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Input-Output Approach**

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The Structure and Evolution of Production, Employment and Human Capital in Portugal: an Input-Output Approach

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Abstract. The main purpose of this paper is to analyse the structure and evolution of production, employment and human capital in Portugal, using an inter-industry approach. A descriptive analysis of the sector composition of gross output, value added and employment is made, followed by a quantification of changes in relative labour productivity and primary input content of final demand components. Next, the evolution of employment multipliers is quantified, as well as the structure of labour force qualifications by sector. Although remarkable improvements have been achieved in the past, the low educational levels of its workers, on average, remains one the main vulnerabilities of Portugal in the global and knowledge economy of our days. In this context, the main contribution of the paper is the quantification of human capital requirements of final demand changes by component. Using an input-output approach combining sector productivities and labour qualifications, output multipliers and final demand structure, it is possible to quantify the growth in employment by level of qualification resulting from a unitary growth of private and public consumption, investment and exports. This exercise is made for 1995 and 2008, using input-output domestic flow tables from *INE* and *DPP* and employment qualifications from *Quadros de Pessoal* database.

Keywords: Employment, Human Capital, Input-Output Analysis, Portugal

JEL: C57; D67

The Structure and Evolution of Output, Employment and Human Capital in Portugal: an input-output approach

1. Introduction

The main purpose of this paper is to quantify the changes in the structure of economic activity, employment multipliers and human capital requirements of final demand components in the Portuguese economy, in the period 1995-2008, within an input-output framework.

The evolution of output, value added and employment structure by sectors in Portugal illustrates the significant changes in the last years, with a relative decay of agriculture, mining and (almost all) manufacturing activities and a reinforcement of utilities, construction and private and public services (Lopes, 2012).

These changes were common to most developed economies due to the globalization process and the emergence of new competitors, mainly China, but in Portugal they were accentuated by the inadequate adjustment to the adoption in 1999 of a strong currency, the Euro (Amaral, 2013). For an interesting analysis of these trends at a regional level see Martins and Barradas (2009).

A negative consequence of this process was the slowdown (in fact, almost the standstill) of average productivity growth, due to the lower efficiency of the sectors that were reinforced after Portugal had begun to prepare for membership in the Economic and Monetary Union (Leão et al, 2011; Reis, 2013). The majority of these sectors are marked by low-skilled labour and weak productivity growth, as is shown in this paper.

Another consequence was the significant increase in external dependency, measured in this paper by the quantification of the direct and indirect import content of final demand components, namely private consumption, investment and exports. The Leontief model is particularly indicated for this analysis, because it pays attention not only to the direct external dependency of productive activities but also to the indirect and induced

dependencies associated to the interindustry flows (Leontief, 1951). In Portugal, the import content of final demand has grown significantly between 1995 and 2008.

On top of this comes one of the main structural vulnerabilities of the Portuguese economy, i.e. the low level of its labour force qualifications although remarkable improvements have been achieved in the last decades (see Alves et al, 2010).

An important contribution of this paper is the quantification of the human capital requirements of final demand changes by component. It is an input-output approach combining sectoral productivities and labour qualifications, output multipliers and final demand structure. It allows the quantification of growth in employment by level of qualification resulting from a unitary growth of private consumption, public consumption, investment and exports.

The rest of the paper is organized as follows. In the next section the theoretical and methodological framework is presented and discussed. In section 3, an application to the Portuguese case in two years, 1995 and 2008, is made. After presenting the data sources - input-output domestic flow tables from the Portuguese Statistics Institute (INE) and *Departamento de Prospectiva e Planeamento* (DPP) and employment qualifications from *Quadros de Pessoal* – a descriptive analysis of the sectoral structure of output, value added and imports is made, as well as a brief comparison of sectoral productivities in both years. Then, primary input contents of final demand components are quantified, followed by a quantitative assessment of employment multipliers and sectoral employment qualifications. The empirical part of the paper ends with the quantification of employment by level of qualification associated with each final demand component increase. Finally, in section 4 some concluding remarks are made.

2. Theoretical and methodological framework

In order to assess the impact on employment by level of qualification of changes in the different components of final demand (private consumption, public consumption, investment and exports) several steps are necessary.

The first is the construction of E , the matrix representing the educational structure of labour force. This matrix has a dimension $(l \times n)$, with l the levels of education and n the number of sectors.

Secondly, a diagonal $(n \times n)$ matrix P of the sectoral average productivities is considered. The diagonal elements of this matrix are the ratios of gross output and employment (in number of workers) of the n sectors of the economy.

The next step concerns the Leontief inverse matrix, L , of output multipliers, which, as it is well known, results from the solution of the Leontief system: $Ax + y = x$, where x is the column vector of gross outputs of the n sectors of the economy, y is the final demand vector and A is the technical (intermediate input) coefficient matrix. Provided that the Simon-Hawking conditions are fulfilled, this system has always a positive (meaningful) solution, given by: $y = (I-A)^{-1} x$. The so-called Leontief inverse $(I-A)^{-1}$ is commonly represented as L , and its generic element l_{ij} is an output multiplier giving the increase in sector i 's gross output when the final demand direct to j sector has a unitary increase. This is the basic result of the Leontief model, with many useful applications since the important works of the 1950's of Rasmussen (1956), Chenery and Watanabe (1958) and Hirschman (1958). For a clear and rigorous explanation of the model see Miller and Blair (2009). Recent applications to Portugal are, among others, Reis and Rua (2006), Lopes et al (2011) and Amaral et al (2012).

