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ABSTRACT

This work aims to test the Verdoorn Law, with the alternative specifications of (1)Kaldor (1966), for the five Portuguese regions (NUTS II), from 1986 to 1994 and from 1995 to 1999. It is intended to test, yet in this work, the alternative interpretation of (2)Rowthorn (1975) about the Verdoorn's Law for the same regions and periods. The results of this study are about each one of the manufactured industries operating in the Portuguese regions.

Keywords: Verdoorn law; panel data; manufactured industries; Portuguese regions.

1. INTRODUCTION

Kaldor rediscovered the Verdoorn law in 1966 and since then this law has been tested in several ways, using specifications, samples and different periods (3)(Martinho, 2011). However, the conclusions drawn differ, some of them rejecting the Law of Verdoorn and other supporting its validity. (4)Kaldor (1966, 1967) in his attempt to explain the causes of the low rate of growth in the UK, reconsidering and empirically investigating Verdoorn's Law, found that there is a strong positive relationship between the growth of labor productivity (p) and output (q), i.e. p = f (q). Or alternatively between employment growth (e) and the growth of output, ie, e = f (q).

Another interpretation of Verdoorn's Law, as an alternative to the Kaldor, is presented by (5)Rowthorn (1975, 1979). Rowthorn argues that the most appropriate specification of Verdoorn's Law is the ratio of growth of output (q) and the growth of labor productivity (p) with employment growth (e), i.e., q = f (e) and p = f (e), respectively (as noted above, the exogenous variable in this case is employment). On the other hand, Rowthorn believes that the empirical work of Kaldor (1966) for the period 1953-54 to 1963-64 and the (6)Cripps and Tarling (1973) for the period 1951 to 1965 that confirm Kaldor's Law, not can be accepted since they are based on small samples of countries, where extreme cases end up like Japan have great influence on overall results.

It should be noted, finally, that several authors have developed a body of work in order to test the Verdoorn's Law in a regional context, including (7)Leon-Ledesma (1998).

2. ALTERNATIVE SPECIFICATIONS OF VERDOORN'S LAW

The hypothesis of increasing returns to scale in industry was initially tested by Kaldor (1966) using the following relations:

$p_i = a + bq_i$, Verdoorn law (1)

$e_i = c + dq_i$, Kaldor law (2)

where pi, qi and ei are the growth rates of labor productivity, output and employment in the industrial sector in the economy i.

On the other hand, the mathematical form of Rowthorn specification is as follows:

$p_i = \lambda_1 + \varepsilon_1 e_i$, firts equation of Rowthorn (3)

$q_i = \lambda_2 + \varepsilon_2 e_i$, second equation of Rowthorn (4)

where $\lambda_1 = \lambda_2$ e $\varepsilon_2 = (1 + \varepsilon_1)$, because $p_i = q_i - e_i$. In other words, $q_i - e_i = \lambda_1 + \varepsilon_1 e_i$, $q_i = \lambda_1 + e_i + \varepsilon_1 e_i$, so, $q_i = \lambda_1 + (1 + \varepsilon_1) e_i$.

Rowthorn estimated these equations for the same OECD countries considered by Kaldor (1966), with the exception of Japan, and for the same period and found that ε_2 was not statistically different from unity and therefore ε_1 was not statistically different from zero. This author thus confirmed the hypothesis of constant returns to scale in manufacturing in the developed countries of the OECD. (8)Thirlwall (1980) criticized these results, considering that the Rowthorn interpretation of Verdoorn's Law is static, since it assumes that the Verdoorn coefficient depends solely on the partial elasticity of output with respect to employment.

3. DATA ANALYSIS

Considering the variables on the models of Kaldor and Rowthorn presented previously and the availability of statistical information, we used the following data disaggregated at regional level. Annual data for the period 1986 to 1994, corresponding to the five regions of mainland Portugal (NUTS II), and for the several manufactured industries in those regions. These data were obtained from Eurostat (Eurostat Regio of Statistics 2000). We also used data for the period from 1995 to 1999, for the same regions of mainland Portugal, and for the several industris. The data for the period 1995 to 1999 were obtained from the INE (National Accounts 2003).

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 manufacturing industries, enable us to present the conclusions referred following.

