0 otherwise. Although the literature has proposed other forms for the W matrix, we use a standardized binary contacts matrix.

Spatial autocorrelation can adopt two alternative formulations in regression models. The first case - structural spatial dependences across observations on the dependent variable - is the one denoted thus by Anselin spatial lag model:

[8] $$y = \rho W y + X\beta + \varepsilon$$

where y is a vector of n observations of the dependent variable (therefore, n is equal to the number of territorial units); W is the contacts matrix of order n˘n; X is a n˘k matrix of exogenous variables; β is the vector of the k estimated parameters; ρ is the spatial autocorrelation coefficient and, lastly, Ó is the vector of error terms of the model of order nˇ1. The meaning of ρ is highly relevant to our analysis: a ρ value equal to 0.3 indicates that a unitary increase of the endogenous variable in an area provokes an increase of this variable in the neighbouring territorial areas by 0.3 units. Structural dependence arises when the model's dependent variable depends on the surrounding observations' dependent variable values. If [8] is the correct model, but the model is estimated without the spatial autocorrelation term, a significant explanatory variable has been omitted. The estimated coefficient vector β will therefore be biased, and all inferences based on the model invalid.

The second formulation of spatial autocorrelation - spatial dependence across error terms - is the denominated spatial error model, which can be expressed as follows:

$$
\begin{aligned}
&y = X\beta + \varepsilon \\
&\varepsilon = \lambda W\varepsilon + \zeta
\end{aligned}
\qquad [9]
$$

where λ is the autoregressive parameter, and spatial dependence is embodied in the error term. As noted above, if the model studied presents spatial autocorrelation, but this has not been taken into account, the OLS estimation of β is inefficient and the inference is incorrect. The spatial error model may arise because of measurement problems in the data or because of the omission of variables. As with the spatial lag model, ignoring spatial dependence invalidates standard statistical tests. In this case, parameter estimates are inefficient but, unlike the spatial lag case, the estimates are still unbiased.

In Bernat (1996) there is an interpretation of the differences between the two forms of spatial autocorrelation in the context of Kaldor's laws. In the first case, the growth of a region is directly affected by growth in neighbouring regions, and this effect is independent of the effect of exogenous variables on the endogenous variable. As ρ rises, and therefore greater spatial dependence exists, the greater the influence a region will have on the evolution of contiguous regions. In the context of the study of Kaldor's laws applied to European regions, this would mean that an increase in industrial production in a region will favour the economic development not only of this region but also of its neighbours, including the regions without industrial sector growth. Thus, the study of the spatial autocorrelation coefficient ρ gives us valuable information on the mutual influence of growth, and will add to our knowledge of how externalities affect the regional development of economic activities in Europe.

The interpretation of the second formulation of spatial autocorrelation in [9], though statistically similar to [8], is radically different in economic terms. In this second approach, the growth in a region affects the growth in the neighbouring regions only if their growth is above that considered "normal"[6]. High growth in one region would not affect neighbouring regions as long as the growth was consistent with the underlying relationship between GDP growth and manufacturing growth. On the other hand, neighbouring regions will be affected when industrial growth in a region departs from the expected value for this variable. The interpretation of this model is less intuitive than that of the former, but it should be noted that in both cases the presence of spatial effects invalidates the results obtained by the OLS estimation model.

In the next section we will test Kaldor's laws in the context of the European regions in the period 1984-1992, incorporating the spatial relationships between the regions. If this spatial relation exists, the tests presented in the econometrics literature will determine which of the specifications of spatial autocorrelation described in this section is more suitable.

4. EMPIRICAL RESULTS

In the first place we will analyze whether the spatial distribution of the variables used to test Kaldor's laws in the European regions is merely random, or responds to an autocorrelation or a spatial dependence pattern. We use Moran's I and Geary's C statistics. If the null hypothesis of a territorial random distribution of the variables is rejected, we will have evidence that the value attained by these variables in a region is affected by their value in the neighbouring regions.