The last component needed is y^k , the $(n \times 1)$ vector of the structure of each final demand component, with k varying in private consumption, public consumption, investment and exports.

Then, we can obtain the product $z^k = E^T (P)^{-1} L y^k$, which is a column vector of dimension l , giving the employment by level of qualification necessary to fulfill one unity of final demand component k .

It is an interesting analysis to compare the different components of z , when the final demand components k are changing. This is the main result of the empirical section of this paper. Besides this, employment multipliers are also calculated, in its traditional

format, namely pre-multiplying the Leontief inverse by the row vector of sectoral employment coefficients. The generic element of this (row) vector of multipliers gives a useful information, the employment created in the economy when the final demand directed to a specific sector has a unitary increase.

Also important, although not directly linked to employment or qualifications, is the so-called Gama matrix, which gives the primary input contents (wages, profits, indirect taxes and imports) of the final demand components (private and public consumption, investment and exports). This is a (4 x 4) matrix, calculated according to the following formula:

$$\text{Gama} = a^v L a^y + a^z,$$

in which a^v is the (4 x n) matrix of primary input vertical coefficients, a^y is the (n x 4) vertical coefficients of final demand components directed to (domestic) sectors and a^z is the (4 x 4) matrix of vertical coefficients of the so-called fourth quadrant of the input-output table, with the first two rows null (wages and profits) and positive values in the last two rows, corresponding to indirect taxation and imports with direct incidence on final demand components.

3. Structure and evolution of Portuguese economy: 1995-2008

In this section a detailed empirical analysis is made of the Portuguese economy at sectoral level and its evolution over the period 1995-2008, using several indicators for 25 industries. The analysis covers gross output value, value added, employment, labour productivity, primary input content of final demand, employment multipliers, labour force qualifications and the employment content of the different components of final demand, e.g. private consumption, public consumption, investment and exports.

Two main databases are used. The first is the (domestic flow) input-output tables of DPP with data from INE. The detailed description of these tables is made in Dias et al (2001) and Dias (2009). There are some differences in the sectors used in these

matrices, and this has conditioned the sectoral aggregation made in this paper, in order to make both sources compatible. The 25 resulting sectors are shown in Appendix 1.

The second source of data is the so-called *Quadros de Pessoal*, a large database collected on an annual basis about the Portuguese firms and its workers, provided by the Ministry of Solidarity and Social Security. It covers people working in the private business sector (around 3.3 million workers, in 2009), excluding liberal professionals. This database was used to build the matrix of labour force qualifications by sector, for the years 1995 and 2008. It must be noticed that in the cases of agriculture and public service sectors the data covered by *Quadros de Pessoal* is very low, and so the corresponding results must be read with due caution.

3.1 Descriptive analysis of Output, Value Added and Employment

Starting with a brief description of the sectoral evolution of the Portuguese economy in the period 1995-2008, the main trends, already mentioned, are the relative loss of importance of tradable sectors (agriculture, mining and manufactures) and the reinforcement of utilities, construction, real estate and services at general, both private and public. This is true in the case of (gross) output value (Table 1), value added (Table 2) and employment (Table 3).

In 1995, the rank of sectors in terms of gross output has in the top five positions Trade and repair services; Real estate and business services; Construction; Textiles, wearing and leather products and Food, beverages and tobacco products. In 2008, Real estate and Trade change positions with Construction very close to Trade. Transport and communication services and Utilities reinforce its relative weight substituting Textiles and Food products.

The two most significant value added generating sectors in 1995 are Trade (14,7%) and Real estate (14%), at a large distance from all the others. Next, come Public administration (7,8%), Construction (6,7%) and Education services (6,4%). The reinforcement of Real estate after this year was overwhelming, attaining 22,3% of all the value added generated in Portuguese economy in 2008 (note that, by data

limitations, this sector includes also R&D and other business services, but these are very less relevant components compared with real estate activities).

Table 1: Gross output value (domestic) at basic current prices (10⁶ €)

Sectors	1995		2008	
	Value	%	Value	%
1-Agriculture, fishing, hunting	6.064	3,94	7.453	2,20
2 - Mining	609	0,40	1.307	0,39
3- Food, beverages, tobacco	10.662	6,92	14.969	4,43
4-Textiles, wearing, leather pr.	10.967	7,12	8.957	2,65
5-Wood and cork	2.034	1,32	3.303	0,98
6- Pulp, paper, printed matter	4.225	2,74	5.259	1,56
7-Coke, refined petroleum pr.	1.594	1,03	7.900	2,34
8-Chemicals	3.267	2,12	5.722	1,69
9-Rubber and plastic products	1.333	0,87	2.990	0,88
10-Other non-metallic min. pr.	2.921	1,90	5.039	1,49
11-Basic metals, exc machin.	2.772	1,80	8.822	2,61
12-Machinery and equipment	5.217	3,39	8.176	2,42
13-Transport equipment	3.142	2,04	6.283	1,86
14-Other manufact. goods n.e.c.	1.788	1,16	5.861	1,73
15-Electricity, gas, water	5.292	3,44	18.474	5,46
16-Construction work	14.317	9,30	32.974	9,75
17-Trade and repair services	18.371	11,93	35.888	10,62
18-Hotel and restaurant serv.	5.649	3,67	13.379	3,96
19-Transport and commun. serv.	7.808	5,07	24.094	7,13
20-Financial services	5.765	3,74	17.879	5,29
21-Real estate, R&D and bus. S.	17.170	11,15	53.278	15,76
22-Public admin.; def.; s. sec. S.	6.955	4,52	15.344	4,54
23-Education services	5.611	3,64	11.246	3,33
24-Health and social work serv.	6.472	4,20	15.529	4,59
25-Other services	3.970	2,58	7.936	2,35
Total	153.976	100,00	338.063	100,00

