

## **Aplicaciones al medio ambiente**

**Valoraciones de las emisiones en España en un marco input-output**

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**Julio Sánchez-Chóliz and Rosa Duarte (2004): CO<sub>2</sub> emissions embodied in international trade: Evidence for Spain.**

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The objective of this paper is to analyse the sectoral impacts that Spanish international trade relations have on present levels of atmospheric pollution using an Input-Output model. We try to evaluate the exports and imports of the Spanish economy in terms of the direct and indirect CO<sub>2</sub> emissions (CO<sub>2</sub> embodied) generated in Spain and abroad. The results show a **slightly exporting** behaviour in the Spanish economy which, nevertheless, hides important pollution interchanges. Moreover, the sectors **Transport Material, Mining and Energy, Non-metallic industries, Chemical and Metals** are the most relevant CO<sub>2</sub> exporters and Other services, **Construction, Transport Material and Food** the biggest CO<sub>2</sub> importers, and those whose **domestic final demands also embody around 70 % of the CO<sub>2</sub> emissions.**

## Methodology.

### Basic model:

$\mathbf{x} = \mathbf{A}\mathbf{x} + \mathbf{y}$ ;  $\mathbf{A} = \{\mathbf{X}_{ij}/\mathbf{x}_j\}$ ;  $\mathbf{y}$  including  $\mathbf{y}^m$  (finished goods);  $\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{y}$ ;  $(\mathbf{I} - \mathbf{A})^{-1} = \{\alpha_{ij}\}$  is the Leontief inverse

### Decompositions

$$\mathbf{A}^d = \{\mathbf{X}_{ij}^d/\mathbf{x}_j\} \text{ and } \mathbf{A}^m = \{\mathbf{X}_{ij}^m/\mathbf{x}_j\}; \quad \mathbf{A} = \mathbf{A}^d + \mathbf{A}^m; \quad \mathbf{x}^m = \mathbf{A}^m\mathbf{x} + \mathbf{y}^m = \mathbf{A}^m(\mathbf{I} - \mathbf{A})^{-1}\mathbf{y} + \mathbf{y}^m$$

### Valor agua

$$\mathbf{c}^d = \{\mathbf{c}_{ij}^d\} = \{\mathbf{C}_{ij}^d/\mathbf{x}_j\}; \quad \mathbf{C}^d \text{ is the direct emission}; \quad \mathbf{v}^d = \{\mathbf{v}_{ij}^d\} = \mathbf{c}^d(\mathbf{I} - \mathbf{A})^{-1}; \quad \mathbf{v}_{ij}^d = \mathbf{c}_{1j}^d\alpha_{1j} + \mathbf{c}_{2j}^d\alpha_{2j} + \dots + \mathbf{c}_{ij}^d\alpha_{ij} + \dots + \mathbf{c}_{nj}^d\alpha_{nj}$$

### Valoración total en emisiones

$$\mathbf{C} = \mathbf{C}^d + \mathbf{C}^m = \mathbf{v}^d\mathbf{y} + \mathbf{v}^d\mathbf{A}^m(\mathbf{I} - \mathbf{A})^{-1}\mathbf{y} + \mathbf{v}^d\mathbf{y}^m = [\mathbf{c}^d + \mathbf{c}^d(\mathbf{I} - \mathbf{A})^{-1}\mathbf{A}^m](\mathbf{I} - \mathbf{A})^{-1}\mathbf{y} + \mathbf{c}^d(\mathbf{I} - \mathbf{A})^{-1}\mathbf{y}^m = (\mathbf{v}^d + \mathbf{v}^m)\mathbf{y} + \mathbf{v}^d\mathbf{y}^m = \mathbf{v}^1\mathbf{y} + \mathbf{v}^d\mathbf{y}^m$$

### Final balance:

$$\mathbf{B} = \mathbf{v}^t\mathbf{z} - \mathbf{C}^m = (\mathbf{v}^d\mathbf{z} + \mathbf{v}^m\mathbf{z}) - (\mathbf{v}^m\mathbf{y} + \mathbf{v}^d\mathbf{y}^m) = \mathbf{v}^d[\mathbf{z} - \mathbf{A}^m(\mathbf{I} - \mathbf{A})^{-1}(\mathbf{y} - \mathbf{z}) - \mathbf{y}^m] = \mathbf{c}^d(\mathbf{I} - \mathbf{A})^{-1}[\mathbf{z} - \mathbf{A}^m(\mathbf{I} - \mathbf{A})^{-1}(\mathbf{y} - \mathbf{z}) - \mathbf{y}^m],$$

## Empirical analysis.

“Spanish I-O tables” for 1995, and “Satellite Atmospheric Accounts” for 1997, INE (2001 and 2002).

