

EMPLOYMENT GENERATED FROM THE MULTIPLIER EFFECT OF THE SPANISH PAPER INDUSTRY

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Abstract: The paper industry is really important in the production system because it is closely intertwined to many activities. Therefore, any change in its production will affect its employment and also the employment of its suppliers. In this study we analyse the effect that the Spanish paper industry exerted through the production system in terms of employment in 2005 (last year for which the last Symmetric Input-Output Table is available). In this study we use an Economic Input Output-Life Cycle Assessment (EIO-LCA) to highlight the important impact that this industry has on the employment of its direct and indirect suppliers.

Keywords: Employment, Environment Input-Output Life Cycle Assessment, Multiplier effect, Paper industry.

JEL classification codes: Q56, R11, R15.

1. Introduction

In this paper we focus on the paper industry. The main reason is that it is an industry closely related to many other industries as a provider, and, any change in its production will affect the production of many other activities. In fact, if we take the production structure of the Spanish paper industry in 2005 from the symmetric input-output table elaborated by the Spanish Statistics Institute (INE, 2009), it can be noticed how this industry requires a high amount of inputs: 8,081.3 million euro, 64.1% of them domestic and 35.9% imported.

If we analyze the origin of the domestic inputs required by the paper industry to elaborate its own production, we will notice that these inputs come from a diverse group of industries. In other words, an increase in the paper and cardboard production would involve a higher demand by the paper industry of inputs from other activities. That supposes that the direct suppliers have to increase their production in order to provide that demand of inputs.

Moreover, these suppliers would also transfer their higher demand to their own suppliers, thus creating a chain effect triggered by higher production and an increased cash flow associated with it. That is, a multiplier effect on production will take place. In brief, due to the intersectoral relationships between the paper industry and the remaining of industries, any change in the production of the paper industry will have an impact on the production of the rest of industries, and, as a consequence, on their employment levels.

Furthermore, input-output tables (INE, 2009) show that paper industry had 53.4 thousand employees in 2005 measured in full-time equivalent jobs or FTE jobs, defined as total hours worked divided by the average annual number of hours worked in full-time jobs within the economic territory (European Commission, 1996), which represents 0.3% of the total employment in Spain. Figure 1 shows the employment generated by economic activities in 2005. Despite of having lower employees than other activities, paper industry is closely related too many other activities, and as we

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have mentioned above, it exerts a multiplier effect on its suppliers that will have consequences on their employment levels. Therefore, this analyses is aimed at estimating, not only the employment generated in the own paper industry, but the impact generated on the employment of their supplier industries as a consequence of the multiplier effect from paper industry.