Source: INE and authors' calculations

In the second position of the value added rank is now Trade and communication services, with a slight relative decay to 12,4%, followed again at a large distance by Public administration (7,1%). A sector clearly gaining weight in these years is Financial services, entering to the fourth position of the rank (6,95%). In the fifth position (almost ex-aequae) are Construction (6,79%) and Transport services (6,68%).

Table 2: Value added, at basic current prices (10⁶ €)

Sectors	1995		2008	
	Value	%	Value	%
1-Agriculture, fishing, hunting	3.677	5,00	3.111	1,99
2 - Mining	364	0,50	553	0,35
3- Food, beverages, tobacco	2.560	3,48	3.184	2,03
4-Textiles, wearing, leather pr.	3.572	4,86	3.021	1,93
5-Wood and cork	645	0,88	768	0,49
6- Pulp, paper, printed matter	1.439	1,96	1.710	1,09
7-Coke, refined petroleum pr.	-88	-0,12	428	0,27
8-Chemicals	996	1,35	1.373	0,88
9-Rubber and plastic products	390	0,53	835	0,53
10-Other non-metallic min. pr.	1.157	1,57	1.679	1,07
11-Basic metals, exc machin.	856	1,16	2.495	1,59
12-Machinery and equipment	1.387	1,89	2.190	1,40
13-Transport equipment	666	0,91	1.099	0,70
14-Other manufact. goods n.e.c.	610	0,83	2.186	1,40
15-Electricity, gas, water	2.609	3,55	4.306	2,75
16-Construction work	4.920	6,69	10.624	6,79
17-Trade and repair services	10.798	14,68	19.339	12,36
18-Hotel and restaurant serv.	1.928	2,62	7.066	4,51
19-Transport and commun. serv.	4.492	6,11	10.450	6,68
20-Financial services	4.243	5,77	10.879	6,95
21-Real estate, R&D and bus. S.	10.276	13,97	34.888	22,29
22-Public admin.; def.; s. sec. S.	5.764	7,84	11.076	7,08
23-Education services	4.707	6,40	9.630	6,15
24-Health and social work serv.	3.724	5,06	8.811	5,63
25-Other services	1.871	2,54	4.790	3,06
Total	73.562	100,00	156.494	100,00

Source: INE and authors' calculations

In terms of employment, measured by the number of workers, “Trade and repair services” is largely the dominant sector in both years (more than 16%). In 1995, Agriculture is still the second employer sector with almost 13%, and the fourth is another traditional sector, “Textiles, wearing and leather products” (8,3%) after “Construction” with 9,7%. Public administration closes the top five employment rank, with 7,2% of the total employment in Portugal.

Between 1995 and 2008, although losing significantly in absolute and relative terms (4%) Agriculture is still the third employer sector, after Construction that increases to almost 11%. As was mentioned before, the destruction of employment in agriculture, textiles and other manufacturing sectors was accompanied by a strong employment creation in all the service sectors, private and public.

Table 3: Employment (number of workers)

Sectors	1995		2008	
	Value	%	Value	%
1-Agriculture, fishing, hunting	547.986	12,80	435.413	8,88
2 - Mining	14.681	0,34	16.723	0,34
3- Food, beverages, tobacco	116.202	2,71	116.574	2,38
4-Textiles, wearing, leather pr.	355.425	8,30	227.733	4,64
5-Wood and cork	63.610	1,49	61.647	1,26
6- Pulp, paper, printed matter	51.785	1,21	20.361	0,42
7-Coke, refined petroleum pr.	1.400	0,03	2.046	0,04
8-Chemicals	25.551	0,60	22.038	0,45
9-Rubber and plastic products	21.972	0,51	27.062	0,55
10-Other non-metallic min. pr.	69.652	1,63	57.190	1,17
11-Basic metals, exc machin.	88.627	2,07	105.494	2,15
12-Machinery and equipment	96.063	2,24	57.024	1,16
13-Transport equipment	34.868	0,81	47.687	0,97
14-Other manufact. goods n.e.c.	62.788	1,47	77.498	1,58
15-Electricity, gas, water	30.085	0,70	47.622	0,97
16-Construction work	414.045	9,67	527.353	10,75
17-Trade and repair services	707.737	16,53	797.731	16,26
18-Hotel and restaurant serv.	204.814	4,78	288.554	5,88
19-Transport and commun. serv.	165.868	3,87	191.691	3,91
20-Financial services	98.572	2,30	101.890	2,08
21-Real estate, R&D and bus. S.	212.953	4,97	270.645	5,52
22-Public admin.; def.; s. sec. S.	307.375	7,18	326.636	6,66
23-Education services	254.125	5,93	322.376	6,57
24-Health and social work serv.	228.901	5,35	365.854	7,46
25-Other services	107.251	2,50	390.118	7,95
Total	4.282.336	100,00	4.904.960	100,00