These spatial autocorrelation contrasts are calculated for the following variables expressed in growth rates: total production (Q), industrial production (QM), non-industrial production (QNM), total employment (E), industrial employment (EM), non-industrial employment (ENM), total labour productivity (P) and industrial labour productivity (PM). For the calculation of these two statistics a standardized binary contact matrix has been defined. Table 1 shows the results of the spatial autocorrelation statistics for the growth rates of these eight variables in the European regions in the period 1984-1992.

Table 1. Spatial autocorrelation

Variables	Moran's I	Geary's C
Q	0.711[a]	-0.296[a]
QM	0.462[a]	-0.574[a]
QNM	0.378[a]	-0.440[a]
E	0.408[a]	-0.748[b]
EM	0.231[a]	-0.716[b]
ENM	0.431[a]	-0.723[b]
P	0.736[a]	-0.306[a]
PM	0.392[a]	-0.604[a]

[a] Indicates significance at the 1% level.
[b] Indicates significance at the 5% level.

The values obtained for the contrasts show the existence of spatial dependence in the period for all the variables. These results suggest that the increase in these eight variables in a region causes an increase in neighbouring regions, and seem to confirm the existence of a strong relation of interdependence between the European regions. Therefore, to test the validity of Kaldor's laws in European regions, we will need to treat the distribution of economic series as non-random.

In order to test Kaldor's three laws we use the models described in the second section of the paper. First, we carry out the OLS estimation of each equation, and then tested for spatial dependence both at the residual level (expression [9]) and at the dependent variable level (expression [8]). With this aim in mind we calculate Moran’s I test of spatial dependence, and

LM_{LAG} (Anselin, 1988b) and LM_{ERR} (Burridge, 1980) tests, both based on the Lagrange multipliers principle. Moran's I is a general test that gives no additional information about the pattern of the spatial process. When there is some kind of spatial autocorrelation in the estimated model, the LM_{LAG} and LM_{ERR} tests select the correct dependence pattern (model [8] or [9]). In the previous section, following Bernat (1996), we noted how important it is to distinguish between the two forms of spatial autocorrelation, since their economic interpretation is radically different.

To implement the LM_{LAG} and LM_{ERR} tests, the errors must be normally distributed. The normality hypothesis is tested in the various equations by means of the Kiefer-Salmon test. The normality of the OLS errors is accepted in all the cases. If the errors are not normally distributed, we have to use Kelejian and Robinson's robust test (1995), also based on the Lagrange multipliers principle, because the LM_{LAG} and LM_{ERR} statistics are based on a likelihood function obtained under the assumption of normality of residuals. In addition, the maximum likelihood estimation of the spatial lag model and of the spatial error model is based on the assumption of normal error terms. Note that the Breusch and Pagan test was calculated for all the estimated equations, as it is impossible to reject the null hypothesis of homoscedasticity in any of the cases, except in the OLS Kaldor's third law[7].

In table 2 we present the estimation of model [2] used in order to test Kaldor's first law, which postulates that industry is the engine of economic growth. The second column shows the OLS parameters. The sign of the β_2 parameter is unexpected, and is highly significant. We next test for the existence of spatial autocorrelation in the model by means of Moran's I statistic, LM_{LAG} and LM_{ERR} tests. All these tests reject the hypothesis of spatial independence between the observations, both at the residual level and at the endogenous variable level. Given that the presence of spatial autocorrelation in the model invalidates the OLS based inference, we estimate the spatial autoregressive model and the model with spatial autoregressive residuals. Following the criterion suggested by Anselin and Rey (1992), and since the LM_{LAG} value is greater than the LM_{ERR} the spatial autoregressive model has been selected. In addition, the LIK and the AIC criteria are used in order to select the best formulation of the model. Both tests support the choice of the spatial autoregressive model[8].

