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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. 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 period. The results of this study are about each one of the manufactured industries operating in the Portuguese regions. This paper pretends, also, to analyze the importance which the natural advantages and local resources are in the manufacturing industry location, in relation with the "spillovers" effects and industrial policies. To this, we estimate the Rybczynski equation matrix for the various manufacturing industries in Portugal, at regional level (NUTS II) and for the period 1986 to 1994.

Keywords: Verdoorn law; geographic concentration; 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.

Taking into account the work of (7)Kim (1999), we seek, aldo, to analyze the importance of the natural advantages and local resources (specific factors of locations) have in explaining the geographic concentration over time in the Portuguese regions, relatively effects "spillovers" and industrial policies (in particular, the modernization and innovation that have allowed manufacturing in other countries take better advantage of positive externalities). For this, we estimated the Rybczynski equation matrix for the different manufacturing industries in the regions of Portugal, for the period 1986 to 1994. It should be noted that while the model of inter-regional trade, the Heckscher-Ohlin-Vanek, presents a linear relationship between net exports and inter-regional specific factors of locations, the Rybczynski theorem provides a linear relationship between regional production and specific factors of locations. In principle, the residual part of the estimation of Rybczynski, measured by the difference between the adjusted degree of explanation (R2) and the unit presents a approximated estimate of the importance not only of the "spillovers" effects, as considered by Kim (1999), but also of the industrial policies, because, industrial policies of modernization and innovation are interconnected with the "spillover" effects. However, it must be some caution with this interpretation, because, for example, although the growth of unexplained variation can be attributed to the growing importance of externalities "Marshallians" or "spillovers" effects and industrial policies, this conclusion may not be correct. Since the "spillovers" effects and industrial policies are measured as a residual part, the growth in the residual can be caused, also, for example, by growth in the randomness of the location of the products manufactured and the growing importance of external trade in goods and factors.

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. THE MODEL THAT ANALYZES THE IMPORTANCE OF NATURAL ADVANTAGES AND LOCAL RESOURCES IN AGGLOMERATION

According to Kim (1999), the Rybczynski theorem states that an increase in the supply of one factor leads to an increased production of the good that uses this factor intensively and a reduction in the production of other goods.

Given these assumptions, the linear relationship between regional output and offers of regional factors, may be the following:

$$Y = A^{-1}V,$$

where Y (nx1) is a vector of output, A (nxm) is a matrix of factor intensities or matrix input Rybczynski and V (mx1) is a vector of specific factors to locations.

For the output we used the gross value added of different manufacturing industries, to the specific factors of the locations used the labor, land and capital. For the labor we used the employees in manufacturing industries considered (symbolized in the following equation by "Labor") and the capital, because the lack of statistical data, it was considered, as a "proxy", the production in construction and public works (the choice of this variable is related to several reasons including the fact that it represents a part of the investment made during this period and symbolize the part of existing local resources, particularly in terms of infrastructure). With regard to land, although this factor is often used as specific of the locations, the amount of land is unlikely to serve as a significant specific factor of the locations. Alternatively, in this work is used the production of various extractive sectors, such as a "proxy" for the land. These sectors, include agriculture, forestry and fisheries (represented by "Agriculture") and production of natural resources and energy (symbolized by "Energy"). The overall regression is then used as follows:

$$\ln Y_{it} = \alpha + \beta_1 \ln Labor_{it} + \beta_2 \ln Agriculture_{it} + \beta_3 \ln Energy_{it} + \beta_4 \ln Construction_{it} + \varepsilon$$

In this context, it is expected that there is, above all, a positive relationship between the production of each of the manufacturing industry located in a region and that region-specific factors required for this industry, in particular, to emphasize the more noticeable cases, between food industry and agriculture, among the textile industry and labor (given the characteristics of this industry), among the industry of metal products and metal and mineral extraction and from the paper industry and forest.

4. DATA ANALYSIS

Considering the variables on the models 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. The data are relative, also, to regional gross value added of agriculture, fisheries and forestry, natural resources and energy and construction and public works. These data were obtained from Eurostat (Eurostat Regio of Statistics 2000).

5. 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.

6. EMPIRICAL EVIDENCE OF GEOGRAPHIC CONCENTRATION

In the results presented in the following table, there is a strong positive relationship between gross value added and labor in particular in the industries of metals, chemicals, equipment and electrical goods, textile and several products. On the other hand, there is an increased dependence on natural and local resources in industries as the mineral products, equipment and electric goods, textile and several products. We found that the location of manufacturing industry is yet mostly explained by specific factors of locations and poorly explained by "spillovers" effects and industrial policies.

