External dependency, value added generation and structural change: an inter-industry approach*

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resumo

A dependência externa de muitos sectores e o baixo valor acrescentado gerado na sua produção, combinados com um relativamente fraco potencial exportador, criam elevados *deficits* externos e crescentes rácios de dívida externa no PIB em diversas economias abertas. Neste artigo, propomos um método empírico para avaliar a evolução destas vulnerabilidades, baseado num tratamento novo dos multiplicadores de produção intersectoriais. O potencial de crescimento do VBP dado pelas somas das colunas da matriz inversa de Leontief (indicadores de interdependência a montante) resulta de três componentes: consumos intermédios, valor acrescentado e inputs importados. Depois de um conveniente arranjo destas três componentes, a evolução dos indicadores de interdependência pode servir para detectar alterações estruturais, particularmente quantificando um efeito (líquido) de crescimento (maior valor acrescentado) e um efeito de dependência externa (mais inputs importados), e para classificar os sectores produtivos de acordo com estes resultados. É feita uma aplicação ao caso português, usando os Quadros Input--Output de 1980, 1995 e 2005. Este método pode também ser útil enquanto um simples, mas sugestivo, instrumento para comparar a evolução de duas ou mais economias, ao longo dos seus processos de desenvolvimento no tempo.

résumé / abstract

The external dependency of many industries and the corresponding low value added generated in production, combined with a relatively weak export potential, create high external deficits and growing debt to GDP ratios in several open economies. In this paper we propose an empirical method to assess the evolution of these vulnerabilities, based on a new treatment of interindustry production multipliers. The (gross) output growth potential given by the column sums of the Leontief inverse matrix (backward linkage indicators) results from three terms: interindustry consumptions, value added and imported inputs. After a convenient arrangement of these terms, the evolution of backward linkage indicators can be used to detect structural changes, particularly quantifying a (net) growth effect (more value-added generation) and an external dependency effect (more imported inputs), and to classify the productive sectors accordingly. An application to the Portuguese Economy is made, using input-output tables for the years 1980, 1995 and 2005. This method can also be useful as a simple, but suggestive, device to compare the evolution of two or more economies, along their development processes in time.

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1. Introduction

The external dependency of many industries (strong reliance on imported inputs) and the associated low value added generated in domestic production are important vulnerabilities in several developed and developing open economies. When associated with a relatively high level of personal consumption and a weak export potential, they tend to create high external deficits and a rapidly growing debt to GDP ratio that request very demanding financial efforts and disturbing macroeconomic imbalances.

In this paper we propose an empirical method to evaluate the changes in the external dependency of the production system of an economy (here measured in a narrow sense by the relative weight of imported inputs in gross output) and its capacity to generate value added, based on a new treatment of interindustry production multipliers.

The column sums of the Leontief inverse matrix (backward linkage indicators) give the output growth of all sectors when the final demand directed to each (correspondent) sector increases by one unity, and this growth potential can be divided in three terms: interindustry flows, value-added and imported inputs (a good exposition of the basic structure and results of the Leontief model is made in Miller and Blair, 2009).

After a convenient arrangement of these terms, the evolution of backward linkage indicators can be used to detect structural changes, particularly quantifying a (net) growth effect (more value-added) and an external dependency effect (more imported inputs), and to classify the productive sectors accordingly.

An application to the Portuguese economy is made for the period 1980-2005, divided in two sub-periods: 1980-1995, with data for 49 industries, based on the United Nations System of National Accounts, SNA1968 – Portuguese version: 1977; and 1995-2005, with data for 60 sectors, based on the European System of Accounts – ESA1995. This method can also be useful as a simple, but suggestive, device to compare the evolution of two or more economies.

Since the pioneering work of Rasmussen (1956) and Hirschman (1958), the concepts of backward and forward linkages have been widely discussed and applied (for an interesting survey and discussion see Drejer, 2002).

More recently, sophisticated methods to deal with structural change have been proposed (Sonis *et al* (1996), Dietzenbacher and van der Linden (1997), Dridi and Hewings (2002), are, among others, very interesting examples).

The strategy in this work is different, and based on the conviction that sometimes, “back to basics” and simplicity enriched with easy visualisation ways to look at the data can play an important role in our understanding of how an economy evolves in time.

2. Interindustry linkages indicators

The Rasmussen traditional method of using compact indicators from the production multipliers matrix (Leontief inverse) is one of the classical references for the analysis of intersectoral relations.