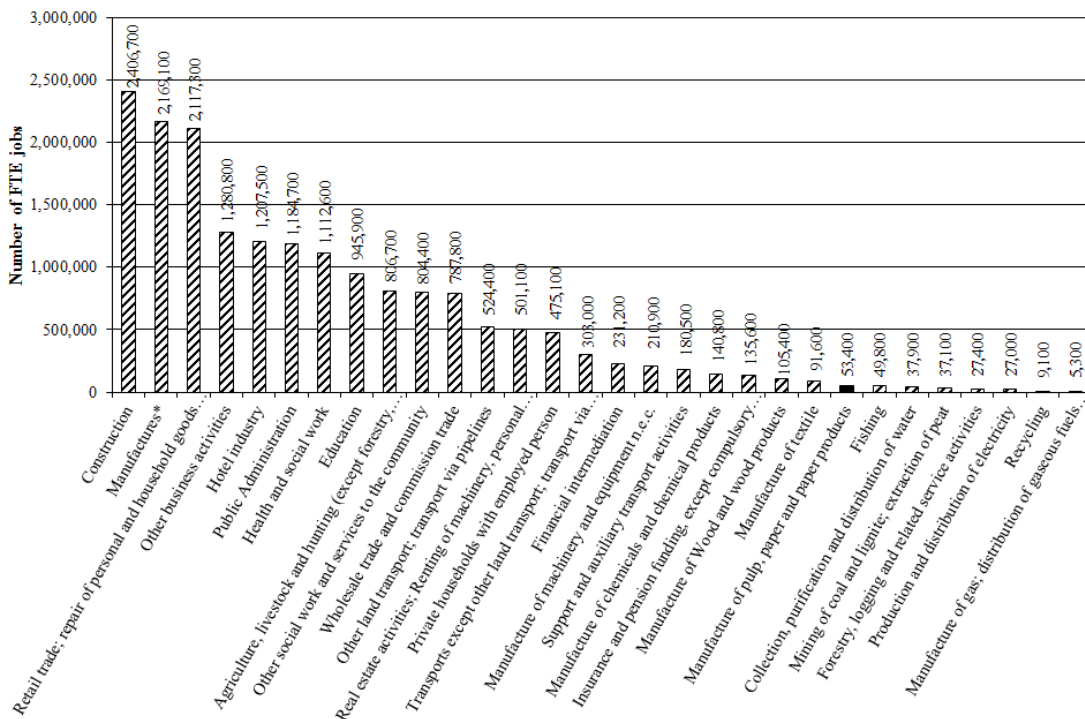


Fig. 1. Number of FTE jobs per economic activity.

*Manufactures (except manufacture of textile, manufacture of wood and wood products, manufacture of pulp, paper and paper products, manufacture of chemicals and chemical products, manufacture of machinery and equipment not elsewhere classified (n.e.c.) and recycling).

2. Methodology of an Economic Input-Output Life Cycle Assessment Model (EIO-LCA).

In the 90s, the Carnegie Mellon University (Pittsburgh, Pennsylvania) developed a new methodology presented as a complementary analysis to process models such as the life cycle assessment (LCA) (Hendrickson et al., 2006). This tool integrates the use of the LCA with economic input-output analysis (EIO), creating the Economic Input Output Life Cycle Assessment (EIO-LCA). This methodology has the advantages of low cost, rapid use, a consistent boundary for analysis and it is more accurate than process models as LCA approach (Michalek et al., 2011; Ruiz et al., 2014). Furthermore, this tool has been the main base to develop other models which explains physical aspects related to environmental impact (see Andrew et al., 2010; Hawkins et al., 2007; Hoekstra and van den Bergh, 2006; Nakamura et al., 2007; Nakamura and Kondo, 2009). Although EIO-LCA is commonly employed to assess the environmental impact of the production of a good or a service, it can also be used to

analyze other social and economic issues, such as employment (Bekhet, 2011; Hendrickson et al., 2006; Valadkhani, 2003; Lenzen, 2001).

Table 1. Classification of industries.

<i>CNP-2002</i>	<i>CNAE-93</i>	<i>Number</i>	<i>Industries</i>
1	A	1	Agriculture, livestock and hunting (except forestry, logging and related service activities)
2	A	2	Forestry, logging and related service activities
3	B	3	Fishing
4,5,6 y 7	C	4	Mining of coal and lignite; extraction of peat
8,12,13,14,15,16,18,19,22,24,25,26,27,28,29,30,32,33,34,35,36, 37 y 38	D	5	Manufactures (except textile, wood and wood products, pulp, paper and paper products, chemicals and chemical products, machinery and equipment n.e.c. and recycling)
17	D	6	Manufacture of textile
20	D	7	Manufacture of Wood and wood products
21	D	8	Manufacture of pulp, paper and paper products
23	D	9	Manufacture of chemicals and chemical products
31	D	10	Manufacture of machinery and equipment n.e.c.
39	D	11	Recycling
11	E	12	Collection, purification and distribution of water
9	E	13	Production and distribution of electricity
10	E	14	Manufacture of gas; distribution of gaseous fuels through mains; steam and hot water supply
40	F	15	Construction
41 y 43	G	16	Retail trade; repair of personal and household goods and Sale and retail of motor vehicles; retail sale of automotive fuel
42	G	17	Wholesale trade and commission trade
44 y 45	H	18	Hotel industry
46,48,49,50, 51 y 52	I	19	Transports except other land transport; transport via pipelines; and Support and auxiliary transport activities
47	I	20	Other land transport; transport via pipelines
50	I	21	Support and auxiliary transport activities
54 y 55	J	22	Insurance and pension funding, except compulsory social security and Auxiliary activities to financial intermediation
53	J	23	Financial intermediation
56, 57, 58 y 59	K	24	Real estate activities; Renting of machinery, personal and household goods; Computer and related activities; Research and development, except Other business activities
60	K	25	Other business activities
67	L	26	Public Administration
61 y 68	M	27	Education
62 y 69	N	28	Health and social work
63,64,65,66,70,71 y 72	O	29	Other social work and services to the community
73	P	30	Private households with employed person

Source: Own creation from INE (2009).