Source: INE and authors' calculations

3.2 Labour productivity and primary input contents of final demand components

An important indicator of the sectoral economic performance and efficiency is the labour productivity, in this case measured by value added by worker. In Table 4 the absolute and relative (to the average of the economy) numbers are shown, for 1995 and 2008. In 1995, the most productive sectors are Electricity, gas and water, Real estate, R&D and business services, Financial services, Chemicals and Pulp, paper and printed matter. The less productive sectors are Agriculture, fishing and hunting, Hotel and restaurant services, Basic metals, except machinery, Textiles, wearing and leather products and Wood and cork products.

Table 4: Productivity (value added per worker)

Sectors	1995		2008	
	Value	%	Value	%
1-Agriculture, fishing, hunting	6.710	35,13	7.146	22,40
2 - Mining	24.812	129,89	33.083	103,69
3- Food, beverages, tobacco	22.027	115,31	27.311	85,60
4-Textiles, wearing, leather pr.	10.049	52,61	13.265	41,58
5-Wood and cork	10.142	53,09	12.466	39,07
6- Pulp, paper, printed matter	27.781	145,43	84.006	263,30
7-Coke, refined petroleum pr.	-62.835	-328,94	209.138	655,50
8-Chemicals	38.975	204,03	62.309	195,29
9-Rubber and plastic products	17.732	92,83	30.840	96,66
10-Other non-metallic min. pr.	16.610	86,95	29.359	92,02
11-Basic metals, exc machin.	9.655	50,54	23.654	74,14
12-Machinery and equipment	14.438	75,58	38.412	120,39
13-Transport equipment	19.114	100,06	23.051	72,25
14-Other manufact. goods n.e.c.	9.709	50,83	28.213	88,43
15-Electricity, gas, water	86.719	453,96	90.431	283,43
16-Construction work	11.883	62,21	20.146	63,14
17-Trade and repair services	15.257	79,87	24.243	75,98
18-Hotel and restaurant serv.	9.415	49,29	24.486	76,75
19-Transport and commun. serv.	27.082	141,77	54.513	170,86
20-Financial services	43.044	225,33	106.773	334,66
21-Real estate, R&D and bus. S.	48.257	252,62	128.907	404,03
22-Public admin.; def.; s. sec. S.	18.751	98,16	33.910	106,28
23-Education services	18.523	96,97	29.872	93,63
24-Health and social work serv.	16.268	85,16	24.084	75,49
25-Other services	17.445	91,32	12.279	38,49
Average	19.102	100,00	31.905	100,00

Source: INE and authors' calculations

In 2008, the most productive sector, at a large distance from all the others, is Coke, refined petroleum products (note that the negative number for this sector in 1995 is probably due to the way taxes were considered in the national accounts). Next come Financial services and Real estate, R&D and business services. Electricity, gas and water decays from the first to the fourth place and Pulp, paper and printed matter maintain the fifth place in the productivity rank. On the other side, Agriculture keeps the last place, and loses significantly for the average productivity, from approximately one third to one fifth. Relative losing sectors are also Wood and cork products (now the second worst) and Textiles, wearing and leather products. Construction maintains its relative productivity, around 60% of the average, but is now the fourth worst sector, due to the relative improvement of Basic metals except machinery, from 50% to 74% of the average.

An interesting analysis of the structure and evolution of an economy is given by the primary input contents of final demand components, the so-called Gama matrix (see Table 5).

Table 5: Gama Matrix - Primary Input contents of Final Demand Components (%)

	1995				2008			
	C	G	I	Ex	C	G	I	Ex
Compensation of employees	27,02	67,46	26,38	32,12	29,05	65,93	28,09	29,12
Operating surplus, gross	35,04	20,79	30,16	31,00	32,31	20,48	24,44	27,31
Indirect taxes less subsidies	14,04	4,08	8,68	1,17	13,18	3,12	9,40	2,07
Use of imported products, cif	23,90	7,67	34,78	35,70	25,46	10,47	38,07	41,51

Source: INE and authors' calculations

One of the most significant structural vulnerabilities of the Portuguese economy is its large external dependency, patent here in a great import content of final demand, particularly Exports and Investment. Unfortunately, it is clearly seen in Table 5 that this weakness has been accentuated between 1995 and 2008, in all the final demand components, but particularly in the case of Exports, from 36 to 41,5%, and in the case of Investment, from 35% to 38%. The import content of Consumption is lower, although showing a slight tendency of increase, from 24 to 25,5%, and the same is true for Public Consumption, but with significantly lower numbers (8 to 10,5%).

The wage content of Consumption and Investment grows a little in this period, and the opposite happens in the case of Exports and Public Consumption. In the last case, of course, this is the main component, with around two thirds.

The operating surplus content, around 30-35% in the private components of final demand, decays in all cases, which is a worrying trend for the economic health of Portuguese companies. The indirect taxation content, in turn, is low and relatively constant in this period.