It is well known that this matrix is obtained by solving an n equations system that equates sector productions to possible uses: intermediate and final demand.

This system can be represented as follows:

$$x = A\,x + y, \qquad (2.1)$$

with: A – (domestic) technical coefficients matrix; x – sectoral production vector; y – (domestic) sectoral final demand vector.

The solution of this system is:

$$x = B\,y, \qquad (2.2)$$

with $B = (I - A)^{-1}$

Each element of B is a production multiplier that gives the total (direct and indirect) effect in one's sector production of a unity increase in domestic final demand of a given sector. That is, b_{ij} is the global impact on the sector i production when the domestic final demand of sector j increases by one unity.

Particular interest in this context has the notion of backward linkage indicators:

$$b_{0j} = \sum_{i=1}^{n} b_{ij} \qquad (j = 1, \ldots, n) \qquad (2.3)$$

This indicator results from summing up the n values of column j and gives the effect on total production (of all sectors) of a unitary change in the final demand directed to j sector. The larger the value of this coefficient, the larger will be the impact of this increase of the final demand on the sector concerned and on all the others. For the method we propose in the next section and its empirical application to the Portuguese economy, this is the most interesting multiplier.

3. Net growth (or efficiency) and external dependency effects

The backward linkage indicators can be used to evaluate the gains in the capacity of an economy to generate value added and the changes in external dependency of an economy from one year to another.

The overall effect of a unity change of final demand is the sum of three terms: interindustry flows, value added and imported inputs.

Moreover, an important property applies: the second and last terms sum up unity, exactly the value of the initial (exogenous) stimulus, and this is so because in equilibrium the total value of sectoral final demand equals the gross value added plus imported inputs of all sectors.

Using this property, and after a convenient arrangement of terms, the evolution of backward linkage indicators, value added and imported input coefficients over time can be used to detect structural changes in the economy.

Particularly, we can quantify the capacity to generate more (or less) value-added by unity of final demand (what in some sense we can call an "efficiency effect", although a peculiar one[1]), and the need to import more (or less) intermediate inputs (a certain kind of "external dependency effect"). And we can classify the productive sectors according to the particular combination of both effects, finding a new kind of "key sectors", those presenting a positive "efficiency" change and a negative "dependency" change.

One way to express formally these ideas is as follows. Considering a unitary increase in j sector's final demand, $\Delta y_j = 1$, its effects on total production are:

1 In order to avoid terminological confusion we call this "efficiency effect" a "net growth effect".

$$\sum_i \Delta x_i = \sum_i b_{ij} = b_{0j} \quad (3.1)$$

By the equilibrium condition between total sectoral final demand and total primary inputs, we have:

$$\Delta y_i = 1 \Rightarrow \Delta\left(\sum_i v_i + \sum_i m_i\right) = 1, \quad (3.2)$$

where v_i and m_i are the value added[2] and the value of imported inputs used by sector i.

Defining, and assuming as constants, the value-added coefficients ($a_i^v = v_i / x_i$) as well as the imported inputs coefficients ($a_i^m = m_i / x_i$), we have:

$$1 = \sum_i b_{ij} a_i^v + \sum_i b_{ij} a_i^m \quad (3.3)$$

Dividing both sides of (3.3) by b_{0j}:

$$1 / b_{0j} = \sum_i (b_{ij} a_i^v) / \sum_i b_{ij} + \sum_i (b_{ij} a_i^m) / \sum_i b_{ij}, \quad (3.4)$$

and, representing by v_j^* and m_j^* the terms in the right hand side of (3.4) (the weighted average of value-added and imported inputs coefficients, respectively), we arrive finally at:

$$1 = b_{0j}(v_j^* + m_j^*). \quad (3.5)$$

This expression can be used in a dynamic (or, as in the present paper, in a comparative static) exercise to detect and quantify the changes in the productive structure of an economy.

Suppose that, for each sector j, we have, between two given years, a **decrease in b_{0j}**. This means that, in order to satisfy a unitary increase in sector j final demand it is necessary a smaller increase in the global production of the economy.

