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Carbon Taxation and Sectors Competitiveness

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Work in Progress

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Abstract

The impact of carbon dioxide emission restrictions on industries competitiveness is amongst policy makers' and industrial federations' main causes for concern. Whereas the macroeconomic impact of such restrictions and their welfare effect have been extensively investigated, sectoral competitiveness was essentially ignored. I develop a straightforward method to assess the short-run impact of emission constraints on sectoral costs, hence on sectors international competitiveness. It uses a simple input-output quantity model to estimate total carbon emissions embodied in sectoral output. The impact on sectors' revenue is inferred by imposing a carbon tax of which the level is set at the carbon value, defined as the equilibrium marginal abatement cost required to fulfil a given reduction objective. International competitiveness is then appraised regarding international exposure to non-constrained economies. Unusually, no data is required but the standard SNA input- output tables in monetary value, making the method very flexible and readily reproducible. Next, it is applied to Belgium. The resulting analysis shows that steel, refinery and chemical industries competitiveness is badly hit, as expected. But it also comes up with new results, highlighting the threat to other major sectors including food-processing and textiles. In terms of cumulative employment, almost three hundred thousand jobs are directly and indirectly at stake. It appears that the method can yield interesting insights from an economic policy perspective.

Keywords: carbon tax, emission constraints, input-output analysis, international competitiveness, sectoral costs.

JEL classification: C67, D57, H23, Q48, Q58.

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1 Introduction

The impact of carbon dioxide emission restrictions on international competitiveness is amongst policy makers' main causes for concern. As the recent climate change conference in Copenhagen emphasized, heads of state and government are reluctant to make emissions reductions commitments that would penalize their national industrial sectors. However, growing concern about global warming has made these kind of engagements ineluctable and many developed countries have already made binding commitments. The extent to which these will affect sectors competitiveness is an issue of major importance.

The question has become a quite buoyant research field for several years. Whereas the macroeconomic impact of emissions restrictions has been extensively investigated, the sectoral level was essentially ignored, although this may yield interesting results from a economic policy standpoint. Indeed, environmental negotiations are notably lobbied by industrial federations that are supposed to bear a disproportionate burden and of which the international competitiveness is supposed to be affected. Stuck between industrial lobbies on the one side and environmental activists on the other, leaders may lack reliable information to assess the relative impacts of climate engagements on the different economic sectors.

This research was initiated with the objective to develop a simple and flexible method to reckon it in the Belgian context. It turns out that the method that was developed may be reproducible in different contexts provided minor adaptations. This paper is about formally setting out this method that allows to assess the short-run impact of emission restrictions on sectoral costs and competitiveness[1]. The results from its application to Belgium show that the constraints affect badly the competitiveness of steel, refinery and chemical industries, as expected. But it produces new results too, stressing the threat to other major sectors including food-processing, textiles and mineral industries. It also turns out that almost three thousand jobs are directly or indirectly affected by the loss of competitiveness.

The paper is organized as follows. The remainder of this section lays out the research, places it in the literature and highlights its novelty. The formal method is exposed in the second section and the data, results and limits of its application to Belgium are discussed in the third one. Section four concludes.

Carbon dioxide emissions are typically a by-product that is directly linked to fossil energy-intensive production and consumption and are thus associated with interindustry activity. Since the early seventies, input-output (I-O) analysis has become a prominent and powerful tool to analyze flows that are closely related to production processes, like energy or emissions. Initiated by Leontief [13], I-O techniques allow to relate total, direct and indirect sectoral output to final demand through interindustry relationships, i.e. they model production in a general equilibrium framework and at a relatively high level of sectoral disaggregation.

[1]This work builds on research carried out at Belgian Federal Planning Bureau during an internship in this institution and led to a master thesis ([10]).

Seminal work on the use of I-O for energy related questions dates back to Cumberland [8], while environmental questions are first addressed by Ayres and Kneese [2] and Leontief [14]. I-O techniques open the way to numerous extensions and policy applications, in particular since the development of social accounting matrix. From the nineties on, global warming concern and the perspective of emission constraints induced a revival of I-O analysis as a tool for estimating total emissions associated with sectoral production. Early estimations are provided by Common and Salma [5] for the UK and Gay and Proops [9] for Australia.

Given its properties, I-O analysis is a natural tool to reckon the economic impact of emission constraints. Since market-based instruments have supplanted the command-and-control approach for a while as a means to curb carbon emissions, an intuitive approach consists in estimating total emissions embodied in sectoral output and considering a pigovian tax levy[2]. This approach was used by Symons, Gay and Proops [16][3].

