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# APPLICATION OF KEYNESIAN AND CONVERGENCE THEORIES IN PORTUGAL. AN ALTERNATIVE APPROACH

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#### ABSTRACT

This work aims to test the Verdoorn Law, with the alternative specifications of (1)Kaldor (1966), for five Portuguese regions (NUTS II) from 1986 to 1994. It is intended to test, even in this work, the alternative interpretation of (2)Rowthorn (1975) of the Verdoorn's Law for the same regions and periods. The results of this work will be complemented with estimates of these relationships to other sectors of the economy than the industry (agriculture and services sectors) and for the total economy of each region. The aim of this paper is, also, to present a further contribution to the analysis of absolute convergence, associated with the neoclassical theory, of the sectoral productivity at regional level.

Keywords: polarization; convergence; Portuguese regions; linear models; panel data.

# **1. INTRODUCTION**

The polarization process is mainly based in the very known Verdoorn law. (3)Verdoorn (1949) was the first author to reveal the importance of the positive relationship between the growth of labor productivity and output growth, arguing that the causality is from output to productivity, thus assuming that labor productivity is endogenous. An important finding of the empirical relationship is the elasticity of labor productivity with respect to output that according to Verdoorn is approximately 0.45 on average, external limits between 0.41 and 0.57. This author also found that the relationship between productivity growth and output growth reflects a kind of production technology and the existence of increasing returns to scale, which contradicts the hypothesis of neoclassical constant returns to scale, or decreasing, and absolute convergence Regional.

The purpose of this the work is, yet, to analyze the absolute convergence of output per worker (as a "proxy" of labor productivity), with the equation of (4)Islam (1995), based on the (5)Solow model (1956).

#### 2. DESCRIPTION OF THE MODELS

The models of the keynesian and convergence theories are developed in several works like (6-7)Martinho (2011a and 2011b).

#### 3. DATA ANALYSIS

Considering the variables on the models referred previously and the availability of statistical information, we used the following data disaggregated at regional level. Annual data for the periods 1986 to 1994 corresponding to the five regions of mainland Portugal (NUTS II), for the different economic sectors and the total economy of these regions. These data were obtained from Eurostat (Eurostat Regio of Statistics 2000).

# 4. EMPIRICAL EVIDENCE OF THE VERDOORN'S LAW

The results in Table 1, obtained in the estimations carried out with the equations of Verdoorn, Kaldor and Rowthorn for each of the sectors of the economy and for the total economy of each of the five regions considered, to state the following.

The industry is the sector that has the biggest increasing returns to scale, followed by agriculture and service sector. Services without the public sector present values for the income scale unacceptable and manufacturing presents surprisingly very low values, reflecting a more intensive use of labor.

It should be noted, finally, for this set of results the following: Verdoorn's equation is the most satisfactory in terms of statistical significance of the coefficient obtained and the degree of explanation in the various estimations. There is, therefore, that productivity is endogenous and generated by the growth of regional and sectoral output.

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 Table 1: Analysis of economies of scale through the equation Verdoorn, Kaldor and Rowthorn, for each of the economic sectors and the five NUTS II of Portugal, for the period 1986 to 1994