It is also true that, in this case, we must have $\Delta m_j^* + \Delta v_j^* > 0$, and so four situations are possible, in a two dimensional space with axes Δv_j^* and Δm_j^*:

– when $\Delta v_j^* > 0$ **and** $\Delta m_j^* < 0$, the decrease in b_{0j} goes with a larger capacity to generate value added (a beneficial "net" growth effect) and a lower necessity of imported inputs (a reduced external dependency effect) – let's call this **area A**, the most virtuous one;

– if $\Delta v_j^* > 0$, $\Delta m_j^* > 0$ **and** $\Delta v_j^* / \Delta m_j^* > 1$, there is a simultaneous increase in "net growth effect" and "external dependency", with the first dominating the second (**area B**);

– with $\Delta m_j^* > 0$, $\Delta v_j^* > 0$, **but** $\Delta m_j^* / \Delta v_j^* > 1$, the increase in "external dependency" is relatively more significant than the increase in "net growth effect" (**area C**);

2 In order to simplify the formal treatment of final demand (exogenous) impacts on the endogenous variables (value added, net taxes on inputs and imported inputs), we include in value added the net taxes on inputs, along with the other net taxes on production already included in this item, according to the SNA 1968 and ESA1995 methodologies; for more details see Eurostat, 2008.

– finally, with $\Delta m_j^* > 0$ **and** $\Delta v_j^* < 0$, the decrease in b_{0j} is totally due to an increase in "external dependency", with a simultaneous decrease in the capacity to generate value added (**area D**, the most disadvantageous situation).

For the case of a b_{0j} **increase** we must have $\Delta m_j^* + \Delta v_j^* < 0$, a worse situation for the economy, at least from the "capacity to generate more value added" point of view. The four possible areas now are (in a descending order):

– **Area A':** $\Delta v_j^* > 0$ **and** $\Delta m_j^* < 0$, **with** $\Delta v_j^* < |\Delta m_j^*|$
– **Area B':** $\Delta v_j^* > 0$ **and** $\Delta m_j^* < 0$, **with** $|\Delta v_j^*| < |\Delta m_j^*|$
– **Area C':** $\Delta v_j^* < 0$ **and** $\Delta m_j^* < 0$, **with** $|\Delta v_j^*| > |\Delta m_j^*|$
– **Area D':** $\Delta v_j^* < 0$ **and** $\Delta m_j^* > 0$, **with** $|\Delta v_j^*| > \Delta m_j^*$

In practical terms, a suggestive way of analysis is the graphical presentation of Δv_j^* and Δm_j^* values in the two-dimensional space above described, distributing the position of the sectors in the possible areas A, B, C, D (for a b_{0j} decrease) and A', B', C', D' (for a b_{0j} increase). The structural change is more beneficial to an economy when more sectors concentrate on A and A' areas and less on areas D and D'.

4. Application to the Portuguese Economy

We have applied the method presented above to the Portuguese economy in two periods: 1980--1995 and 1995-2005, using the Domestic Input-Output Tables with 49 sectors (SCNP1977) and 60 sectors (SEC1995), respectively. In both cases the data sources are Statistics Portugal (INE) and *Departamento de Prospectiva e Planeamento* (DPP).

The main conclusion drawn from the results is the apparent global deterioration of the Portuguese productive system between 1980 and 2005.

For the first sub-period we can see in tables 1 and 2 that there are in both sub-periods more sectors with b_{0j} increasing than with b_{0j} decreasing.

Table 1 – Negative variation of b_{0j}, 1980-95

	Δb_{oj}	Δm_j^*	Δv_j^*	sp	sm	sv	Sector
	-0.365	-0.038	0.147	1.6	1.7	0.8	21 Cereals and Vegetables
	-0.337	-0.022	0.147	0.8	0.2	0.8	23 Drinks
	-0.289	-0.209	0.390	0.1	0.3	0.1	24 Tobacco
	-0.286	-0.105	0.189	2.5	0.4	2.0	6 Electricity, Gas and Water
	-0.189	-0.002	0.034	3.4	0.2	0.8	17 Meat Industry
A	-0.180	-0.171	0.281	1.8	3.4	1.7	32 Recovery and Repairing
	-0.099	-0.027	0.078	0.6	0.4	0.7	45 Other Com. Services
	-0.073	-0.056	0.097	0.3	0.0	0.5	43 Com. Serv. of Education.
	-0.063	-0.014	0.050	0.8	1.6	0.8	14 Non Electrical Machinery
	-0.059	-0.020	0.050	4.0	0.7	5.9	46 N. C. Serv. Of Pub. Adm.

Table 1 – Negative variation of b_{0j}, 1980-95 (cont.)