Direct pollution ( $c_j x_j$ ) versus embodied pollution ( $v_j^d y_j$ )

Domestic pollution versus total embodied in Spanish production, role played by imports

Pollution exported

Positive net balance

**Table 1. Components and ratios of imported and exported pollution.**

(In thousands of t)	Direct CO <sub>2</sub> (1)	Domestic embodied CO <sub>2</sub> (2)	Total embodied CO <sub>2</sub> (3)	CO <sub>2</sub> imported in inputs (4)	CO <sub>2</sub> imported in consumption goods (5)	CO <sub>2</sub> embodied in exports (6)	Domestic CO <sub>2</sub> exported (7)	Imported CO <sub>2</sub> exported	Net balance	(2)/(3)	(6)/[(4) + (5)]	(7)/[(4) + (5)]	(1)/(2)
Agriculture and Livestock	8709	3641	5718	1083	994	4877	3759	1118	2800	0.64	2.35	1.81	2.39
Fishery	4170	1405	3004	131	1468	418	382	36	-1181	0.47	0.26	0.24	2.97
Food	4457	20455	32664	8437	3771	5750	4071	1679	-6459	0.63	0.47	0.33	0.22
Mining and Energy	85498	9209	12374	2874	291	10981	8369	2612	7817	0.74	3.47	2.64	9.28
Non metallic industries	39904	6759	8264	671	834	10111	9198	913	8606	0.82	6.72	6.11	5.90
Chemicals	11069	2646	5807	1292	1869	12993	8731	4262	9833	0.46	4.11	2.76	4.18
Rubber and plastics	575	189	631	178	264	3466	1784	1681	3024	0.30	7.84	4.04	3.05
Metals	17434	1672	3126	707	747	13125	9223	3902	11671	0.53	9.03	6.34	10.43
Machinery	782	3243	8590	2078	3269	5435	3312	2122	88	0.38	1.02	0.62	0.24
Electric & electronic equip.	655	2797	8625	2136	3692	6523	3698	2825	694	0.32	1.12	0.63	0.23
Transport materials	992	14155	33287	14066	5066	28834	14463	14371	9702	0.43	1.51	0.76	0.07
Textiles	1459	4516	9318	3139	1664	2887	1703	1184	-1915	0.48	0.60	0.35	0.32
Leather and Footwear	345	1700	3049	1104	245	1398	848	551	49	0.56	1.04	0.63	0.20
Paper	2568	1711	3000	915	374	2204	1436	768	915	0.57	1.71	1.11	1.50
Wood and furniture	1882	4901	8441	2701	838	1972	1271	701	-1567	0.58	0.56	0.36	0.38
Construction	2890	50723	66693	15970	0	11	8	3	-15959	0.76	0.00	0.00	0.06
Transport services	14174	9236	12351	2868	247	5384	4109	1276	2270	0.75	1.73	1.32	1.53
Other services	8951	67557	97455	29644	254	3747	2604	1143	-26151	0.69	0.13	0.09	0.13
<b>Total</b>	<b>206514</b>	<b>206514</b>	<b>322394</b>	<b>89992</b>	<b>25888</b>	<b>120117</b>	<b>78971</b>	<b>41145</b>	<b>4237</b>				

**Table 2. Sector percentages.**

	Direct CO <sub>2</sub> pollution	Domestic embodied CO <sub>2</sub>	Total embodied CO <sub>2</sub>	CO <sub>2</sub> imported in inputs	CO <sub>2</sub> imported in finished goods	CO <sub>2</sub> embodied in Exports	Domestic CO <sub>2</sub> embodied in Exports	Imported CO <sub>2</sub> exported	Net balance
Agriculture and Livestock	4.22	1.76	1.77	1.20	3.84	4.06	4.76	2.72	66.10
Fishery	2.02	0.68	0.93	0.15	5.67	0.35	0.48	0.09	-27.88
Food	2.16	9.90	10.13	9.38	14.57	4.79	5.15	4.08	-152.46
Mining and Energy	41.40	4.46	3.84	3.19	1.12	9.14	10.60	6.35	184.5
Non metallic industries	19.32	3.27	2.56	0.75	3.22	8.42	11.65	2.22	203.14
Chemicals	5.36	1.28	1.80	1.44	7.22	10.82	11.06	10.36	232.10
Rubber and plastics	0.28	0.09	0.20	0.20	1.02	2.89	2.26	4.09	71.37
Metals	8.44	0.81	0.97	0.79	2.88	10.93	11.68	9.48	275.49
Machinery	0.38	1.57	2.66	2.31	12.63	4.52	4.19	5.16	2.07
Electric & electronic equip.	0.32	1.35	2.68	2.37	14.26	5.43	4.68	6.87	16.38
Transport materials	0.48	6.85	10.33	15.63	19.57	24.00	18.31	34.93	229.00
Textiles	0.71	2.19	2.89	3.49	6.43	2.40	2.16	2.88	-45.21
Leather and Footwear	0.17	0.82	0.95	1.23	0.95	1.16	1.07	1.34	1.16
Paper	1.24	0.83	0.93	1.02	1.44	1.83	1.82	1.87	21.60
Wood and furniture	0.91	2.37	2.62	3.00	3.24	1.64	1.61	1.70	-36.99
Construction	1.40	24.56	20.69	17.75	0.00	0.01	0.01	0.01	-376.69
Transport services	6.86	4.47	3.83	3.19	0.95	4.48	5.20	3.10	53.57
Other services	4.33	32.71	30.23	32.94	0.98	3.12	3.30	2.78	-617.26
<b>Total</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>