Agriculture	1	1				
	Constant	Coefficient	DW	R <sup>2</sup>	G.L.	E.E. (1/(1-b))
Verdoorn	0.042*	0.878*	1 696	0.805	38	
$p_i = a + bq_i$	(5.925)	(12.527)	1.000	0.000	50	
Kaldor	-0.042*	0.123**	1 606	0.075	20	
$e_i = c + dq_i$	(-5.925)	(1.750)	1.090	0.075	30	a / a=
Rowthorn1	-0.010	-0.621**		0.00-		8.197
$p_i = \lambda_1 + \varepsilon_1 e_i$	(-0.616)	(-1.904)	1.568	0.087	38	
Rowthorn2	-0.010	0.379				
$a_1 = \lambda_2 + \varepsilon_2 e_1$	(-0.616)	(1 160)	1.568	0.034	38	
	( 0.010)	(1100)				
muustry	Constant	Coefficient	DW	P <sup>2</sup>	GL	E = (1/(1-b))
	-12 725*	0.992*	511		0.L.	
Verdoorn	(-4,222)	(8,299)	2.001	0.587	37	
Kaldor	12.725*	0.008	0.00/			
	(4.222)	(0.064)	2.001	0.869	37	105 000
Development	15.346*	-0.449*	1 000	0.000	07	125.000
Rowthorn1	(9.052)	(-3.214)	1.889	0.326	37	
Powthorn?	15.346*	0.551*	1 990	0.776	27	
Rowinomz	(9.052)	(3.940)	1.009	0.770	57	
Manufactured	Industry	•	-			
	Constant	Coefficient	DW	R <sup>2</sup>	G.L.	E.E. (1/(1-b))
Verdoorn	8.296*	0.319*	1,679	0.139	37	
	(4.306)	(2.240)		0.100		
Kaldor	-8.296*	0.681*	1.679	0.887	37	
	(-4.306)	(4.///)			-	1.468
Rowthorn1	12.522"	-0.240"	1.842	0.269	37	
	(12.007)	(-2.034)				
Rowthorn2	(12 537)	(8 993)	1.842	0.891	37	
	(12.007)	(0.000)				
Services						
Services	Constant	Coefficient	DW	B <sup>2</sup>	GL	F.F. (1/(1-b))
Services	Constant -0.045*	Coefficient	DW	R <sup>2</sup>	G.L.	E.E. (1/(1-b))
Services Verdoorn	Constant -0.045* (-3.253)	Coefficient 0.802* (6.239)	<b>DW</b> 1.728	<b>R</b> <sup>2</sup> 0.506	<b>G.L.</b> 38	E.E. (1/(1-b))
Services Verdoorn	Constant -0.045* (-3.253) 0.045*	Coefficient 0.802* (6.239) 0.198	DW 1.728	<b>R</b> <sup>2</sup> 0.506	G.L. 38	E.E. (1/(1-b))
Services Verdoorn Kaldor	Constant -0.045* (-3.253) 0.045* (3.253)	Coefficient 0.802* (6.239) 0.198 (1.544)	DW 1.728 1.728	<b>R<sup>2</sup></b> 0.506 0.059	G.L. 38 38	E.E. (1/(1-b))
Services Verdoorn Kaldor	Constant -0.045* (-3.253) 0.045* (3.253) 0.071*	Coefficient 0.802* (6.239) 0.198 (1.544) -0.694*	DW 1.728 1.728	R <sup>2</sup> 0.506 0.059	G.L. 38 38	<b>E.E. (1/(1-b))</b> 5.051
Services Verdoorn Kaldor Rowthorn1	Constant -0.045* (-3.253) 0.045* (3.253) 0.071* (4.728)	Coefficient           0.802*           (6.239)           0.198           (1.544)           -0.694*           (-3.607)	DW 1.728 1.728 1.817	R <sup>2</sup> 0.506           0.059           0.255	G.L. 38 38 38 38	<b>E.E. (1/(1-b))</b> 5.051
Services Verdoorn Kaldor Rowthorn1 Bowthorn2	Constant -0.045* (-3.253) 0.045* (3.253) 0.071* (4.728) 0.071*	Coefficient           0.802*           (6.239)           0.198           (1.544)           -0.694*           (-3.607)           0.306	DW 1.728 1.728 1.817	<b>R</b> <sup>2</sup> 0.506 0.059 0.255 0.063	G.L. 38 38 38 38 38	<b>E.E. (1/(1-b))</b> 5.051
Services Verdoorn Kaldor Rowthorn1 Rowthorn2	Constant -0.045* (-3.253) 0.045* (3.253) 0.071* (4.728) 0.071* (4.728)	Coefficient           0.802*           (6.239)           0.198           (1.544)           -0.694*           (-3.607)           0.306           (1.592)	DW           1.728           1.728           1.817           1.817	R <sup>2</sup> 0.506           0.059           0.255           0.063	G.L.           38           38           38           38           38           38           38           38	<b>E.E. (1/(1-b))</b> 5.051
Services Verdoorn Kaldor Rowthorn1 Rowthorn2 Services (with	Constant -0.045* (-3.253) 0.045* (3.253) 0.071* (4.728) 0.071* (4.728) 0.071* (4.728) 0.001 public sector)	Coefficient           0.802*           (6.239)           0.198           (1.544)           -0.694*           (-3.607)           0.306           (1.592)	DW           1.728           1.728           1.817           1.817	R <sup>2</sup> 0.506           0.059           0.255           0.063	G.L. 38 38 38 38 38 38	<b>E.E. (1/(1-b))</b> 5.051
Services Verdoorn Kaldor Rowthorn1 Rowthorn2 Services (with	Constant -0.045* (-3.253) 0.045* (3.253) 0.071* (4.728) 0.071* (4.728) 0.071* (4.728) out public sector) Constant	Coefficient           0.802*           (6.239)           0.198           (1.544)           -0.694*           (-3.607)           0.306           (1.592)	DW         1.728         1.728         1.817         1.817         DW	R <sup>2</sup> 0.506           0.059           0.255           0.063	G.L. 38 38 38 38 38 38 G.L.	E.E. (1/(1-b)) 5.051 E.E. (1/(1-b))
Services Verdoorn Kaldor Rowthorn1 Rowthorn2 Services (with Verdoorn	Constant -0.045* (-3.253) 0.045* (3.253) 0.071* (4.728) 0.071* (4.728) 0.071* (4.728) out public sector) Constant -0.074* (4.250)	Coefficient           0.802*           (6.239)           0.198           (1.544)           -0.694*           (-3.607)           0.306           (1.592)	DW           1.728           1.728           1.817           1.817           1.817           1.728	R <sup>2</sup> 0.506           0.059           0.255           0.063           R <sup>2</sup> 0.609	G.L. 38 38 38 38 38 38 G.L. 38	E.E. (1/(1-b)) 5.051 E.E. (1/(1-b))
Services Verdoorn Kaldor Rowthorn1 Rowthorn2 Services (with Verdoorn	Constant -0.045* (-3.253) 0.045* (3.253) 0.071* (4.728) 0.071* (4.728) out public sector) Constant -0.074* (-4.250) 0.074*	Coefficient           0.802*           (6.239)           0.198           (1.544)           -0.694*           (-3.607)           0.306           (1.592)	DW         1.728         1.728         1.817         1.817         1.817         DW         1.786	R <sup>2</sup> 0.506           0.059           0.255           0.063           R <sup>2</sup> 0.609	G.L. 38 38 38 38 38 38 G.L. 38	E.E. (1/(1-b)) 5.051 E.E. (1/(1-b))