	Δb_{oj}	Δm_j^*	Δv_j^*	sp	sm	sv	Sector	
	-0.048	-0.091	0.105	1.2	0.3	0.9	11	Other Const. Materials
A	-0.046	-0.009	0.036	0.9	0.0	1.6	41	Real Estate Services
	-0.006	-0.029	0.030	2.1	1.2	1.7	28	Paper, etc.
				20.1	**10.4**	**18.3**		
	-0.513	0.055	0.144	0.5	0.6	0.2	19	Fish Products
	-0.218	0.029	0.058	0.9	1.2	0.8	26	Tanning and Leather
B	-0.171	0.018	0.040	8.3	8.8	6.3	25	Textile and Clothing
	-0.130	0.011	0.034	8.6	2.6	8.3	31	Construction
	-0.046	0.003	0.023	1.3	0.5	1.8	48	N. C. Serv. Of Health
				19.6	**13.7**	**17.4**		
C	-0.118	0.039	0.002	0.6	0.2	0.5	20	Oils and Fats, …
	-0.032	0.010	0.007	0.8	0.1	1.3	49	Other N. C. Services
				1.4	**0.3**	**1.8**		
D	-0.028	0.016	-0.008	3.6	0.4	3.8	34	Restaurants and Hotels

Notes: Columns sp. sv and sm give the percentage of each sector in total production, gross value-added and imports in 1980.

Table 2 – Positive variation of b_{0j}, 1980-95

	Δb_{oj}	Δm_j^*	Δv_j^*	sp	sm	sv	Sector	
	0.020	-0.107	0.098	3.61	0.6	1.6	12	Chemical Products
	0.052	-0.132	0.108	0.6	1.7	0.4	30	Other Transf. Industries
	0.062	-0.095	0.073	1.7	3.6	0.9	7	Metal Ores
	0.069	-0.067	0.043	0.4	0.2	0.3	10	Glass
	0.077	-0.063	0.025	0.7	0.1	1.0	3	Fishing
A'	0.128	-0.058	0.011	0.3	0.2	0.3	9	Porcelains, etc.
	0.140	-0.074	0.009	2.0	0.6	2.7	35	Land Transports
	0.166	-0.192	0.072	3.92	3.8	-0.1	5	Petroleum
	0.177	-0.206	0.135	2.4	8.6	0.7	22	Other Food Products
	0.244	-0.153	0.019	0.1	0.3	0.0	4	Coal
	0.317	-0.186	0.089	1.6	3.1	0.6	36	Sea and Air Transports
				17.3	**52.8**	**8.4**		
B'	0.052	-0.018	-0.015	0.7	0.1	1.1	44	Com. Serv. Of Health
	0.078	-0.027	-0.010	1.0	2.7	0.7	29	Rubber, Plastic Materials

Table 2 – Positive variation of b_{0j}, 1980-95 (cont.)

	Δb_{oj}	Δm_j^*	Δv_j^*	sp	sm	sv	Sector
B'	0.102	-0.035	-0.017	1.6	3.6	1.3	15 Electrical Machinery
	0.164	-0.056	-0.001	6.0	1.5	6.8	1 Agriculture and Hunting
				9.3	**7.9**	**9.9**	
C'	0.068	-0.009	-0.046	1.1	0.0	2.2	2 Forestry
	0.075	-0.001	-0.059	1.6	0.1	3.2	47 N. C. Serv. Of Education
	0.194	-0.026	-0.048	2.3	2.9	2.2	13 Metal Products
	0.200	-0.049	-0.061	2.5	7.4	2.0	16 Transport Equipment
	0.237	-0.004	-0.101	0.7	0.0	1.0	37 Transport Services
	0.322	-0.031	-0.035	1.0	0.3	0.6	18 Dairy Products
				9.2	**10.7**	**11.2**	
D'	0.073	0.050	-0.076	2.4	1.7	1.9	27 Wood and Cork
	0.079	0.009	-0.061	0.9	0.1	1.6	38 Communications
	0.137	0.002	-0.0681	0.7	1.01	6.4	33 Trade
	0.172	0.020	-0.134	2.4	0.2	4.5	39 Banks, Fin. Institutions
	0.234	0.013	-0.128	2.1	0.3	3.4	42 Auxiliary Serv. To Firms
	0.330	0.111	-0.221	0.4	0.1	0.5	40 Insurance
	0.500	0.019	-0.234	0.5	0.2	0.8	8 Non Metal Ores
				19.4	**3.6**	**29.1**	

For the sectors with decreasing b_{0j} only 13 are located in the most virtuous area A (more "net growth effect" and lower external dependency). Moreover, the majority of these sectors are services, utilities or protected sectors.