As its name explains the EIO-LCA model is based on the Input Output tables, especially on the symmetric input-output table. In the case of Spain the most recent symmetric input-output table corresponds to 2005, which is published by the Spanish

Statistics Institute (see INE, 2009). This table includes data on sectoral employment. In particular, we use the number of full-time equivalent jobs (FTE jobs) defined as total hours worked divided by the average annual number of hours worked in full-time jobs within the economic territory, according to European Commission Council Regulation (1996).

The symmetric input-output table covers 73 products that we aggregate into 30 industries to simplify the analysis. This table employs the National Product Classification 2002 (CNP-2002). Each type of good or service distinguished by the CPN-2002 is defined so that it is normally produced by only one industry as defined in the National Classification of Economic Activities 1993 (CNAE-93). The final group of industries analyzed were reported in Table 1.

In this analysis we employ an EIO-LCA model to estimate the effect that Spanish paper industry exerted on its supply chain in 2005.

A supply chain can be defined as the sequence of the total providers of a given industry, in this case, the Spanish paper industry. We can distinguish between those suppliers that provide directly the industry, called direct suppliers, and those ones that do not directly supply the industry but are providers to the providers of the given industry (Ruiz Peñalver et al., 2014 and Rodríguez Molina et al., 2016).

The EIO-LCA method is based on the well-known Leontief model which is explained by equation (1):

$$X_t = (I - A)^{-1}y \quad (1)$$

In an economy with n industries, $(I - A)^{-1}$ is a square $n \times n$ matrix also called total requirement matrix. Each element of it represents the total requirements per unit of demand, y . In this case, we have focused on the Spanish paper industry therefore, vector y represents the demand of this industry.

I represents the square $n \times n$ identity matrix.

A is the domestic technical coefficients matrix. This square matrix represents the inputs (produced in the domestic economy) that the Spanish paper industry requires from the others to produce.

X is the output associated with the desired demand y .

In other words, equation (1) shows the multiplier effect that the production of a good or a service (in our case paper and cardboard products) exerts on the total economy as it takes into account all the elements of the supply chain.

Using this equation we obtain the multiplier effect associated with the direct (equation 2) and indirect (equation 3) suppliers as follows:

$$X_d = (I + A) y \quad (2)$$

$$X_i = [(I - A)^{-1} - (I + A)] y \quad (3)$$

Furthermore, using the symmetric input-output table that corresponds to 2005 (INE, 2009), we create a matrix of FTE jobs R . In an economy with n industries, R is a square $n \times n$ matrix, each element of which is the amount of FTE jobs generated per euro

of industry j 's output (see Annex 2). If we lengthen the Leontief model (equation 1) with matrix R , we obtain the total effect on employment exerted by the Spanish paper industry per euro of output, b_t , as follows:

$$b_t = R(I-A)^{-1}y \quad (4)$$

If we want to differentiate between the effect that the Spanish paper industry exerts on its direct and indirect suppliers, equation (4) must be disaggregated as follows:

$$b_d = R(I+A)y \quad (5)$$

$$b_i = R[(I-A)^{-1} - (I+A)]y \quad (6)$$

In this study b will be an employment vector that captures how the multiplier effect of the paper industry affects the employment of its direct suppliers (equation 5) and its indirect ones (equation 6).

3. Results and discussion

As was indicated before, the aim of this study was to apply an EIO-LCA model to estimate the employment generated by the multiplier effect of the Spanish paper industry in 2005.

Before applying our model, we need to compute the Leontief inverse matrix (Annex 1). As can be noticed, the number of elements different from zero is very high. This indicates that there are a high number of industries with a direct or indirect participation in the supply chain of the paper industry.

Applying the equations (1), (2) and (3) of the demand model, we obtain the multiplier effect that the production of the Spanish paper industry exerts on its supply chain (direct and indirect suppliers). Table 2 reports the results.