Table 2. Kaldor's First Law

	OLS	Spatial lag	Spatial Error
Constant	46.845[a]	35.471[a]	63.738[a]
QM_i-QNM_i	-0.773[a]	-0.721[a]	-0.474[a]
s.a.c.		0.227[a]	0.672[a]
R^2	0.504		
Kiefer-Salmon	0.402		
Breusch-Pagan	0.380	0.550[*]	0.783[*]
AIC	-673.843	-696.174	-681.862
LIK	340.921	345.087	338.931
Moran's I	5.183[a]		
LM_{LAG}	23.132[a]		
LM_{ERR}	11.189[a]		

s.a.c.: The spatial autocorrelation coefficient, ρ for the spatial lag model and λ for the spatial error model.
[a] Indicates significance at the 1% level.
[*] Indicates spatial Breusch-Pagan test

Therefore, Kaldor's first law is tested on the model that incorporates spatial effects, since the conclusions reached with the OLS estimation are wrong in the presence of this dependence**.** We select the spatial autoregressive model. After contrasting this law and the others, there does not appear to be much difference between the OLS estimates and those derived from the spatial lag model. However, the spatial error model yields different estimates, probably due to the omission of variables which are spatially correlated.

Once the spatial effects have been incorporated, there is no empirical evidence for Kaldor's first law. The estimation of model [2] by means of expression [8] gives a value for the β_2 parameter that is significantly different from zero, and negative. There is therefore a negative relation between the growth rate of European regions' GDP and the difference of growth between industrial and non-industrial production. The value of the spatial autocorrelation coefficient, ρ=0.550, indicates that a 10% GDP increase in a region causes a 5.50% increase in the production of neighbouring regions. This shows the paramount importance of spatial externalities in the growth of production in European regions.

Using equation [1] provides favourable evidence for Kaldor's first law, since the sign of the $\cdot_1$ parameter is positive. Moran's I, LM_{LAG} and LM_{ERR} statistics also leads to the acceptance of the spatial dependence hypothesis. In spite of these results, we chose model [2] to test Kaldor's first law, since, as we noted above, equation [1] may present a spurious relation between the two variables analyzed. This is so because industrial production accounts for a significant portion of total GDP.

Kaldor's second law, also known as Verdoorn's law, postulates a positive relation between industrial productivity growth and industrial output growth. In order to test this second law we estimate model [3]. Table 3 shows the results of this estimation. In this case, Moran's I, LM_{LAG} and LM_{ERR} statistics show evidence of the presence of spatial autocorrelation. This leads us to conclude that the OLS estimation of model [3] presents problems. Therefore, as in the former case, it would be necessary to estimate the spatial autoregressive model and the model with autoregressive errors. Following the criteria of Anselin and Rey (1992) and the results derived from the LIK and AIC statistics, we selected the autoregressive model.

Table 3. Kaldor's Second Law

	OLS	Spatial lag	Spatial Error
Constant	14.550[b]	9.402	18.317[a]
QM_i	0.628[a]	0.587[a]	0.560[a]
s.a.c.		0.201[a]	0.397[a]
R^2	0.282		
Kiefer-Salmon	4.510		
Breusch-Pagan	0.672	0.087[*]	0.895[*]
AIC	-690.898	-697.970	-694.218
LIK	341.940	345.985	345.109
Moran's I	2.793[a]		
LM_{LAG}	6.127[a]		
LM_{ERR}	4.149[b]		

s.a.c.: The spatial autocorrelation coefficient, ρ for the spatial lag model and λ for the spatial error model.
[a] Indicates significance at the 1% level.
[b] Indicates significance at the 5% level.
[*] Indicates spatial Breusch-Pagan test.

The QM_i coefficient is significant and positive, as Kaldor's second law predicts. However, it should be noted that the presence of spatial autocorrelation allows the analysis of the significance of regional externalities in European industrial productivity growth during these years. The value of ρ=0.201 indicates that a 10% increase in industrial production causes a 2.01% increase in neighbouring regions. Note that this result shows the impact of the externalities on the growth process of European regions, by showing how regions benefit from their neighbours' growth.