The research I develop here departs from what has already been done on several major points, hence it offers new prospects. One of the main and obvious difference regards the research objective. As far as I am aware, the objective of all previous work on environmental taxation done at the sectoral level (Symons, Gay and Proops [16], Hamilton and Cameron [11], Labandeira and Labeaga [12], Creedy and Martin [6] and Creedy and Sleeman [7]) is to assess the distributional welfare effects that environmental taxation meant to achieve emission restrictions are having on households purchasing power. This is a purely consumption-side approach. I take a completely different stand and try to reckon the impact on industries revenue. This production-side analysis is complementary as severe drops in firms earnings would have important social consequences in terms of job losses and hence affect households purchasing power.

This would happen if not all countries commit to similar emission restrictions. In this case indeed, firms would be tempted to delocalize production –the feared 'carbon leakage'. Yet this is likely to be the case as the recent Copenhagen conference relative failure emphasized: up to now, only the European Union committed to post-2012 emission restrictions in precise figures.

Of course, not all sectors would experience revenue drop because of environmental taxation. It essentially depends on the extent to which industries are able to shift forward the tax to consumers. Therefore, in order to assess the impact on international competitiveness, a distinction should be made between competitive and non-competitive production. The I-O framework allows it since it records sectoral imports and exports. In the analysis, I am using a very basic criterion based on the output proportion that is exported outside the EU, which can of course be easily refined.

Another main difference regards the data used and the method that ensues. Previous research is based on sectoral energy use and/or emissions data and uses I-O techniques

[2]Note the approach is very different from the usual I-O taxation impact analysis that began with the seminal work of Aaron [1].

[3]Although these references are the first formal example of such approach, it was initially hinted by Bullard and Herendeen [4].

to infer the total emissions required for the consumption of final demand products. This approach requires important data on energy use and emissions for both the industry and households that may be difficult to treat, if available. The method I develop here is much more flexible and easily implementable as it solely rests on the regular I-O table of interindustry flows in monetary data, from which fossil energy use and hence emissions are derived using an energy prices vector. Limits are discussed in section three.

It is worth stressing that, despite its public policy implications, this kind of assessment of the sectoral impact of emission constraints is extremely rare in the literature[4]. As this may be related to the availability of data that was required by the previous methods, this one should allow applied economists to carry out this kind of investigation widely.

Eventually, unlike previous work, which only provide exploratory investigations using some arbitrary carbon tax level, this method incorporates emission constraints, hence initial impact, as they actually are. To this end, I use the concept of carbon value, defined as the equilibrium marginal abatement cost required to fulfill the reductions objectives. Its level comes from the PRIMES energy model, the european reference regarding energetic prospectives, that provides national economic research agencies with various output regarding energy variables[5].

2 The method

Consider an economy with n sectors. Sector i's total output in value is the sum of intermediate and final consumption. It is written

$$x_i = \sum_{j=1}^{n} x_{ij} + y_i \tag{1}$$

where x_{ij} is sector j's intermediate demand for sector i's output and y_i denotes final demand for domestic sector i's output, consisting of households consumption, investment, government consumption and exports. Equivalently, total input into sector j breaks down into intermediate consumption of domestic production, imports and value added, i.e.

$$x_j = \sum_{i=1}^{n} x_{ij} + \sum_{i=1}^{n} m_{ij} + v_j \tag{2}$$

where m_{ij} designates sector j's demand for foreign sector i's imports and v_j is added value, which is essentially made up of labor and capital remuneration. Imports and added value are usually referred to as primary inputs, as opposed to intermediate inputs x_{ij}'s. Note that by standard accounting, total output (uses) equals total input (resources).

[4] For instance, this is the very first example for Belgium. To my knowledge, such research have been carried out for the UK (Symons, Gay and Proops [16]), Canada (Hamilton and Cameron [11]), Spain (Labandeira and Labeaga [12]), Australia (Creedy and Martin [6]) and New Zealand (Creedy and Sleeman [7]) only.

[5] See Bossier et al. [3] for the most recent data for Belgium.

In the economy, the interindustry flow from sector i to sector j is linearly related to the total output of sector j. The essential assumption of I-O models regards the production technology: sectors are assumed to use inputs in fixed proportions under constant returns to scale, i.e. inputs are not substitutable. Consequently, the economy is fully described by the following set of fixed coefficients

$$a_{ij} = \frac{x_{ij}}{x_j}\ , \quad b_{ij} = \frac{m_{ij}}{x_j}\ , \quad w_j = \frac{v_j}{x_j} \qquad \text{for } i = 1, ..., n \text{ and for } j = 1, ..., n$$

which are referred to as the technical coefficients, the imports coefficients and the value added coefficient, respectively[6]. This hypothesis of fixed sectoral interdependencies is generally accepted in the short-run[7].