Services Verdoorn Kaldor Rowthorn1 Rowthorn2 Services (with Verdoorn Kaldor	Constant -0.045* (-3.253) 0.045* (3.253) 0.071* (4.728) 0.071* (4.728) out public sector) Constant -0.074* (-4.250) 0.074* (4.250)	Coefficient           0.802*           (6.239)           0.198           (1.544)           -0.694*           (-3.607)           0.306           (1.592)             Coefficient           1.020*           (7.695)           -0.020           (0.140)	DW           1.728           1.728           1.817           1.817           1.817           1.786           1.786	R <sup>2</sup> 0.506           0.059           0.255           0.063           R <sup>2</sup> 0.609           0.001	G.L. 38 38 38 38 38 38 G.L. 38 38	E.E. (1/(1-b)) 5.051 E.E. (1/(1-b))
Services Verdoorn Kaldor Rowthorn1 Rowthorn2 Services (with Verdoorn Kaldor	Constant -0.045* (-3.253) 0.045* (3.253) 0.071* (4.728) 0.071* (4.728) 0.071* (4.728) 0.074* (-4.250) 0.074* (4.250) 0.075*	Coefficient           0.802*           (6.239)           0.198           (1.544)           -0.694*           (-3.607)           0.306           (1.592)             Coefficient           1.020*           (7.695)           -0.020           (-0.149)           0.902*	DW         1.728         1.728         1.728         1.817         1.817         DW         1.786         1.786	R <sup>2</sup> 0.506           0.059           0.255           0.063           R <sup>2</sup> 0.609           0.001	G.L. 38 38 38 38 38 38 G.L. 38 38	E.E. (1/(1-b)) 5.051 E.E. (1/(1-b)) 
Services Verdoorn Kaldor Rowthorn1 Rowthorn2 Services (with Verdoorn Kaldor Rowthorn1	Constant -0.045* (-3.253) 0.045* (3.253) 0.071* (4.728) 0.071* (4.728) 0.071* (4.728) 0.074* (4.250) 0.074* (4.250) 0.076* (4.350)	Coefficient           0.802*           (6.239)           0.198           (1.544)           -0.694*           (-3.607)           0.306           (1.592)           Coefficient           1.020*           (7.695)           -0.020           (-0.149)           -0.903*           (-4.736)	DW         1.728         1.728         1.728         1.817         1.817         DW         1.786         1.786         1.847	R <sup>2</sup> 0.506           0.059           0.255           0.063           R <sup>2</sup> 0.609           0.001           0.371	G.L. 38 38 38 38 38 38 G.L. 38 38 38 38 38	E.E. (1/(1-b)) 5.051 E.E. (1/(1-b)) 
Services Verdoorn Kaldor Rowthorn1 Rowthorn2 Services (with Verdoorn Kaldor Rowthorn1	Constant -0.045* (-3.253) 0.045* (3.253) 0.071* (4.728) 0.071* (4.728) 0.071* (4.728) 0.071* (4.728) 0.074* (-4.250) 0.074* (4.250) 0.076* (4.350) 0.076*	Coefficient           0.802*           (6.239)           0.198           (1.544)           -0.694*           (-3.607)           0.306           (1.592)           Coefficient           1.020*           (7.695)           -0.020           (-0.149)           -0.903*           (-4.736)           0.097	DW         1.728         1.728         1.728         1.817         1.817         DW         1.786         1.786         1.847	R <sup>2</sup> 0.506           0.059           0.255           0.063           R <sup>2</sup> 0.609           0.001           0.371	G.L. 38 38 38 38 38 38 G.L. 38 38 38 38	E.E. (1/(1-b)) 5.051 E.E. (1/(1-b)) 
Services Verdoorn Kaldor Rowthorn1 Rowthorn2 Services (with Verdoorn Kaldor Rowthorn1 Rowthorn2	Constant -0.045* (-3.253) 0.045* (3.253) 0.071* (4.728) 0.071* (4.728) 0.071* (4.728) 0.071* (4.728) 0.074* (-4.250) 0.074* (4.250) 0.076* (4.350) 0.076* (4.350)	Coefficient           0.802*           (6.239)           0.198           (1.544)           -0.694*           (-3.607)           0.306           (1.592)           Coefficient           1.020*           (7.695)           -0.020           (-0.149)           -0.903*           (-4.736)           0.097           (0.509)	DW         1.728         1.728         1.728         1.817         1.817         DW         1.786         1.786         1.847         1.847	R <sup>2</sup> 0.506           0.059           0.255           0.063           R <sup>2</sup> 0.609           0.001           0.371           0.007	G.L. 38 38 38 38 38 38 G.L. 38 38 38 38 38 38 38	E.E. (1/(1-b)) 5.051 E.E. (1/(1-b)) 
Services Verdoorn Kaldor Rowthorn1 Rowthorn2 Services (with Verdoorn Kaldor Rowthorn1 Rowthorn2 All Sectors	Constant -0.045* (-3.253) 0.045* (3.253) 0.071* (4.728) 0.071* (4.728) 0.071* (4.728) 0.071* (4.728) 0.074* (-4.250) 0.074* (4.250) 0.076* (4.350)	Coefficient           0.802*           (6.239)           0.198           (1.544)           -0.694*           (-3.607)           0.306           (1.592)           Coefficient           1.020*           (7.695)           -0.020           (-0.149)           -0.903*           (-4.736)           0.097           (0.509)	DW         1.728         1.728         1.728         1.817         1.817         DW         1.786         1.786         1.847         1.847	R <sup>2</sup> 0.506           0.059           0.255           0.063           R <sup>2</sup> 0.609           0.001           0.371           0.007	G.L.         38         38         38         38         38         38         38         38         38         38         38         38         38         38         38         38         38         38         38	E.E. (1/(1-b)) 5.051 E.E. (1/(1-b))  