For example, the impact that the production of the Spanish paper industry (11,188.3 million euro in 2005) exerted on the manufacture of chemicals and chemical products (industry 9) was 642.4 million euro. Of this impact, 613.2 million euro corresponded to direct suppliers and 29.2 to indirect suppliers.

The output of the Spanish paper industry in 2005 was 11,188.3 million euro and had an impact on the total output of the economy of 19,869.9 million euro. From this total, 18,353.5 million euro corresponded to direct suppliers and 1,516.4 to indirect ones. As can be noticed, the interactions between suppliers give place to a multiplier effect, stronger for the direct suppliers and weaker for the indirect suppliers.

Although the impact that the paper industry has on each indirect supplier may be small individually, taken as a whole they can be significant, because the number of activities implied is likely to be high (Hendrickson et al. 2006; Lenzen et al. 2003). Once the impact on production is calculated we estimate the effect on employment. We define matrix R that represents the total number of FTE jobs per million euro of output for each industry.

Table 2. Multiplier effect on the production of total, direct and indirect suppliers of the Spanish paper industry, 2005 (millions of euro).

Industry	Total suppliers	Direct suppliers	Indirect suppliers	Industry	Total suppliers	Direct suppliers	Indirect suppliers
1	69.7	24.0	45.8	16	165.9	126.3	39.6
2	455.2	446.5	8.6	17	669.5	599.7	69.8
3	1.1	0.3	0.9	18	43.7	29.9	13.8
4	45.9	34.2	11.7	19	281.2	202.6	78.7
5	964.1	606.4	357.7	20	641.5	548.3	93.1
6	139.1	124.8	14.4	21	434.1	326.2	107.9
7	458.6	424.5	34.1	22	75.5	50.3	25.1
8*	11,717.3	11,696.9	20.4	23	187.7	143.7	44.0
9	642.4	613.2	29.2	24	334.1	237.1	97.1
10	124.6	101.4	23.2	25	965.8	828.0	137.8
11	149.5	139.4	10.2	26	0.0	0.0	0.0
12	23.0	17.7	5.3	27	26.5	21.5	5.1
13	660.5	582.4	78.1	28	16.8	10.2	6.7
14	279.6	250.3	29.3	29	0.1	0.0	0.1
15	296.9	168.0	129.0	30	0.0	0.0	0.0
				Total	19,869.9	18,353.5	1,516.4

Source: Own creation from INE (2009). *Sector 8 is paper industry. Its high values are due to the fact that they include the multiplier effect of its suppliers plus its own 2005 output (11.2 billion euros). This is 11.7 billion euros from them, 11.6 correspond to direct suppliers and 20.4 to indirect suppliers.

Equations (4), (5) and (6) are used to obtain the employment generated by the multiplier effect of the Spanish paper industry. Table 3 records the results.

Table 3. Employment generated by the Spanish paper industry, 2005 (number of FTE jobs).

Industry	Total Suppliers	Direct Suppliers	Indirect Suppliers	Industry	Total Suppliers	Direct Suppliers	Indirect Suppliers
1	1,524	524	1,000	16	3,924	2,987	937
2	7,272	7,133	138	17	7,410	6,638	772
3	26	6	20	18	520	357	164
4	303	225	77	19	1,395	1,005	390
5	5,600	3,523	2,078	20	8,145	6,963	1,183
6	1,386	1,243	143	21	2,748	2,065	683
7	4,792	4,436	356	22	402	268	134
8	55,927	55,829	97	23	1,286	985	301
9	2,327	2,221	106	24	1,148	814	333
10	1,032	840	192	25	13,516	11,588	1,928
11	275	257	19	26	-	-	-
12	177	136	41	27	554	448	106
13	563	496	67	28	270	163	107
14	191	171	20	29	1	0	1
15	2,611	1,477	1,134	30	-	-	-
				Total	125,323	112,795	12,528

Source: Own creation from INE (2009).

Taking again the manufacture of chemicals and chemical products as an example, we can notice how a demand of 642.4 million euro from the paper industry (see table 2) generated an impact on employment of 2,327 FTE jobs. In the case of direct suppliers, a demand of 613.2 million euro from the paper industry generated 2,221 FTE jobs whereas the impact on indirect suppliers was much more modest: the demand of the paper industry is 29.2 million euro and the employment generated by this demand is 106 FTE jobs.