With this assumption, equations (1) and (2) can be re-written in terms of their sectoral relationships:

$$x_i = \sum_{j=1}^{n} a_{ij} x_j + y_i \tag{3}$$

and

$$x_j = \sum_{i=1}^{n} a_{ij} x_j + \sum_{i=1}^{n} b_{ij} x_j + w_j \tag{4}$$

Because there are n sectors, hence n equations, matrix notation is commonly used in I-O economics; under matrix form, (3) and (4) are respectively written

$$\mathbf{x} = \mathbf{A}\mathbf{x} + \mathbf{y} \tag{5}$$

and

$$\mathbf{x}' = \mathbf{x}'\mathbf{A} + \mathbf{x}'\mathbf{B} + \mathbf{x}'\widehat{\mathbf{W}} \tag{6}$$

where $\mathbf{A}$ and $\mathbf{B}$ are the n-square matrix of technical and imports coefficients respectively, $\mathbf{y}$ is the n-final demand vector, $\mathbf{w}$ the n-value added vector (the prime symbols stands for transposition while the hat above a vector name in upper case indicates a diagonal matrix of which the elements are the vector ones).

Re-arranging (5) yields the analytical formulation of the standard I-O quantity model:

$$\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\,\mathbf{y} \tag{7}$$

where $\mathbf{I}$ is the unit matrix and $(\mathbf{I} - \mathbf{A})^{-1}$ is the well-known Leontief inverse or total requirements matrix, of which the (i, j)'s element indicates the total, direct and indirect

[6] For each sector j, the associated production function -the so-called Leontief technology- takes the form

$$x_j\ (x_{ij}, m_{ij}, v_j) = \min\left(\frac{x_{ij}}{a_{ij}}, \frac{m_{ij}}{b_{ij}}, \frac{v_j}{w_j}\right) \qquad \text{for } i = 1, ..., n$$

This is nothing else than a particular case of the CES production function where factors are perfect complements.

[7] The reader who is not familiar with I-O modelling is referred to the second chapter of Miller and Blair's textbook [15].

domestic production of sector i needed for sector j to satisfy a unitary final demand. It captures the sectoral linkages between sectors[8].

Therefore, the total requirement of each sector j in product i to satisfy final demand is

$$\mathbf{T} = (\mathbf{I} - \mathbf{A})^{-1}\,\widehat{\mathbf{Y}} \tag{8}$$

Similarly, the total imports embodied in domestic production aimed at satisfying the final demand are

$$\mathbf{Z} = \mathbf{B}\,(\mathbf{I} - \mathbf{A})^{-1}\,\widehat{\mathbf{Y}} \tag{9}$$

Assume that all sectors face the same intermediates and imports prices. Then, pre-multiplying (7) and (9) by a diagonal n-matrix of which the diagonal elements are the inverse of output and imports prices respectively yields total embodiment in terms of physical quantities:

$$\mathbf{Q} = \widehat{\mathbf{P}_{\mathbf{X}}^{-1}}\,(\mathbf{I} - \mathbf{A})^{-1}\,\widehat{\mathbf{Y}} \tag{10}$$

$$\mathbf{R} = \widehat{\mathbf{P}_{\mathbf{M}}^{-1}}\,\mathbf{B}\,(\mathbf{I} - \mathbf{A})^{-1}\,\widehat{\mathbf{Y}} \tag{11}$$

Therefore, the final demand total embodiment in domestic intermediates and imports in terms of physical quantities is

$$\mathbf{Q} + \mathbf{R} = \left(\widehat{\mathbf{P}_{\mathbf{X}}^{-1}} + \widehat{\mathbf{P}_{\mathbf{M}}^{-1}}\,\mathbf{B}\right)(\mathbf{I} - \mathbf{A})^{-1}\,\widehat{\mathbf{Y}} \tag{12}$$

Pre-multiplying by a n-coefficients vector $\mathbf{e_c}$ that takes the suitable emission coefficient value for primary (fossil) energy sectors and zero otherwise, one gets the n-row vector of total industry emissions required to satisfy final demand. Eventually assume the tax on carbon emissions is fully passed on in the output price. Then, multiplying by the carbon value t, one obtains the sectoral costs increase due to emission constraints as

$$\boldsymbol{\Delta}\mathbf{c}' = t\,\mathbf{e}'_{\mathbf{c}}\left(\widehat{\mathbf{P}_{\mathbf{X}}^{-1}} + \widehat{\mathbf{P}_{\mathbf{M}}^{-1}}\,\mathbf{B}\right)(\mathbf{I} - \mathbf{A})^{-1}\,\widehat{\mathbf{Y}} \tag{13}$$

which can be expressed as a ratio to added value as

$$\frac{\boldsymbol{\Delta}\mathbf{c}}{\mathbf{v}} = \left[\widehat{\mathbf{V}^{-1}}\left(t\,\mathbf{e}'_{\mathbf{c}}\left(\widehat{\mathbf{P}_{\mathbf{X}}^{-1}} + \widehat{\mathbf{P}_{\mathbf{M}}^{-1}}\,\mathbf{B}\right)(\mathbf{I} - \mathbf{A})^{-1}\,\widehat{\mathbf{Y}}\right)\right]' \tag{14}$$

where $\mathbf{v}$ is the n-vector of added value. This is an expression for the sectoral costs increase relative to added value, which can be interpreted as the variation in industries' revenue[9]. The impact on sectors competitiveness is assessed using expression (14) together with I-O tables information on sectors imports from and exports to non-constrained economies.