Services Verdoorn Kaldor Rowthorn1 Rowthorn2 Services (with Verdoorn Kaldor Rowthorn1 Rowthorn2 All Sectors	Constant -0.045* (-3.253) 0.045* (3.253) 0.071* (4.728) 0.071* (4.728) 0.071* (4.728) 0.071* (4.728) 0.074* (-4.250) 0.074* (4.250) 0.076* (4.350) 0.076* (4.350) Constant	Coefficient           0.802*           (6.239)           0.198           (1.544)           -0.694*           (-3.607)           0.306           (1.592)           Coefficient           1.020*           (7.695)           -0.020           (-0.149)           -0.903*           (-4.736)           0.097           (0.509)	DW         1.728         1.728         1.728         1.817         1.817         DW         1.786         1.786         1.847         DW	R <sup>2</sup> 0.506         0.059         0.255         0.063         R <sup>2</sup> 0.609         0.001         0.371         0.007	G.L. 38 38 38 38 38 38 G.L. 38 38 38 38 38 G.L. G.L.	E.E. (1/(1-b)) 5.051 E.E. (1/(1-b)) E.E. (1/(1-b)) E.E. (1/(1-b))
Services Verdoorn Kaldor Rowthorn1 Rowthorn2 Services (with Verdoorn Kaldor Rowthorn1 Rowthorn2 All Sectors	Constant -0.045* (-3.253) 0.045* (3.253) 0.071* (4.728) 0.071* (4.728) 0.071* (4.728) 0.071* (4.728) 0.071* (4.728) 0.071* (4.728) 0.074* (-4.250) 0.076* (4.350) 0.076* (4.350) Constant -0.020*	Coefficient           0.802*           (6.239)           0.198           (1.544)           -0.694*           (-3.607)           0.306           (1.592)           Coefficient           1.020*           (7.695)           -0.903*           (-4.736)           0.097           (0.509)	DW         1.728         1.728         1.728         1.817         1.817         DW         1.786         1.786         1.847         1.847         DW	R <sup>2</sup> 0.506           0.059         0.255           0.063         0.063           R <sup>2</sup> 0.609           0.001         0.371           0.007         R <sup>2</sup>	G.L. 38 38 38 38 38 38 38 38 38 38	E.E. (1/(1-b)) 5.051 E.E. (1/(1-b)) E.E. (1/(1-b)) E.E. (1/(1-b))
Services Verdoorn Kaldor Rowthorn1 Rowthorn2 Services (with Verdoorn Kaldor Rowthorn1 Rowthorn2 All Sectors Verdoorn	Constant           -0.045*           (-3.253)           0.045*           (3.253)           0.071*           (4.728)           0.071*           (4.728)           0.071*           (4.728)           0.071*           (4.728)           0.071*           (4.728)           0.071*           (4.728)           0.071*           (4.728)           0.074*           (-4.250)           0.076*           (4.350)           0.076*           (4.350)           0.076*           (4.350)           0.076*           (4.350)	Coefficient           0.802*           (6.239)           0.198           (1.544)           -0.694*           (-3.607)           0.306           (1.592)           Coefficient           1.020*           (-0.149)           -0.903*           (-4.736)           0.097           (0.509)	DW         1.728         1.728         1.728         1.817         1.817         DW         1.786         1.786         1.847         1.847         DW         1.595	R <sup>2</sup> 0.506           0.059           0.255           0.063           R <sup>2</sup> 0.609           0.001           0.371           0.007           R <sup>2</sup> 0.648	G.L.         38	E.E. (1/(1-b)) 5.051 E.E. (1/(1-b)) E.E. (1/(1-b)) E.E. (1/(1-b))
Services Verdoorn Kaldor Rowthorn1 Rowthorn2 Services (with Verdoorn Kaldor Rowthorn1 Rowthorn2 All Sectors Verdoorn Kaldor	Constant           -0.045*           (-3.253)           0.045*           (3.253)           0.071*           (4.728)           0.071*           (4.728)           0.071*           (4.728)           0.071*           (4.728)           0.071*           (4.728)           0.071*           (4.728)           0.071*           (4.728)           0.074*           (-4.250)           0.076*           (4.350)           0.076*           (4.350)           0.076*           (4.350)           0.076*           (4.350)           0.020*           0.020*	Coefficient           0.802*           (6.239)           0.198           (1.544)           -0.694*           (-3.607)           0.306           (1.592)           Coefficient           1.020*           (7.695)           -0.020           (-0.149)           -0.903*           (-4.736)           0.097           (0.509)	DW         1.728         1.728         1.728         1.817         1.817         DW         1.786         1.786         1.847         1.847         DW         1.595         1.595	R <sup>2</sup> 0.506           0.059           0.255           0.063           R <sup>2</sup> 0.609           0.001           0.371           0.007           R <sup>2</sup> 0.648           0.019	G.L. 38 38 38 38 38 38 38 38 38 38	E.E. (1/(1-b)) 5.051 E.E. (1/(1-b)) E.E. (1/(1-b)) E.E. (1/(1-b))