As table 3 shows, paper industry has been the sector which has generated more employment. This industry has generated 55.9 thousand employees. From them, 53.4 thousand employees correspond to its 2005 output (the obtained results agree with available data from INE surveys) and only 2.5 thousand employees are related to its total multiplier effect. The most of this employment has been generated by direct suppliers (2.4 thousand employees) and only 97 employees by indirect suppliers. In general, the multiplier effect of the paper industry on the economy in 2005 generated a total of 125,323 FTE jobs, 112,795 in industries that are direct suppliers and 12,528 in industries that are indirect suppliers.

On a broad basis, the most favored were manufacturing, followed by services and by the primary sector. By industries, paper industry (sector 8) has the highest level of employment. This is due to the fact that its employment level includes the multiplier effect, that paper industry generates on other activities (then it affects itself), plus its own employment level.

We can highlight the impact generated on the employment of other business activities (sector 25) with 13,516 FTE jobs, other land transport (sector 20) with 8,145 FTE jobs, wholesale and commission trade (sector 17 with 7,410 FTE jobs), forestry, logging and related service activities (sector 2 with 7,276 FTE jobs) and manufactures (except manufacture of textile, manufacture of wood and wood products, manufacture of pulp, paper and paper products, manufacture of chemicals and chemical products, manufacture of machinery and equipment n.e.c. and recycling) (sector 5 with 5,600 FTE jobs).

As for the direct suppliers, the industries with the highest impact were of course paper industry (sector 8) with 55,829 FTE jobs, other business activities (sector 25 with 11,588 FTE jobs), forestry, logging and related service activities (sector 2 with 7,133 FTE jobs) and wholesale and commission trade (sector 17 with 6,638 FTE jobs), manufacture of wood and wood products (sector 7 with 4,436 FTE jobs) and manufactures (except manufacture of textile, manufacture of wood and wood products, manufacture of pulp, paper and paper products, manufacture of chemicals and chemical products, manufacture of machinery and equipment n.e.c. and recycling) (sector 5 with 3,523 FTE jobs).

Concerning the indirect suppliers, the industries with the highest impact were manufactures (except manufacture of textile, manufacture of wood and wood products, manufacture of pulp, paper and paper products, manufacture of chemicals and

chemical products, manufacture of machinery and equipment n.e.c. and recycling) (sector 5 with 2,078 FTE jobs), other business activities (sector 25 with 1,928), other land transport (sector 20 with 1,183 FTE jobs) construction (sector 15 with 1,134 FTE jobs) and agriculture, livestock and hunting except forestry, logging and related service activities (sector 1 with 1,000 FTE jobs).

4. Conclusions

Despite of EIO-LCA is usually applied to explain the supply chain impacts of producing goods and services, especially environmental impacts, in this study we have applied an EIO-LCA model in order to estimate the impact on employment generated by the Spanish paper industry in 2005 as a result of the multiplier effect it exerts in the production system.

The core of the model is both the direct requirements and the Leontief inverse matrix. The last one captures this multiplier effect on direct and indirect suppliers, and, as was mentioned, almost of its elements showed values different from zero, although the a kind of “*distance-decay*” effect is observed, the coefficients being higher for the direct suppliers and lower for the indirect suppliers of first level, much lower for the indirect suppliers of second-level and so on. That explains why indirect suppliers do not have a high importance individually but just in group because they involve a large group of industries.

As for the FTE jobs generated by this multiplier effect, the results show that services are the major beneficiaries, followed by manufacturing and by primary activities. By industries, we can highlight the impact on other business activities, other land transport, wholesale and commission trade, forestry, logging and related service activities and manufactures except manufacture of textile, manufacture of wood and wood products, manufacture of pulp, paper and paper products, manufacture of chemicals and chemical products, manufacture of machinery and equipment and recycling.

In brief, this study confirms that the EIO-LCA model can be used to analyze socio-economic issues and not only environmental effects throughout the economy. Additionally, results show that the Spanish paper industry is interconnected to many other industries, and its production is associated with 125,323 FTE jobs through the production system. Therefore, the intermediate relations of the Spanish paper industry with the rest of the economy imply that any change in its production will have a great impact on the production and the employment levels of a lot of industries which are involved in the papermaking process.

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