Among the sectors with increasing b_{0j}, only 11 are in the area with positive variation of the capacity to generate more value-added (A').

These results can be better visualised in Figures 1 and 2. It could be expectable that, as an economy develops over time most sectors should be concentrated in virtuous areas A and A'.

In fact, it is not what we get in this case and it is difficult to explain these findings for the evolution of the Portuguese productive structure between 1980 and 1995. It was a period of normalisation of political, economic and social conditions, of economic integration in the (then) European Economic Community (since 1986) and of relatively strong growth and real convergence at macroeconomic level. However, it is important to note that this analysis was made using data at current prices and therefore the methodology used does not allow us to reach conclusions about the breakdown of the effects between price effects and technological or other real effects.

Although we have not in Portugal domestic flows input-output data at constant prices, there are nonetheless good reasons to support the view that the kind of effects that we tried to measure should in fact be measured at current prices as we have actually done.

Figure 1 – Negative variation of b_{0j}, 1980-95

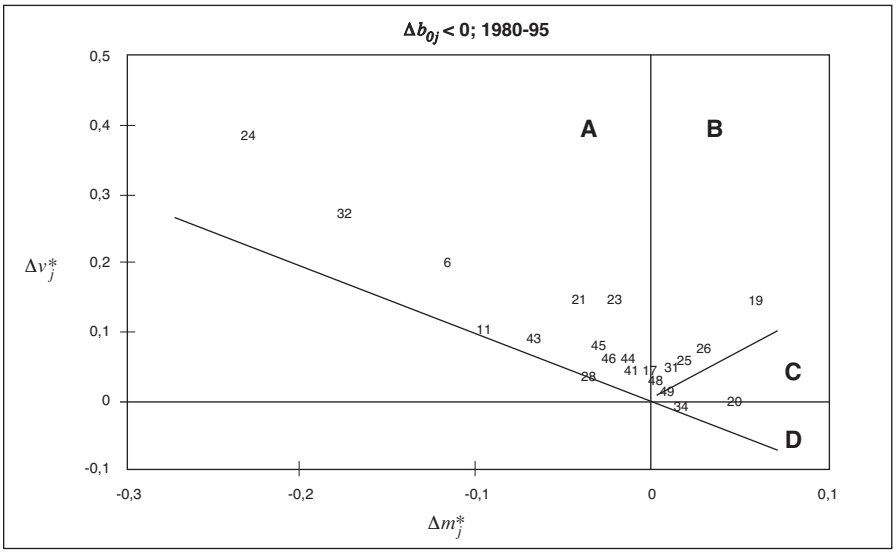
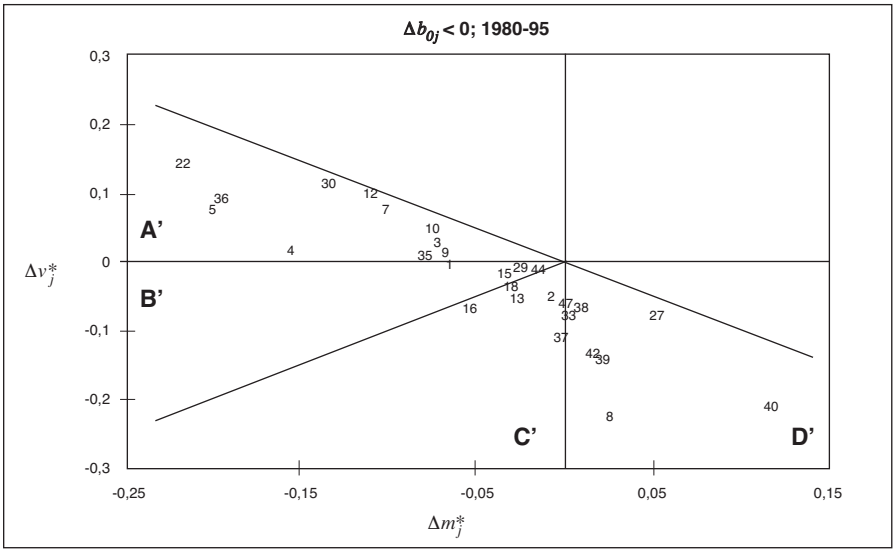