Manufacturing industries that have, respectively, higher increasing returns to scale are the industry of transport equipment (5.525), the food industry (4.274), industrial minerals (3.906), the metal industry (3.257), the several industry (2.222), the textile industry (1.770), the chemical industry (1.718) and industry equipment and electrical goods (presents unacceptable values). The paper industry has excessively high values. Note that, as expected, the transportation equipment industry and the food industry have the best economies of scale (they are modernized industries) and the textile industry has the lowest economies of scale (industry still very traditional, labor intensive, and in small units).

Also in Table 1 presents the results of an estimation carried out with 9 manufacturing industries disaggregated and together (with 405 observations). By analyzing these data it appears that were obtained respectively for the coefficients of the four equations, the following elasticities: 0.608, 0.392, -0.275 and 0.725. Therefore, values that do not indicate very strong increasing returns to scale, as in previous estimates, but are close to those obtained by Verdoorn and Kaldor.

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

Metal Industry						
	Constant	**Coefficient**	**DW**	**R^2**	**G.L.**	**E.E. (1/(1-b))**
Verdoorn $p_i = a + bq_i$	-4.019* (-2.502)	0.693* (9.915)	1.955	0.898	29	3.257
Kaldor $e_i = c + dq_i$	4.019* (2.502)	0.307* (4.385)	1.955	0.788	29	
Rowthorn1 $p_i = \lambda_1 + \varepsilon_1 e_i$	-12.019 (-0.549)	0.357 (1.284)	1.798	0.730	29	
Rowthorn2 $q_i = \lambda_2 + \varepsilon_2 e_i$	-12.019 (-0.549)	1.357* (4.879)	1.798	0.751	29	
Mineral Industry						
	Constant	**Coefficient**	**DW**	**R^2**	**G.L.**	**E.E. (1/(1-b))**
Verdoorn	-0.056* (-4.296)	0.744* (4.545)	1.978	0.352	38	3.906
Kaldor	0.056* (4.296)	0.256 (1.566)	1.978	0.061	38	
Rowthorn1	-0.023 (-0.685)	-0.898* (-9.503)	2.352	0.704	38	
Rowthorn2	-0.023 (-0.685)	0.102 (1.075)	2.352	0.030	38	
Chemical Industry						
	Constant	**Coefficient**	**DW**	**R^2**	**G.L.**	**E.E. (1/(1-b))**
Verdoorn	0.002 (0.127)	0.418* (6.502)	1.825	0.554	34	1.718
Kaldor	-0.002 (-0.127)	0.582* (9.052)	1.825	0.707	34	