Table 2: Results of estimations for the years 1986-1994

$$\ln Y_{it} = \alpha + \beta_1 \ln Labor_{it} + \beta_2 \ln Agriculture_{it} + \beta_3 \ln Energy_{it} + \beta_4 \ln Construction_{it} + \varepsilon$$

	IMT (2)	IMI (1)	IPQ (1)	IEE (1)	IET (1)	IAL (2)	ITE (1)	IPA (1)	IPD (2)
α	10.010 (0.810)					34.31(*) (3.356)			83.250(*) (5.412)
Dummy1		18.753(*) (5.442)	-13.467(*) (-3.134)	14.333(*) (2.811)	9.183 (1.603)		15.175(*) (3.652)	17.850(*) (3.162)	
Dummy2		19.334(*) (5.733)	-12.679(*) (-2.930)	13.993(*) (2.802)	10.084(**) (1.766)		14.904(*) (3.597)	17.532(*) (3.100)	
Dummy3		19.324(*) (5.634)	-13.134(*) (-3.108)	14.314(*) (2.804)	10.155(**) (1.797)		14.640(*) (3.534)	18.586(*) (3.313)	
Dummy4		18.619(*) (5.655)	-11.256(*) (-2.599)	14.022(*) (2.857)	9.384 (1.627)		15.067(*) (3.647)	15.001(*) (2.654)	
Dummy5		17.860(*) (5.629)	-11.060(*) (-2.682)	12.629(*) (2.653)	7.604 (1.377)		13.206(*) (3.344)	13.696(*) (2.574)	
β_1	1.420(*) (4.965)	0.517(*) (4.651)	1.098(*) (8.056)	0.817(*) (7.695)	0.397(*) (2.455)	0.378(*) (2.000)	0.809(*) (5.962)	-0.071 (-0.230)	0.862(*) (10.995)
β_2	0.844 (1.353)	-0.358(*) (-2.420)	0.709(*) (2.628)	-0.085 (-0.480)	-0.314 (-0.955)	-0.026 (-0.130)	-0.484(**) (-1.952)	-0.171 (-0.505)	-0.148 (-0.780)
β_3	0.431 (1.468)	-0.242(*) (-3.422)	0.120 (0.721)	-0.084 (-0.876)	0.147 (0.844)	-0.067 (-0.706)	-0.229(**) (-1.738)	-0.165 (-0.904)	-0.524(*) (-5.289)
β_4	-1.459(*) (-4.033)	0.359(*) (2.629)	0.260 (1.185)	0.061 (0.318)	0.433(*) (2.066)	0.166 (0.853)	0.529(*) (2.702)	0.427 (1.596)	-0.085 (-0.461)
Sum of the elasticities	1.236	0.276	2.187	0.709	0.663	0.451	0.625	0.020	0.105
R^2 adjusted	0.822	0.993	0.987	0.996	0.986	0.968	0.997	0.983	0.999
Residual part	0.178	0.007	0.013	0.004	0.014	0.032	0.003	0.017	0.001
Durbin-Watson	1.901	2.246	1.624	1.538	2.137	1.513	2.318	1.956	2.227
Hausman test	(c)	115.873(b)(*)	26.702(b)(*)	34.002(b)(*)	9.710(b)(*)	(c)	34.595(b)(*)	26.591(b)(*)	1.083(a)

For each of the industries, the first values correspond to the coefficients of each of the variables and values in brackets represent t-statistic of each; (1) Estimation with variables "dummies"; (2) Estimation with random effects; (*) coefficient statistically significant at 5% (**) Coefficient statistically significant at 10%; IMT, metals industries; IMI, industrial mineral;, IPQ, the chemicals industries; IEE, equipment and electrical goods industries; EIT, transport equipment industry; ITB, food industry; ITE, textiles industries; IPA, paper industry; IPD, manufacturing of various products; (a) accepted the hypothesis of random effects; (b) reject the hypothesis of random effects; (c) Amount not statistically acceptable.

7. 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.

Of referring that the location of the Portuguese manufacturing industry is still mostly explained by specific factors of locations and the industrial policies of modernization and innovation are not relevant, especially those that have come from the European Union, what is more worrying.

So, we can say that, although, the strong increasing returns to scale in the same industries, the location of the manufactured industries in Portugal is mostly explained by the specific factors of the locations.

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