Figure 2 – Positive variation of b_{0j}, 1980-95



For the second and more recent sub-period, 1995-2005, the tendency for more sectors with b_{0j} increasing than decreasing remains (see Tables 3 and 4), and the percentage of sectors in virtuous areas (A and A') is even smaller (see Figures 3 and 4), representing around 20% of gross output (against 37,4% in 1980-95) and value added (26,7% in 1980-95). On the other hand, there is a great reinforcement of sectors in the most disadvantage areas (D + D'), from 23% to 51% in terms of production, and from 33% to 48% in terms of value added.

Table 3 – Negative variation of b_{0j}, 1995-2005

	Δb_{oj}	Δm_j^*	Δv_j^*	sp	sm	sv	Sector	
	-0.237	-0.018	0.126	0.2	0.0	0.2	73	Research and development services
	-0.226	-0.006	0.069	3.7	2.6	2.7	55	Hotel and restaurant services
	-0.153	-0.002	0.053	1.1	1.6	0.8	22	Printed matter and recorded media
A	-0.033	-0.002	0.025	3.6	0.4	6.3	80	Education services
	-0.030	-0.064	0.077	0.1	0.4	0.1	30	Office machinery and computers
	-0.023	-0.002	0.009	2.6	4.5	1.5	18	Wearing apparel; furs
	-0.008	-0.015	0.019	0.7	0.2	0.8	66	Insurance and pension funding services
				12.0	**9.71**	**2.4**		
	-0.149	0.009	0.058	0.5	0.2	0.7	93	Other services
B	-0.098	0.007	0.026	1.6	3.3	1	19	Leather and leather products
				2.1	**3.5**	**1.7**		
	-0.148	0.03	0.004	0.4	0.2	0.2	91	Membership organisation services n.e.c.
C	-0.034	0.014	0.002	4.2	2.1	5.4	85	Health and social work services
	-0.02	0.004	0.003	0.9	0.2	1.1	63	Supp./ aux. transport serv.; travel agency serv.
				5.5	**2.5**	**6.7**		
	-0.226	0.195	-0.04	1	7.4	-0.1	23	Coke, refined petrol. prod. and nuclear fuels
	-0.116	0.152	-0.113	0.1	0	0.1	37	Secondary raw materials
D	-0.1	0.065	-0.034	1.6	1.8	1.1	2	Pulp, paper and paper products
	-0.094	0.061	-0.018	1.6	7	0.5	34	Motor vehicles, trailers and semi-trailers
	-0.045	0.119	-0.094	0.8	3.8	0.3	32	Radio, televi., comm. equip. and apparatus

Table 3 – Negative variation of b_{0j}, 1995-2005 (cont.)

	Δb_{oj}	Δm_j^*	Δv_j^*	sp	sm	sv	Sector
	-0.035	0.016	-0.008	6.8	9.3	2.9	15 Food products and beverages
D	-0.012	0.02	-0.015	3	5.3	2.3	17 Textiles
	-0.01	0.036	-0.031	0.4	0.7	0.4	35 Other transport equipment
				15.3	**35.3**	**7.5**	

Notes: Columns sp. sv and sm give the percentage of each sector in total production, gross value-added and imports in 1995.

Table 4 – Positive variation of b_{0j}, 1995-2005

	Δb_{oj}	Δm_j^*	Δv_j^*	sp	sm	sv	Sector
	0.007	-0.019	0.017	5.8	3.4	5.5	74 Other business services
A'	0.013	-0.079	0.074	1.2	4.1	0.5	29 Machinery and equipment n.e.c.
	0.041	-0.043	0.030	1.0	3.0	0.4	28 Fab. metal prod., except mach. and equip.
				8.01	**0.5**	**6.4**	
B'	0.034	-0.013	-0.002	2.8	2.6	3.4	50 Trade, maint., repair serv. of motor vehicles
				2.8	**2.6**	**3.4**	
	0.008	-0.002	-0.003	4.1	0.3	6.5	70 Real estate services
	0.114	-0.015	-0.036	0.3	0.1	0.4	67 Services auxiliary to financial intermediation
	0.120	0.000	-0.043	6.0	2.8	7.0	51 Wholesale trade
C'	0.120	0.000	-0.048	3.1	0.9	4.0	52 Retail trade services
	0.143	-0.003	-0.050	2.1	5.9	1.3	24 Chemicals, chemical products
	0.161	-0.005	-0.068	0.1	0.0	0.2	90 Sewage, refuse disposal services, sanitation
	0.179	-0.008	-0.089	2.8	0.7	4.5	65 Financial interm. services, except insurance
				18.51	**0.72**	**3.9**	
	0.036	0.028	-0.038	1.9	1.5	1.5	26 Other non-metallic mineral products
	0.052	0.006	-0.025	0.9	2.2	0.5	25 Rubber and plastic products
D'	0.056	0.028	-0.050	0.3	0.0	0.4	41 Collected and purified water, distr. water
	0.058	0.001	-0.022	1.5	0.7	1.7	92 Recreational, cultural and sporting services