Services Verdoorn Kaldor Rowthorn1 Rowthorn2 Services (with Verdoorn Kaldor Rowthorn1 Rowthorn2 All Sectors Verdoorn Kaldor	Constant           -0.045*           (-3.253)           0.045*           (3.253)           0.071*           (4.728)           out public sector)           Constant           -0.074*           (-4.250)           0.076*           (4.350)           0.076*           (4.350)           0.076*           (2.090)	Coefficient           0.802*           (6.239)           0.198           (1.544)           -0.694*           (-3.607)           0.306           (1.592)           Coefficient           1.020*           (7.695)           -0.020           (-0.149)           -0.903*           (-4.736)           0.097           (0.509)	DW         1.728         1.728         1.728         1.817         1.817         DW         1.786         1.786         1.847         1.847         DW         1.595         1.595	R <sup>2</sup> 0.506           0.059           0.255           0.063           R <sup>2</sup> 0.609           0.001           0.371           0.007           R <sup>2</sup> 0.648           0.019	G.L.         38	E.E. (1/(1-b)) 5.051 E.E. (1/(1-b)) E.E. (1/(1-b)) E.E. (1/(1-b)) 10.753
Services Verdoorn Kaldor Rowthorn1 Rowthorn2 Services (with Verdoorn Kaldor Rowthorn1 Rowthorn2 All Sectors Verdoorn Kaldor Rowthorn1	Constant           -0.045*           (-3.253)           0.045*           (3.253)           0.071*           (4.728)           out public sector)           Constant           -0.074*           (-4.250)           0.076*           (4.350)           0.076*           (4.350)           0.076*           (2.090)           0.020*           (2.090)           0.056*	Coefficient           0.802*           (6.239)           0.198           (1.544)           -0.694*           (-3.607)           0.306           (1.592)           Coefficient           1.020*           (7.695)           -0.020           (-0.149)           -0.903*           (-4.736)           0.097           (0.509)           Coefficient           0.907*           (8.367)           0.093           (0.856)           -0.648*	DW         1.728         1.728         1.728         1.817         1.817         DW         1.786         1.786         1.847         1.847         DW         1.595         1.595         2.336	R <sup>2</sup> 0.506           0.059           0.255           0.063           R <sup>2</sup> 0.609           0.001           0.371           0.007           R <sup>2</sup> 0.648           0.019           0.255	G.L. 38 38 38 38 38 38 38 38 38 38	E.E. (1/(1-b)) 5.051 E.E. (1/(1-b)) E.E. (1/(1-b)) E.E. (1/(1-b)) 10.753
Services Verdoorn Kaldor Rowthorn1 Rowthorn2 Services (with Verdoorn Kaldor Rowthorn1 Rowthorn2 All Sectors Verdoorn Kaldor Rowthorn1	Constant           -0.045*           (-3.253)           0.045*           (3.253)           0.071*           (4.728)           out public sector)           Constant           -0.074*           (-4.250)           0.076*           (4.350)           0.076*           (4.350)           0.076*           (4.350)           0.076*           (4.350)	Coefficient           0.802*           (6.239)           0.198           (1.544)           -0.694*           (-3.607)           0.306           (1.592)           Coefficient           1.020*           (7.695)           -0.020           (-0.149)           -0.903*           (-4.736)           0.097           (0.509)           Coefficient           0.907*           (8.367)           0.093           (0.856)           -0.648*           (-2.670)	DW         1.728         1.728         1.728         1.817         1.817         DW         1.786         1.786         1.786         1.847         1.847         DW         1.595         2.336	R <sup>2</sup> 0.506           0.059           0.255           0.063           R <sup>2</sup> 0.609           0.001           0.371           0.007           R <sup>2</sup> 0.648           0.019           0.255	G.L.         38	E.E. (1/(1-b)) 5.051 E.E. (1/(1-b)) E.E. (1/(1-b)) E.E. (1/(1-b)) 10.753
Services Verdoorn Kaldor Rowthorn1 Rowthorn2 Services (with Verdoorn Kaldor Rowthorn1 Rowthorn2 All Sectors Verdoorn Kaldor Rowthorn1 Rowthorn1 Rowthorn1	Constant           -0.045*           (-3.253)           0.045*           (3.253)           0.071*           (4.728)           out public sector)           Constant           -0.074*           (-4.250)           0.076*           (4.350)           0.076*           (4.350)           0.076*           (4.350)           0.076*           (4.350)	Coefficient           0.802*           (6.239)           0.198           (1.544)           -0.694*           (-3.607)           0.306           (1.592)           Coefficient           1.020*           (7.695)           -0.903*           (-4.736)           0.097           (0.509)           Coefficient           0.907*           (8.367)           0.093           (0.856)           -0.648*           (-2.670)           0.352	DW         1.728         1.728         1.728         1.817         1.817         DW         1.786         1.786         1.786         1.847         1.847         1.595         1.595         2.336         2.336	R <sup>2</sup> 0.506           0.059           0.255           0.063           R <sup>2</sup> 0.609           0.001           0.371           0.007           R <sup>2</sup> 0.648           0.019           0.255           0.2255	G.L.         38         32	E.E. (1/(1-b)) 5.051 E.E. (1/(1-b)) E.E. (1/(1-b)) E.E. (1/(1-b)) 10.753