3.3 Employment Multipliers, Qualifications and Final Demand Components

The productive technology of each sector and the linkages between sectors determine the importance of each sector in what concerns employment, in the sense that for increasing production in a given sector more labor force is needed either directly or indirectly - in this case for producing the inputs needed to increase the production in the sector.

An important indicator of the employment potential of aggregate and sectoral output changes is the so-called employment multiplier, giving the growth in employment directly and indirectly generated by a unitary increase in final demand of each sector. Looking at the values in Table 6, the main conclusion to be drawn is the substantial decrease in these multipliers, for two reasons. First of all, this is because inflation reduces the real effects of a given nominal final demand value. Secondly, because the employment content of production is reduced when an economy grows and develops, due to the substitution of labour for capital. Combining these two effects on average a million euro increase in final demand created 43 jobs in 1995 and only 24 in 2008. If we work with 2008 final demand value at constant prices of 1995 (using the deflators shown in Table A1) the number of jobs created is 33,6 (See Table A2), and so the factor substitution effect is responsible for -22% in employment creation (-9,4/43).

A comparison of relative employment multipliers by sector, allows us to conclude that they are large and increasing in Agriculture, (Other) Services, Wood and cork, Textiles, wearing and leather products and Education and Health services. Construction, Food,

beverages and tobacco, Hotel and restaurant services, and Public Administration, have large but declining multipliers. The lowest relative multipliers are those of Coke and refined petroleum products (a very capital intensive sector, of course), Electricity, gas and water (with a significant decay from 117% to 36% of the average), Financial services, Real estate, Chemicals and Pulp, paper and printed matter.

Another important subject is the evolution of the qualification of the labour force, given by the workers' education levels. The first thing to note in this case is that for the overall economy there was a very rapid increase in the content of secondary and high school in employment, in the thirteen years from 1995 to 2008 (see Table 7).

Table 6: Employment multipliers (by 10⁶ €)

Sectors	1995		2008	
	Value	Rel. to av.	Value	Rel. to av.
1-Agriculture, fishing, hunting	109,901	255,66	74,351	312,44
2 - Mining	34,293	79,78	19,455	81,76
3- Food, beverages, tobacco	56,829	132,20	30,170	126,78
4-Textiles, wearing, leather pr.	53,387	124,19	35,900	150,86
5-Wood and cork	70,481	163,96	40,270	169,22
6- Pulp, paper, printed matter	31,847	74,08	11,687	49,11
7-Coke, refined petroleum pr.	5,907	13,74	0,987	4,15
8-Chemicals	18,455	42,93	9,627	40,45
9-Rubber and plastic products	28,474	66,24	15,025	63,14
10-Other non-metallic min. pr.	29,983	69,75	20,016	84,11
11-Basic metals, exc machin.	24,003	55,84	19,345	81,29
12-Machinery and equipment	54,605	127,03	11,025	46,33
13-Transport equipment	12,331	28,69	12,277	51,59
14-Other manufact. goods n.e.c.	54,886	127,68	21,731	91,32
15-Electricity, gas, water	50,280	116,97	8,582	36,06
16-Construction work	64,894	150,96	29,819	125,31
17-Trade and repair services	31,556	73,41	27,857	117,06
18-Hotel and restaurant serv.	64,894	150,96	31,131	130,82
19-Transport and commun. serv.	22,997	53,50	13,784	57,92
20-Financial services	23,085	53,70	8,883	37,33
21-Real estate, R&D and bus. S.	48,033	111,74	9,495	39,90
22-Public admin.; def.; s. sec. S.	49,105	114,23	25,152	105,69
23-Education services	48,033	111,74	30,805	129,45
24-Health and social work serv.	46,429	108,01	29,750	125,02
25-Other services	39,990	93,03	57,791	242,85
Average	42,987	100,00	23,797	100,00

Source: INE and authors' calculations

In 1995, 17,8 % of the employed labour force attained secondary or high schooling and this percentage almost doubled in 2008 to 35.1%. This is an evolution that is generally verified among all the sectors, even for agriculture that however still shows in 2008 a relative high percentage of non-school workers in its employment (6.6%). Agriculture and Mining were the only sectors that increased the proportion of basic grade but this is actually a progress since this increase was compensated by a decline in non-school labour force.