Table 4 – Positive variation of b_{0j}, 1995-2005 (cont.)

	Δb_{oj}	Δm_j^*	Δv_j^*	sp	sm	sv	Sector
	0.067	0.009	-0.031	1.1	2.2	0.8	36 Furniture; other manufactured goods n.e.c.
	0.073	0.010	-0.066	0.5	0.0	0.9	2 Forestry
	0.077	0.024	-0.063	0.3	0.1	0.4	5 Fish
	0.084	0.027	-0.063	1.1	2.9	0.8	31 Electrical machinery and apparatus n.e.c.
	0.086	0.006	-0.027	9.3	5.4	7.2	45 Construction work
	0.087	0.031	-0.068	0.2	0.4	0.2	33 Medical, precision, optical instrum.
	0.095	0.128	-0.167	0.8	1.6	0.7	27 Basic metals
	0.105	0.026	-0.060	3.2	1.1	3.7	1 Agriculture, hunting
	0.141	0.020	-0.079	0.4	0.1	0.6	72 Computer and related services
	0.142	0.004	-0.095	4.5	0.9	7.8	75 Public admin., defence, social security
D'	0.145	0.019	-0.056	1.3	1.3	0.9	20 Wood, cork
	0.150	0.065	-0.134	0.1	0.1	0.1	16 Tobacco
	0.165	0.025	-0.073	0.3	0.2	0.3	61 Water transport services
	0.177	0.025	-0.122	0.1	0.0	0.2	13 Metal ores
	0.192	0.041	-0.105	0.3	0.1	0.3	14 Other mining and quarrying
	0.247	0.075	-0.164	0.6	0.9	0.6	62 Air transport services
	0.260	0.093	-0.166	3.2	1.9	3.1	40 Electrical energy, gas, steam and hot water
	0.265	0.006	-0.114	1.7	1.0	2.2	64 Post and telecommunication services
	0.270	0.026	-0.161	0.7	0.1	1.1	71 Renting services of mach. and equipment
	0.288	0.046	-0.167	1.5	0.4	2.1	60 Land transport; transport via pipeline
				35.82	**5.13**	**8.1**	

However, there is at least one positive tendency in the structural evolution of the Portuguese productive system concerning the sectoral composition of virtuous areas A and A'. In 1980-95 there is a clear predominance of services, nontradables or low technology sectors (Tobaco, Electricity, gas and water, Recovery and repairing, Cereals and vegetables, Drinks, Commercial Services of Education, Other Commercial Services, etc.). In 1995-2005 enter in these areas of great value added creation and lower external dependency several medium and high technology