Note: \* Coefficient statistically significant at 5%, \*\* Coefficient statistically significant at 10%, GL, Degrees of freedom; EE, Economies of scale.

# 5. EMPIRICAL EVIDENCE OF ABSOLUTE CONVERGENCE, PANEL DATA

Table 2 presents the results of absolute convergence of output per worker, obtained in the panel estimations for each of the economic sectors and the sectors to the total level of NUTS II, from 1986 to 1994 (a total of 45 observations, corresponding to regions 5 and 9 years).

The convergence results obtained in the estimations carried out are statistically satisfactory to each of the economic sectors and all sectors of the NUTS II.

Agriculture						-						
Method	Const.	<b>D</b> <sub>1</sub>	$D_2$	$D_3$	$D_4$	<b>D</b> <sub>5</sub>	Coef.	T.C.	DW	R <sup>2</sup>	G.L.	
Pooling	0.558 (1.200)						-0.063 (-1.163)	-0.065	1.851	0.034	38	
LSDV		4.127* (4.119)	4.207* (4.116)	4.496* (4.121)	4.636* (4.159)	4.549* (4.091)	-0.514* (-4.108)	-0.722	2.202	0.352	34	
GLS	0.357 (0.915)						-0.040 (-0.871)	-0.041	1.823	0.020	38	
Industry												
Method	Const.	<b>D</b> <sub>1</sub>	$D_2$	D <sub>3</sub>	$D_4$	D <sub>5</sub>	Coef.	T.C.	DW	R <sup>2</sup>	G.L.	
Pooling	2.906* (2.538)						-0.292* (-2.525)	-0.345	1.625	0.144	38	
LSDV		6.404* (4.345)	6.459* (4.344)	6.695* (4.341)	6.986* (4.369)	6.542* (4.334)	-0.667* (-4.344)	-1.100	1.679	0.359	34	
GLS	3.260* (2.741)						-0.328* (-2.729)	-0.397	1.613	0.164	38	
Manufactured Industry												
Method	Const.	<b>D</b> <sub>1</sub>	D <sub>2</sub>	D <sub>3</sub>	$D_4$	D <sub>5</sub>	Coef.	T.C.	DW	R <sup>2</sup>	G.L.	
Pooling	1.806** (1.853)						-0.186** (-1.845)	-0.206	1.935	0.082	38	
LSDV		6.625* (4.304)	6.669* (4.303)	6.941* (4.303)	6.903* (4.318)	6.626* (4.293)	-0.699* (-4.301)	-1.201	1.706	0.357	34	
GLS	1.655** (1.753)						-0.171** (-1.745)	-0.188	1.946	0.074	38	
Services												
Services												
Method	Const.	<b>D</b> <sub>1</sub>	<b>D</b> <sub>2</sub>	D <sub>3</sub>	D <sub>4</sub>	D <sub>5</sub>	Coef.	T.C.	DW	R <sup>2</sup>	G.L.	
Method Pooling	<b>Const.</b> 5.405* (4.499)	D <sub>1</sub>	<b>D</b> <sub>2</sub>	<b>D</b> <sub>3</sub>	D4	D5	Coef. -0.554* (-4.477)	<b>T.C.</b> -0.807	<b>DW</b> 1.874	<b>R</b> <sup>2</sup> 0.345	<b>G.L.</b> 38	
Services           Method           Pooling           LSDV	Const. 5.405* (4.499)	<b>D</b> <sub>1</sub> 7.193* (5.290)	<b>D</b> <sub>2</sub> 7.169* (5.301)	<b>D</b> <sub>3</sub> 7.313* (5.284)	<b>D</b> <sub>4</sub> 7.153* (5.292)	<b>D</b> <sub>5</sub> 7.273* (5.293)	Coef. -0.554* (-4.477) -0.741* (-5.275)	<b>T.C.</b> -0.807 -1.351	<b>DW</b> 1.874 2.051	<b>R<sup>2</sup></b> 0.345 0.451	<b>G.L.</b> 38 34	
Method Pooling LSDV GLS	Const. 5.405* (4.499) 5.627* (4.626)	<b>D</b> <sub>1</sub> 7.193* (5.290)	<b>D</b> <sub>2</sub> 7.169* (5.301)	<b>D</b> <sub>3</sub> 7.313* (5.284)	<b>D</b> <sub>4</sub> 7.153* (5.292)	<b>D</b> <sub>5</sub> 7.273* (5.293)	Coef. -0.554* (-4.477) -0.741* (-5.275) -0.577* (-4.604)	<b>T.C.</b> -0.807 -1.351 -0.860	<b>DW</b> 1.874 2.051 1.886	<b>R</b> <sup>2</sup> 0.345 0.451 0.358	G.L. 38 34 38	
Method Pooling LSDV GLS Services (with	Const. 5.405* (4.499) 5.627* (4.626)	D <sub>1</sub> 7.193* (5.290) c sector)	<b>D</b> <sub>2</sub> 7.169* (5.301)	<b>D</b> <sub>3</sub> 7.313* (5.284)	<b>D</b> <sub>4</sub> 7.153* (5.292)	<b>D</b> <sub>5</sub> 7.273* (5.293)	Coef. -0.554* (-4.477) -0.741* (-5.275) -0.577* (-4.604)	<b>T.C.</b> -0.807 -1.351 -0.860	DW           1.874           2.051           1.886	R <sup>2</sup> 0.345           0.451           0.358	G.L. 38 34 38	
Method Pooling LSDV GLS Services (with Method	Const. 5.405* (4.499) 5.627* (4.626) nout publi Const.	D <sub>1</sub> 7.193* (5.290) c sector) D <sub>1</sub>	D <sub>2</sub> 7.169* (5.301) D <sub>2</sub>	D <sub>3</sub> 7.313* (5.284) D <sub>3</sub>	D₄ 7.153* (5.292) D₄	D₅ 7.273* (5.293) D₅	Coef. -0.554* (-4.477) -0.741* (-5.275) -0.577* (-4.604) Coef.	<b>T.C.</b> -0.807 -1.351 -0.860 <b>T.C.</b>	DW 1.874 2.051 1.886 DW	<b>R</b> <sup>2</sup> 0.345 0.451 0.358 <b>R</b> <sup>2</sup>	G.L. 38 34 38 G.L.	