As we noted in section 2, four main specifications are proposed by the literature in order to test Kaldor's third law. The model with the best performance is model [6], and so table 4 presents the results of this model alone. Nevertheless, we should bear in mind that the conclusions reached by means of the study of this specification do not differ much from those that derive from specifications [4], [5] and [7]. Model [6] asserts that productivity increases in the economy depend positively on industrial production increases and negatively on non-industrial employment. Moran's I, LM_{LAG} and LM_{ERR} statistics, presented at the bottom of Table 4, indicate the presence of spatial autocorrelation in model [6]. For this reason, we estimate the models with spatial dependence effects. As in the two other laws, the spatial lag model is selected.

Table 4. Kaldor's Third Law

	OLS	**Spatial lag**	**Spatial Error**
Constant	25.624[a]	21.312[a]	55.576[a]
QM_i	0.865[a]	0.800[a]	0.446[a]
ENM_i	-0.660[a]	-0.671[a]	-0.568[a]
s.a.c.		0.171[a]	0.823[b]
R^2	0.498		
Kiefer-Salmon	3.139		
Breusch-Pagan	7.709[b]	3.622[*]	3.967[*]
AIC	-666.278	-673.396	-642.540
LIK	325.139	332.698	318.270
Moran's I	4.850[a]		
LM_{LAG}	18.294[a]		
LM_{ERR}	4.852[b]		

s.a.c.: The spatial autocorrelation coefficient, ρ for the spatial lag model and λ for the spatial error model.
[a] Indicates significance at the 1% level.
[b] Indicates significance at the 5% level.
[*] Indicates spatial Breusch-Pagan test.

The parameters estimated validate Kaldor's third law: that is to say, labour productivity depends positively on industrial production growth and negatively on non-industrial employment. The significance of the externalities in European regional productivity growth is confirmed. Thus, the empirical evidence suggests that only Kaldor's second and third laws are compatible with the pattern of growth of European regions in the period 1984-1992.

5. CONCLUSIONS

In this article we study whether the European regions validate Kaldor's laws of growth in the period 1984-1992. The estimated models suggest that only the second and the third law hold for the European economy. The first law is only validated when the specification analyzed is [1], and indeed in this case the relation may be spurious. We also study whether the spatial distribution of the variables is random or responds to an autocorrelation or a spatial dependence pattern. The spatial dependence analysis, as we stress throughout the paper, is important for both statistical and economic reasons. From the statistical viewpoint, if the model presents spatial autocorrelation, this could invalidate the inference derived from the OLS estimation. From the economic viewpoint, the presence of spatial autocorrelation in a model allows the study of externalities in the territorial unit analyzed, which makes the spatial econometrics technique particulary attractive. In the analysis of the three laws, there is strong evidence of the presence of spatial autocorrelation. This must be taken to indicate that economic growth has a favourable effect on growth in neighbouring areas.

One of the most important criticisms of Kaldor's propositions is the direction of causality of his second and third laws. The direction may in fact be the reverse of that proposed by the author. For instance, the second law states that manufacturing productivity growth is an increasing function of manufacturing output growth, although it ignores the fact that the relation may be the exact reverse: i.e., that rapid productivity growth stimulates demand. Thus, it may be that it is demand that explains the correlations observed (the same also applies, to a certain extent, in the case of Kaldor's third law).

Another limitation of this investigation, although it does not invalidate the conclusions, is the binary standardized contacts matrix that we used. This matrix only considers as potentially dependent those regions which share a physical border. A worthwhile extension of this study would be to define a contacts matrix that takes account of characteristics of the areas under consideration, such as accessibility, commercial transactions or any other type of economic bond[9]. Among the most important findings of this analysis are the presence of a significant spatial autocorrelation and the fact that correcting for this spatial dependence improves the fit of the models.