Table 7: Schooling structure of labour force by sector

Sectors	1995				2008			
	No Scho.	Basic	Second.	High	No Scho.	Basic	Second.	High
1-Agriculture, fishing, hunting	14,36	75,21	3,97	2,37	6,57	78,96	7,69	5,10
2 - Mining	8,19	80,28	6,22	3,12	2,74	80,59	10,31	5,83
3- Food, beverages, tobacco	4,87	82,26	7,44	2,95	2,23	76,39	14,02	6,60
4-Textiles, wearing, leather pr.	3,04	91,98	4,12	0,86	1,18	88,33	7,79	0,10
5-Wood and cork	5,75	86,04	4,78	1,36	2,44	82,75	9,53	4,96
6- Pulp, paper, printed matter	1,97	73,88	16,92	5,56	0,58	52,97	26,52	19,73
7-Coke, refined petroleum pr.	14,74	37,67	17,65	20,98	0,05	44,12	18,89	36,94
8-Chemicals	1,95	68,14	18,18	9,96	0,47	47,96	28,04	23,39
9-Rubber and plastic products	4,01	80,70	10,35	3,34	1,05	70,29	19,03	9,26
10-Other non-metallic min. pr.	5,41	83,81	6,55	2,50	1,64	77,70	13,33	6,94
11-Basic metals, exc machin.	3,18	86,09	6,52	2,14	1,12	76,90	14,76	6,51
12-Machinery and equipment	1,79	77,27	12,92	5,00	0,45	64,01	22,27	13,13
13-Transport equipment	1,49	79,40	12,33	5,90	0,49	71,66	18,78	8,94
14-Other manufact. goods n.e.c.	3,70	88,24	5,05	1,10	1,35	81,83	12,22	4,28
15-Electricity, gas, water	1,63	71,29	15,53	11,03	0,95	48,59	24,68	25,21
16-Construction work	5,59	82,95	5,60	3,13	2,50	76,33	10,91	8,56
17-Trade and repair services	1,25	74,43	17,28	4,19	0,52	59,91	28,99	10,05
18-Hotel and restaurant serv.	2,56	84,28	8,94	1,02	1,42	75,10	18,14	3,65
19-Transport and commun. serv.	0,77	76,00	14,75	6,34	0,50	59,10	26,93	12,96
20-Financial services	0,34	41,77	39,13	17,53	0,04	13,29	43,51	43,03
21-Real estate, R&D and bus. S.	3,08	56,59	22,74	12,34	0,42	36,37	32,13	30,55
22-Public admin.; def.; s. sec. S.	2,20	67,81	13,79	12,12	1,00	47,49	20,62	30,68
23-Education services	1,72	43,81	18,26	32,80	0,65	31,32	19,89	48,02
24-Health and social work serv.	2,91	65,17	15,88	12,24	0,39	36,06	25,20	38,04
25-Other services	2,09	67,70	18,22	8,05	1,73	63,19	20,60	13,61
Total	2,98	76,59	12,57	5,25	1,27	62,83	21,27	13,86

Note: the totals for each sector and the whole economy are not 100% because the education level of a small number of workers is unknown.

Source: QdP and authors' calculations

On the other side, the sectors with the most qualified labour force are, as expected, Education services, Financial services, Health and social work services, Coke and refined petroleum products, Public Administration, defence and social security services, Real estate, R&D and business services, Electricity, gas and water and Chemicals.

In what concerns the human capital content of the components of the final demand it is interesting to compare exports with domestic demand components. It is a well established consensus that one of the effects of globalization is to foster innovation (and therefore investment in human capital) in the export oriented sectors. This may be true for the direct needs of exports in human capital. But it is not necessarily true when we consider also the indirect needs, that is to say, the needs of human capital, of the sectors that produce inputs for the production of exported products.

The interesting thing to note is that for Portugal exports were in 1995 the component of final demand with the lowest needs both directly and indirectly of secondary + high school grades and the progress was modest till 2008 (see Table 9). Adding secondary and high grades, exports changed their position with investment but with a small difference.

There is therefore no indication that the stimulus to competitiveness and concomitant investment in human capital due to globalization had a more significant impact in the Portuguese economy for the period 1995-2008 than domestic demand.

In fact, Public Consumption is by far the final demand component with a large impact on employment creation as a whole and on more qualified jobs, both in the case of total (direct plus indirect) effects (see Tables 8 and 9, and Table A.3 for final demand constant price values), as in the case of (only) direct effects (see Table A.4, in Appendix 2). This is an expected result, giving the final demand structure of employment by school grade, presented in Table 10. For example, of all the workers with high grade qualifications, around 60% are public employees, slightly above this value in 1995 and only marginally below in 2008. And the second most qualified sector is Private Consumption, not Investment or Exports, which is a worrying signal, in terms of efficiency and external competitiveness of the Portuguese economy in a globalized and knowledge intensive world.

Table 8: Employment by 10⁶ € directed to each Final Demand component

	1995					2008				
School Grade	C	G	I	Ex	FD	C	G	I	Ex	FD
No School	1,717	1,130	1,826	1,656	6,330	0,285	0,229	0,426	0,333	1,273
Basic	26,502	28,870	29,873	32,869	118,112	10,693	11,619	13,920	13,363	49,596
Secondary	4,499	7,197	3,360	3,704	18,760	3,978	5,881	2,937	3,234	16,030
High	2,013	7,859	1,475	1,459	12,806	2,682	9,209	1,931	1,677	15,499
Total	34,731	45,056	36,534	39,687	156,008	17,638	26,938	19,213	18,607	82,397

Source: QdP; INE and authors' calculations

Table 9: Schooling structure of Employment by Final Demand component

	1995					2008				
School Grade	C	G	I	Ex	FD	C	G	I	Ex	FD
No School	4,94	2,51	5,00	4,17	4,06	1,62	0,85	2,22	1,79	1,54
Basic	76,31	64,07	81,77	82,82	75,71	60,62	43,13	72,45	71,82	60,19
Secondary	12,95	15,97	9,20	9,33	12,02	22,55	21,83	15,28	17,38	19,45
High	5,80	17,44	4,04	3,68	8,21	15,21	34,19	10,05	9,01	18,81
Total	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00

Source: QdP; INE and authors' calculations

Table 10: Final Demand structure of Employment by School Grade (%)