Method Pooling LSDV GLS Services (with Method Pooling	Const. 5.405* (4.499) 5.627* (4.626) nout publi Const. 5.865* (4.079)	D <sub>1</sub> 7.193* (5.290) c sector) D <sub>1</sub>	D <sub>2</sub> 7.169* (5.301) D <sub>2</sub>	D <sub>3</sub> 7.313* (5.284) D <sub>3</sub>	D <sub>4</sub> 7.153* (5.292) D <sub>4</sub>	D₅ 7.273* (5.293) D₅	Coef. -0.554* (-4.477) -0.741* (-5.275) -0.577* (-4.604) Coef. -0.589* (-4.073)	T.C.         -0.807         -1.351         -0.860         T.C.         -0.889	DW           1.874           2.051           1.886           DW           1.679	R <sup>2</sup> 0.345           0.451           0.358           R <sup>2</sup> 0.304	G.L. 38 34 38 G.L. 38	
Method Pooling LSDV GLS Services (with Method Pooling LSDV	Const. 5.405* (4.499) 5.627* (4.626) rout public Const. 5.865* (4.079)	D <sub>1</sub> 7.193* (5.290) c sector) D <sub>1</sub> 6.526* (4.197)	D <sub>2</sub> 7.169* (5.301) D <sub>2</sub> 6.523* (4.195)	D <sub>3</sub> 7.313* (5.284) D <sub>3</sub> 6.635* (4.191)	D <sub>4</sub> 7.153* (5.292) D <sub>4</sub> 6.506* (4.176)	D₅ 7.273* (5.293) D₅ 6.561* (4.192)	Coef. -0.554* (-4.477) -0.741* (-5.275) -0.577* (-4.604) Coef. -0.589* (-4.073) -0.658* (-4.188)	T.C.         -0.807         -1.351         -0.860         T.C.         -0.889         -1.073	DW           1.874           2.051           1.886           DW           1.679           1.684	R <sup>2</sup> 0.345           0.451           0.358           R <sup>2</sup> 0.304           0.342	G.L. 38 34 38 G.L. 38 34	
Method Pooling LSDV GLS Services (with Method Pooling LSDV GLS	Const. 5.405* (4.499) 5.627* (4.626) rout publi Const. 5.865* (4.079) 5.027* (3.656)	D <sub>1</sub> 7.193* (5.290) c sector) D <sub>1</sub> 6.526* (4.197)	D₂ 7.169* (5.301) D₂ 6.523* (4.195)	D <sub>3</sub> 7.313* (5.284) D <sub>3</sub> 6.635* (4.191)	D₄         7.153*         (5.292)         D₄         6.506*         (4.176)	D₅ 7.273* (5.293) D₅ 6.561* (4.192)	Coef. -0.554* (-4.477) -0.741* (-5.275) -0.577* (-4.604) Coef. -0.589* (-4.073) -0.658* (-4.188) -0.505* (-3.649)	T.C.         -0.807         -1.351         -0.860         T.C.         -0.889         -1.073         -0.703	DW           1.874           2.051           1.886           DW           1.679           1.684           1.682	R <sup>2</sup> 0.345           0.451           0.358           R <sup>2</sup> 0.304           0.342           0.260	G.L. 38 34 38 G.L. 38 34 38	
Method Pooling LSDV GLS Services (with Method Pooling LSDV GLS All sectors	Const. 5.405* (4.499) 5.627* (4.626) rout publi Const. 5.865* (4.079) 5.027* (3.656)	D <sub>1</sub> 7.193* (5.290) <b>c sector)</b> D <sub>1</sub> 6.526* (4.197)	D₂ 7.169* (5.301) D₂ 6.523* (4.195)	D <sub>3</sub> 7.313* (5.284) D <sub>3</sub> 6.635* (4.191)	D₄         7.153*         (5.292)         D₄         6.506*         (4.176)	D₅         7.273*         (5.293)         D₅         6.561*         (4.192)	Coef. -0.554* (-4.477) -0.741* (-5.275) -0.577* (-4.604) Coef. -0.589* (-4.073) -0.658* (-4.188) -0.505* (-3.649)	T.C.         -0.807         -1.351         -0.860         T.C.         -0.889         -1.073         -0.703	DW         1.874         2.051         1.886         DW         1.679         1.684         1.682	R <sup>2</sup> 0.345           0.451           0.358           R <sup>2</sup> 0.304           0.342           0.260	G.L. 38 34 38 G.L. 38 34 38	
Services         Method         Pooling         LSDV         GLS         Services (with Method         Pooling         LSDV         GLS         Method         Pooling         LSDV         GLS         Method         Pooling         LSDV         GLS         All sectors         Method	Const. 5.405* (4.499) 5.627* (4.626) rout publi Const. 5.865* (4.079) 5.027* (3.656) Const.	D <sub>1</sub> 7.193* (5.290) c sector) D <sub>1</sub> 6.526* (4.197) D <sub>1</sub>	D <sub>2</sub> 7.169* (5.301) D <sub>2</sub> 6.523* (4.195) D <sub>2</sub>	D <sub>3</sub> 7.313* (5.284) D <sub>3</sub> 6.635* (4.191) D <sub>3</sub>	D₄         7.153*         (5.292)         D₄         6.506*         (4.176)	D₅ 7.273* (5.293) D₅ 6.561* (4.192) D₅	Coef. -0.554* (-4.477) -0.741* (-5.275) -0.577* (-4.604) Coef. -0.589* (-4.073) -0.658* (-4.188) -0.505* (-3.649) Coef.	T.C.         -0.807         -1.351         -0.860         T.C.         -0.889         -1.073         -0.703         T.C.	DW         1.874         2.051         1.886         DW         1.679         1.684         1.682	R <sup>2</sup> 0.345           0.451           0.358           R <sup>2</sup> 0.304           0.342           0.260           R <sup>2</sup>	G.L. 38 34 38 G.L. 38 34 38 G.L. G.L.	