Although the empirical evidence suggests that the results are consistent with Kaldor's laws, it does not seem very convincing that a model of such simplicity could explain productivity through production increases. It seems that there are other explanations for industrial productivity growth: losses of employment, technological diffusion at international level, different productive specialization in the territorial units, or increases in competitiveness due not only to price decreases but also to improved quality and technical advances.

ENDNOTES:

1. See Kaldor (1966, 1975 and 1978) for a detailed presentation of his postulates.
2. The hypothesis that technological progress is not an exogenous variable in the production function, suggested by Kaldor's laws has since been developed in the endogenous growth literature (Lucas, 1988, Romer, 1990 and 1994 and Grossman and Helpman, 1991). This literature uses imperfect competition and increasing returns to explain the efficiency improvements due to knowledge accumulation. These authors suggest that technological change lies at the heart of economic growth. Technological change provides the incentive for continued capital accumulation, and also, capital accumulation and technological change account for much of the increase in labour productivity.
3. The consideration of technical progress as a decisive element for economic growth is based on Young's (1928) article.
4. The model of "learning by doing" was suggested by Arrow (1962).
5. The SpaceStat (version 1.8) program has been used to calculate all the results (see Anselin, 1995).
6. According to Bernat (1996) the "normal" concept refers to the growth predicted by the model [9] .
7. Tables 2, 3, and 4 show the results of the Kiefer-Salmon normality test and of the Breusch-Pagan heteroscedascity test for each of the OLS estimated models.
8. The presence of spatial autocorrelation supposes that the R^2 determination coefficient is not a good statistic for determining the goodness of the adjustment. Following the literature, the Akaike information (AIC) test and the value of the log likelihood (LIK) test have been

calculated for each one of the models. By the AIC criterion, the model with a lesser value is chosen; by the LIK criterion, the greater one is selected.

9. The binary contacts matrix has a number of limitations. In his study of the validation of Kaldor's laws in U.S. states, Bernat (1996) obtains similar results using either a binary contacts or a matrix based on the distances between territorial units analyzed.

6. REFERENCES

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APPENDIX: EUROPEAN REGIONS USED IN THE STUDY

BELGIQUE/BELGIË	Bruxelles/Brussels	IRELAND	Ireland
	Region Wallonne		
	Vlaams Gewest	ITALIA	Abruzzi-Molise
			Campania
DANMARK	Danmark		Centro
			Emilia-Romagna
DEUTSCHLAND	Baden-Württemberg		Lazio
	Bayern		Lombardia
	Berlin		Nord Est
	Bremen		Nord Ovest
	Hamburgo		Sardegna
	Hessen		Sicilia
	Niedersachsen		Sud
	Nordrhein-Westfalen		
	Rheinland-Pfalz	LUXEMBOURG	Luxembourg
	Saarland		
	Schleswig-Holstein	NEDERLAND	Noord-Nederland
			Oost-Nederland
ELLADA	Ellada		West-Nederland
			Zuid-Nederland
ESPAÑA	Andalucía		
	Aragón	PORTUGAL	Alentejo
	Asturias		Algarve
	Baleares		Centro
	Canarias		Lisboa e Vale do Tejo
	Cantabria		Norte
	Castilla-La Mancha		
	Castilla-León	UNITED KINGDOM	East Anglia
	Cataluña		East Midlands
	Comunidad Valenciana		North
	Extremadura		North West
	Galicia		Northern Ireland
	Madrid		Scotland
	Murcia		South East
	Navarra		South West
	País Vasco		Wales
	La Rioja		West Midlands
			Yorkshire-Humberside
FRANCE	Bassin Parisien		
	Centre-Est		
	Est		
	Ile de France		
	Mediterranée		
	Nord-Pas-de-Calais		
	Ouest		
	Sud-Ouest		

Source: REGIO data bank (EUROSTAT).