	1995					2008				
School Grade	C	G	I	Ex	FD	C	G	I	Ex	FD
No School	27,13	17,86	28,85	26,16	100,00	22,38	17,98	33,45	26,19	100,00
Basic	22,44	24,44	25,29	27,83	100,00	21,56	23,43	28,07	26,94	100,00
Secondary	23,98	38,36	17,91	19,74	100,00	24,82	36,69	18,32	20,17	100,00
High	15,72	61,37	11,52	11,39	100,00	17,31	59,42	12,46	10,82	100,00
Total	22,26	28,88	23,42	25,44	100,00	21,41	32,69	23,32	22,58	100,00

Source: QdP; INE and authors' calculations

3.4 Human capital, labour productivity and efficiency: a macroeconomic approach

An interesting macroeconomic result can be drawn from the previous sectoral analysis, if we could obtain an aggregate index of human capital used in production from the calculations made so far. The most natural way of doing this is starting from the number years of schooling, s , weighting each school grade by the minimum number of years needed to obtain it.

Let us consider: No school - 0 years; Basic - 6 years; Secondary - 12 years; High - 16 years. Assuming these number of years and using the elements of the last line in table 7 we get that the average number of years needed to produce final demand in 1995 was:

$s = 0.030 \times 0 + 0.766 \times 6 + 0.126 \times 12 + 0.053 \times 16 = 7.0$ years. And for 2008, we have: $s = 0.013 \times 0 + 0.628 \times 6 + 0.213 \times 12 + 0.139 \times 16 = 8.5$ years.

That means that the years of schooling increased 1.6% annually between 1995 and 2008. In the same period, according to Table 11, the annual rate of growth of labour productivity was 1,23%, so that we can conclude that this increase was lower than the growth of the years of schooling.

Table 11: GDP per person employed in Portugal (constant prices)

1995	26,543
2008	31,122

Source: AMECO

Consider now the approach of Barro and Lee (2010) where h , that is, human capital is an exponential function of the number of years of schooling: $h = e^{\theta s}$. Starting from a Cobb-Douglas constant returns function the following equation for the GDP per worker is given by

$$\ln y = \ln A + \alpha \ln k + (1-\alpha) \theta s$$

where y is GDP per worker, k is the stock of physical capital per worker and s the years of education of the labor force.

Since there is no indication that for the Portuguese economy k/y declined between 1995 and 2008, that is that the derivative $(\ln k)'$ was lower than $(\ln y)'$ this may signal that there was a decay in total factor productivity.

4. Concluding remarks

This paper studies the structure and evolution of production, employment and human capital in Portugal, from 1995 to 2008, the last year for which input-output data is

available. The inter-industry approach used is useful for uncovering the main macroeconomic trends in this period.

Starting with a descriptive analysis of the sector composition of gross output, value added and employment, the main conclusion to be highlighted is the relative decay of tradable (agriculture, mining and most manufacturing) sectors and the reinforcement of non tradable (utilities and service) sectors.

Next, a quantification of changes in relative labour productivity points to a decay in traditional sectors (agriculture, wood and cork products, textiles and construction work) and an upgrade of dynamic sectors as coke and refined petroleum products, financial services, electricity, gas and water and pulp, paper and printed matter.

As about the evolution of employment multipliers, the main conclusion is a substantial decrease in its values, not only explained by the price effects of calculations in current prices, but also because of the real employment content of production decay, expected when an economy grows and develops, due to the substitution of labour for capital, and confirmed for the Portuguese case using constant price final demand values.

One of the most important indicators studied in this paper was the structure of labour force qualifications by sector. Although remarkable improvements have been achieved in the past, the low educational levels of its workers, on average, remains one the main vulnerabilities of Portugal in the global and knowledge economy of our days. In this context, the main contribution of the paper is the quantification of human capital requirements of final demand changes by component.

Using an input-output approach combining sector productivities and labour qualifications, output multipliers and final demand structure, it is possible to quantify the growth in employment by level of qualification resulting from a unitary growth of private and public consumption, investment and exports.

An interesting conclusion is that in the Portuguese case exports were in 1995 the component of final demand with the lowest needs both directly and indirectly of secondary plus high school grades and the progress was modest till 2008. There is

therefore no indication that the stimulus to competitiveness and concomitant investment in human capital due to globalization had a more significant impact in the Portuguese economy for the period 1995-2008 than domestic demand.

On the other hand, public consumption is by far the final demand component with a large impact on employment creation as a whole and on more qualified jobs, both in the case of total (direct plus indirect) as in the case of only directed effects. And the second “most qualified” sector is private consumption, not investment or exports, which is a worrying signal in terms of efficiency and external competitiveness of the Portuguese economy in a globalized and knowledge intensive world.

The paper ends with another worrying, macroeconomic, result. After building an aggregate index of human capital used in production from the sectoral calculations of the previous sections, an increase of 1.6% annually between 1995 and 2008 emerges. However, in the same period the annual rate of growth of labour productivity was only around 1,2%, which signals a weak global (or average) efficiency of the Portuguese economy in the last fifteen years, possibly due to a slight but continued decay of total factor productivity.

The data used in the paper are the input-output domestic flow tables from *INE* and *DPP* for the years 1995 and 2008 and employment qualifications from *Quadros de Pessoal* database. Additionally, the construction of price deflators necessary for calculating final demand and labour productivity values at constant prices, was based on AMECO series.