Figure 3 – Negative variation of b_{0j}, 1995-2005

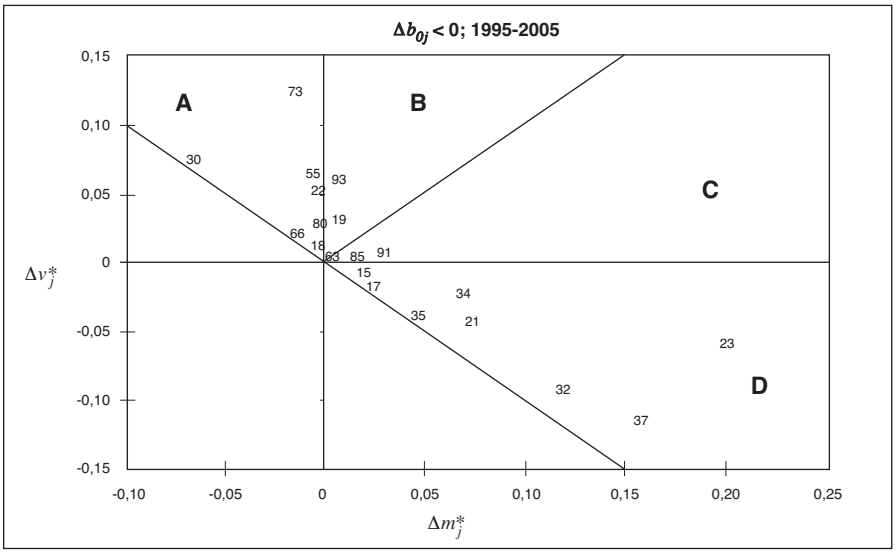
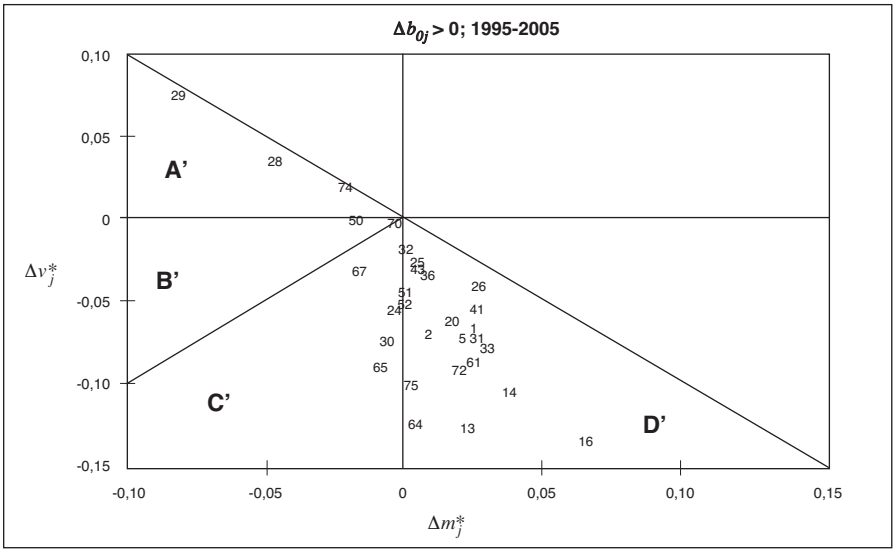


Figure 4 – Positive variation of b_{0j}, 1995-2005



sectors as Office machinery, R&D services, Machinery and equipment, Fabricated metal products, Wearing apparel, Other business services. Considering the strong export potential and innovation dynamics of these sectors, it would be very important to keep them in virtuous areas and reinforce significantly its weight in the Portuguese productive system. However, assessing the potential macroeconomic gains of reinforcing these sectors is of course well beyond the scope of this paper, based as it is on a demand led, constant technical coefficients, static input--output model.

5. Concluding remarks

In this paper we have proposed a simple method to study the structural changes of an economy, using the traditional Rasmussen indicators based on the production multipliers matrix or Leontief inverse. This method is appropriate to assess the external dependency of industries (strong reliance on imported inputs) and the associated low value added generated in domestic production, an important vulnerability in several open economies.

We used the method to analyse the evolution of the Portuguese productive structure between 1980 and 2005, divided in two sub-periods, until and post-1995. Our results point to a mixed pattern, with the positive gains in the capacity to generate value added and importing less intermediate inputs overcome by many losses and an increased external dependency for the majority of sectors, particularly in more recent years. However, our results also point to an apparent upgrade of the Portuguese productive system with more medium and high technology sectors entering in the virtuous areas of value added generation and less dependency.

External dependency is not necessarily bad. It may be the result of increased benefits from international division of labour. What is not *a priori* desirable is that the decrease in production needed to satisfy an increase in domestic demand should be a consequence of domestic production being supplanted by imports.

One of the possible explanations for the results obtained is the great variation in the structure of domestic final demand. One natural extension of our method is to deal with a concept of multiplier that is immune to that variation: the singular value decomposition method proposed in Ciaschini (1993).

It is important to emphasise that, although conditioned by the well-known limitations of the traditional gross multipliers (Oosterhaven and Stelder, 2002), the method we propose can be used as a simple, but (visually) suggestive, device to quantify the structural changes of an economy. And with some refinements it can also be useful to compare the evolution of two or more economies along their development paths.

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