Services         Method         Pooling         LSDV         GLS         Services (with Method         Pooling         LSDV         GLS         Method         Pooling         LSDV         GLS         Method         Pooling         LSDV         GLS         All sectors         Method         Pooling	Const. 5.405* (4.499) 5.627* (4.626) Tout publi Const. 5.865* (4.079) 5.027* (3.656) Const. 3.166* (3.603)	D <sub>1</sub> 7.193* (5.290) C sector) D <sub>1</sub> 6.526* (4.197) D <sub>1</sub>	D₂ 7.169* (5.301) D₂ 6.523* (4.195) D₂	D <sub>3</sub> 7.313* (5.284) D <sub>3</sub> 6.635* (4.191) D <sub>3</sub>	D₄         7.153*         (5.292)         D₄         6.506*         (4.176)         D₄	D₅ 7.273* (5.293) D₅ 6.561* (4.192) D₅ D₅	Coef. -0.554* (-4.477) -0.741* (-5.275) -0.577* (-4.604) Coef. -0.589* (-4.073) -0.658* (-4.188) -0.505* (-3.649) Coef. -0.328* (-3.558)	T.C.         -0.807         -1.351         -0.860         T.C.         -0.889         -1.073         -0.703         T.C.         -0.397	DW         1.874         2.051         1.886         DW         1.679         1.684         1.682         DW         1.785	R <sup>2</sup> 0.345           0.451           0.358           R <sup>2</sup> 0.304           0.342           0.260           R <sup>2</sup> 0.250	G.L. 38 34 38 G.L. 38 34 38 G.L. 38	
Method Pooling LSDV GLS Services (with Method Pooling LSDV GLS All sectors Method Pooling LSDV	Const. 5.405* (4.499) 5.627* (4.626) rout publi Const. 5.865* (4.079) 5.027* (3.656) Const. 3.166* (3.603)	D <sub>1</sub> 7.193* (5.290) D <sub>1</sub> 6.526* (4.197) D <sub>1</sub> 0 6.080* (5.361)	D₂ 7.169* (5.301) D₂ 6.523* (4.195) D₂ D₂ 0.030* (5.374)	D <sub>3</sub> 7.313* (5.284) D <sub>3</sub> 6.635* (4.191) D <sub>3</sub> D <sub>3</sub> 6.308* (5.347)	D <sub>4</sub> 7.153* (5.292) D <sub>4</sub> 6.506* (4.176) D <sub>4</sub> 6.202* (5.379)	D₅ 7.273* (5.293) D₅ 6.561* (4.192) D₅ D₅ 6.193* (5.359)	Coef. -0.554* (-4.477) -0.741* (-5.275) -0.577* (-4.604) Coef. -0.589* (-4.073) -0.658* (-4.188) -0.505* (-3.649) Coef. -0.328* (-3.558) -0.643* (-5.333)	T.C.         -0.807         -1.351         -0.860         T.C.         -0.889         -1.073         -0.703         T.C.         -0.397         -1.030	DW         1.874         2.051         1.886         DW         1.679         1.684         1.682         DW         1.785         2.181	R <sup>2</sup> 0.345           0.451           0.358           R <sup>2</sup> 0.304           0.342           0.260           R <sup>2</sup> 0.250           0.460	G.L. 38 34 38 G.L. 38 34 38 G.L. 38 34 38	

 Table 2: Analysis of convergence in productivity for each economic sectors of the five NUTS II of Portugal, for

 the period 1986 to 1994

Note: Const. Constant; Coef., Coefficient, TC, annual rate of convergence; \* Coefficient statistically significant at 5%, \*\* Coefficient statistically significant at 10%, GL, Degrees of freedom; LSDV, method of fixed effects with variables dummies; D1 ... D5, five variables dummies corresponding to five different regions, GLS, random effects method.

#### 6. FINAL CONCLUSIONS

In the estimates made for each of the economic sectors, with the Verdoorn law, it appears that the industry is the largest that has increasing returns to scale, followed by agriculture and service sector.

On the other hand, we find some signs of convergence, analyzing the results of the estimations with the models of the neoclassical theory.

So, we can say for this period that we find some signs of convergence, specifically in the industry, but are not strong enough to avoid the disparities between the Portuguese regions, although the results for the manufactured industry are more consistent as expected.

Alert! This author has published many duplicate versions of very similar papers with slightly different titles, but without an appropriate notice. This may apply to this contribution, too.

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