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Appendix 1: List of the sectors used in section 3

1 - Agriculture, fishing and hunting
2 - Mining
3 - Food, beverages and tobacco
4 - Textiles, wearing and leather products
5 - Wood and products of wood and cork (except furniture)
6 - Pulp, paper and printed matter
7 - Coke, refined petroleum products and nuclear fuels
8 - Chemicals, chemical products and man-made fibers
9 - Rubber and plastic products
10 - Other non-metallic mineral products
11 - Basic metals and metal products, except machinery
12 - Machinery and equipment
13 - Transport equipment
14 - Other manufactured goods n.e.c.
15 - Electricity, gas and water
16 - Construction work
17 - Trade and repair services
18 - Hotel and restaurant services
19 - Transport and communication services
20 - Financial services
21 - Real estate, R&D and business services
22 - Public administration and defence services; compulsory social security services
23 - Education services
24 - Health and social work services
25 - Other services

Appendix 2: Auxiliary Tables

Table A1: Price deflators - ECU/EUR: 2005 = 100

	C	G	I	Ex	FD
1995	74,670	71,246	78,105	90,874	76,585
1996	76,555	73,357	80,672	90,273	78,381
1997	78,428	74,849	82,491	91,953	81,274
1998	80,149	75,499	83,205	91,772	83,199
1999	83,294	78,445	85,529	92,709	85,011
2000	86,002	85,845	89,670	97,672	89,031
2001	89,076	87,302	91,717	98,315	91,387
2002	92,407	88,681	93,954	98,312	93,479
2003	95,184	92,634	95,128	96,906	95,141
2004	97,537	93,962	97,540	98,367	97,419
2005	100,000	100,000	100,000	100,000	100,000
2006	102,781	102,063	102,701	104,408	103,062
2007	105,689	105,912	104,927	106,428	105,509
2008	107,361	109,781	108,067	109,076	108,280
2008/2005	1,438	1,541	1,384	1,200	1,414

Source: AMECO

Table A2: Employment multipliers (by 10⁶ € - constant prices 1995)

Sectors	1995		2008	
	Value	Rel. to av.	Value	Rel. to av.
1-Agriculture, fishing, hunting	109,901	255,66	105,121	312,44
2 - Mining	34,293	79,78	27,507	81,76
3- Food, beverages, tobacco	56,829	132,20	42,656	126,78
4-Textiles, wearing, leather pr.	53,387	124,19	50,758	150,86
5-Wood and cork	70,481	163,96	56,936	169,22
6- Pulp, paper, printed matter	31,847	74,08	16,523	49,11
7-Coke, refined petroleum pr.	5,907	13,74	1,395	4,15
8-Chemicals	18,455	42,93	13,611	40,45
9-Rubber and plastic products	28,474	66,24	21,244	63,14
10-Other non-metallic min. pr.	29,983	69,75	28,300	84,11
11-Basic metals, exc machin.	24,003	55,84	27,351	81,29
12-Machinery and equipment	54,605	127,03	15,588	46,33
13-Transport equipment	12,331	28,69	17,358	51,59
14-Other manufact. goods n.e.c.	54,886	127,68	30,725	91,32
15-Electricity, gas, water	50,280	116,97	12,133	36,06
16-Construction work	64,894	150,96	42,160	125,31
17-Trade and repair services	31,556	73,41	39,386	117,06
18-Hotel and restaurant serv.	64,894	150,96	44,015	130,82
19-Transport and commun. serv.	22,997	53,50	19,488	57,92
20-Financial services	23,085	53,70	12,559	37,33
21-Real estate, R&D and bus. S.	48,033	111,74	13,425	39,90
22-Public admin.; def.; s. sec. S.	49,105	114,23	35,561	105,69
23-Education services	48,033	111,74	43,554	129,45
24-Health and social work serv.	46,429	108,01	42,062	125,02
25-Other services	39,990	93,03	81,708	242,85
Average	42,987	100,00	33,645	100,00

Source: INE and authors' calculations

Table A3: Employment by 10⁶ € directed to each (total) Final Demand component (constant prices 1995)

School Grade	1995					2008				
	C	G	I	Ex	FD	C	G	I	Ex	FD
No School	1,717	1,130	1,826	1,656	6,330	0,402	0,353	0,589	0,400	1,744
Basic	26,502	28,870	29,873	32,869	118,112	15,081	17,904	19,260	16,040	68,285
Secondary	4,499	7,197	3,360	3,704	18,760	5,611	9,062	4,063	3,882	22,618
High	2,013	7,859	1,475	1,459	12,806	3,783	14,190	2,671	2,013	22,657
Total	34,731	45,056	36,534	39,687	156,008	24,876	41,509	26,584	22,334	115,303

Source: QdP; INE and authors' calculations

Table A4: Schooling structure of Employment by (total) Final Demand component - direct effects

School Grade	1995				2008			
	C	G	I	Ex	C	G	I	Ex
No School	2,96	2,22	6,70	4,17	0,86	0,76	4,05	2,52
Basic	72,24	60,63	79,27	80,36	52,30	41,44	69,61	66,60
Secondary	14,85	15,68	9,05	10,23	26,21	21,91	15,66	19,71
High	6,84	17,69	4,17	4,44	19,94	35,66	11,46	12,09

Source: QdP; INE and authors' calculations