Rowthorn1	9.413* (9.884)	0.109 (0.999)	1.857	0.235	33	
Rowthorn2	9.413* (9.884)	1.109* (10.182)	1.857	0.868	33	
Electrical Industry						
	Constant	**Coefficient**	**DW**	**R^2**	**G.L.**	**E.E. (1/(1-b))**
Verdoorn	0.004 (0.208)	-0.126 (-1.274)	1.762	0.128	32	---
Kaldor	-0.004 (-0.208)	1.126* (11.418)	1.762	0.796	32	
Rowthorn1	0.019 (1.379)	-0.287* (-4.593)	1.659	0.452	32	
Rowthorn2	0.019 (1.379)	0.713* (11.404)	1.659	0.795	32	
Transport Industry						
	Constant	**Coefficient**	**DW**	**R^2**	**G.L.**	**E.E. (1/(1-b))**
Verdoorn	-0.055* (-2.595)	0.819* (5.644)	2.006	0.456	38	5.525
Kaldor	0.055* (2.595)	0.181 (1.251)	2.006	0.040	38	
Rowthorn1	-0.001 (-0.029)	-0.628* (-3.938)	2.120	0.436	32	
Rowthorn2	-0.001 (-0.029)	0.372* (2.336)	2.120	0.156	32	
Food Industry						
	Constant	**Coefficient**	**DW**	**R^2**	**G.L.**	**E.E. (1/(1-b))**
Verdoorn	0.006 (0.692)	0.766* (6.497)	2.191	0.526	38	4.274
Kaldor	-0.006 (-0.692)	0.234** (1.984)	2.191	0.094	38	
Rowthorn1	0.048* (2.591)	-0.679* (-4.266)	1.704	0.324	38	
Rowthorn2	0.048* (2.591)	0.321* (2.018)	1.704	0.097	38	
Textile Industry						
	Constant	**Coefficient**	**DW**	**R^2**	**G.L.**	**E.E. (1/(1-b))**
Verdoorn	-0.008 (-0.466)	0.435* (3.557)	2.117	0.271	34	1.770
Kaldor	0.008 (0.466)	0.565* (4.626)	2.117	0.386	34	
Rowthorn1	0.002 (0.064)	-0.303* (-2.311)	1.937	0.136	34	
Rowthorn2	0.002 (0.064)	0.697* (5.318)	1.937	0.454	34	
Paper Industry						
	Constant	**Coefficient**	**DW**	**R^2**	**G.L.**	**E.E. (1/(1-b))**
Verdoorn	-0.062* (-3.981)	1.114* (12.172)	1.837	0.796	38	∞
Kaldor	0.062* (3.981)	-0.114 (-1.249)	1.837	0.039	38	
Rowthorn1	0.028 (1.377)	-1.053* (-4.134)	1.637	0.310	38	
Rowthorn2	0.028 (1.377)	-0.053 (-0.208)	1.637	0.001	38	
Several Industry						
	Constant	**Coefficient**	**DW**	**R^2**	**G.L.**	**E.E. (1/(1-b))**
Verdoorn	-1.212 (-0.756)	0.550* (8.168)	2.185	0.529	37	2.222
Kaldor	1.212 (0.756)	0.450* (6.693)	2.185	0.983	37	
Rowthorn1	8.483* (24.757)	0.069 (1.878)	2.034	0.175	37	
Rowthorn2	8.483* (24.757)	1.069* (29.070)	2.034	0.975	37	
9 Manufactured Industry Together						

	Constant	Coefficient	DW	R^2	G.L.	E.E. (1/(1-b))
Verdoorn	-0.030* (-6.413)	0.608* (19.101)	1.831	0.516	342	2.551
Kaldor	0.030* (6.413)	0.392* (12.335)	1.831	0.308	342	
Rowthorn1	-0.003 (-0.257)	-0.275* (-4.377)	1.968	0.053	342	
Rowthorn2	-0.003 (-0.257)	0.725* (11.526)	1.968	0.280	342	

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

In Table 2 are the results of an estimation carried out for nine manufacturing industries disaggregated and together, as in the face of data availability (short period of time and lack of disaggregated data for these industries in NUTS III) this is a way to estimate considered the equations for the different manufacturing industries during this period. For the analysis of the data reveals that the values of the coefficients of the four equations are, respectively, 0.774, 0.226, -0.391 and 0.609 (all statistically significant), reflecting the increasing returns to scale increased slightly in this economic sector, i.e. of 2.551 (Table 1) to 4.425.

Table 2: Analysis of economies of scale through the equation Verdoorn, Kaldor and Rowthorn, for nine manufacturing industries together for the period 1995 to 1999 and five in mainland Portugal NUTS II

9 Manufactured Industry Together						
	Constant	**Coefficient**	**DW**	R^2	**G.L.**	**E.E. (1/(1-b))**
Verdoorn $p_i = a + bq_i$	0.004 (0.766)	0.774* (20.545)	2.132	0.703	178	4.425
Kaldor $e_i = c + dq_i$	-0.004 (-0.766)	0.226* (6.010)	2.132	0.169	178	
Rowthorn1 $p_i = \lambda_1 + \varepsilon_1 e_i$	0.049* (4.023)	-0.391* (-3.392)	2.045	0.112	132	
Rowthorn2 $q_i = \lambda_2 + \varepsilon_2 e_i$	0.049* (4.023)	0.609* (5.278)	2.045	0.214	132	

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

5. CONCLUSIONS

At the level of estimates made for manufactured industries, it appears that those with, respectively, higher dynamics are the transport equipment industry, food industry, minerals industrial, metals industry, the several industries, the textile industry, chemical industry and equipment and electrical goods industry. The paper industry has excessively high values.

The results of the estimations made in the second period (1995-1999), notes that the manufactured industry provides greater increasing returns to scale.

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