[8]The successive linkages clearly appear if one recalls that, since the matrix norm of A is smaller than unity by construction, the Leontief inverse is equal to the matrix expansion $\mathbf{I} + \mathbf{A} + \mathbf{A}^2 + \mathbf{A}^3 + ...$ where the successive terms are the Keynesian effects of final demand on production.

[9]Note revenue is view here in the wide sense of turnover; a better measure for earnings drop could be obtained easily by subtracting labor remuneration.

3 Application to Belgium

3.1 Data

I have used the most recent quinquennial I-O table available for Belgium, which describes the Belgian economy in 2000 and has the 143 × 143 format[10]. Interindustry flows are expressed in monetary value. Sectors are identified with FPB codes, which roughly corresponds to NACE-Bel rev.1.1.

Belgium's position regarding primary fossil energy is particular as it has no fossil fuel resources, hence all the primary fossil energy is imported[11]. The products considered for fossil energy imports are coal and lignite, crude petrol, coke, refined petroleum products and gas. The main source for the construction of the vector of energy prices as they were in 2000 is the International Energy Agency, while the source for the emission coefficients is the Intergovernmental Panel on Climate Change. Data treatment is extensively detailed in the research mentioned above on which this paper builds [10].

The carbon value corresponds to the objectives set by the European Union in its Energy/Climate Package. In this scenario, the EU independently commits to a twenty percent cut of its emissions by 2020 compared to 1990 levels, as well as to a twenty percent share of renewable energy in gross final energy demand and a twenty percent-increased energy efficiency. The corresponding carbon value amounts to EUR 33.5/tCO_2 (see Bossier et al. [3] for more information).

Finally, I have improved the method in the Belgian context by reckoning in the price increase of imported electricity. Belgium is indeed a net electric power-importing country. As imported electricity comes from France and Germany, emission constraints put up its price. This increase has been estimated by Federal Planning Bureau and I have taken it into account in sectors direct and indirect use of imported electric power.

3.2 Results

Before dealing with the results, it is worth mentioning that the estimation of total carbon emissions obtained with this method (some 180 millions of tons) is in the same order of magnitude as the inventory by the Belgian National Climate Commission (about 130 millions of tons). The large exportations of products embodied with carbon that isn't burnt yet (see below) probably account for an important part of the difference. However, this method's main advantage compared to what has been done at the macro level lies in its sectoral disaggregation, hence the results should be interpreted in relative rather than absolute terms.

Gross results appear in Table 1. The results of the calculation of expression (14) for Belgium are displayed in the first column. The second column contains data on sectors outside-European Union exports share, while sectoral employment appears in the third

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[10]This table is used with the courtesy of Federal Planning Bureau. It is not published owing to data confidentiality. The official publication has a 60 × 60 format.

[11]Note it simplifies expression (14) to $\frac{\mathbf{\Delta c}}{\mathbf{v}} = \left[\widehat{\mathbf{V}^{-1}}\left(t\ \mathbf{e}_{\mathbf{c}}'\widehat{\mathbf{P}_{\mathbf{M}}^{-1}}\left(\mathbf{I}-\mathbf{A}\right)^{-1}\widehat{\mathbf{Y}}\right)\right]'$.

one. Total, direct and indirect (or 'cumulative') sectoral employment is computed thanks to the Leontief inverse[12] and reported in column four. Employment statistics are recorded in full-time job equivalents. The last column contains data on sectoral production as a share of gross national product.

TABLE 1 HERE

As expected, manufacture's revenue is the most affected, with a eight-percent decrease on average. Transportation sectors are logically also strongly affected. Construction and trade come next. Services, in general, suffer less. Note that the impact on agriculture is relatively low, but it doesn't take into account other GHG gases of which the emission might be constrained soon too.

Table 2 brings together the sectors of which the revenue are seriously hit. Many of the worst affected sectors take part to the EU emission trading scheme: refinery, chemical, iron and steel, mineral industries, as well as electric power generation. Other affected industries include the different sectors of food-processing, transports, fishing and building, as well as rubber and plastic industries.

Note that the manufacture of refined petroleum products is a special case. Indeed the method is based on total fossil energy embodiment, but an important portion of the energy embodied in refined petroleum products is not burnt yet, hence did not generate emissions. Therefore, the enormous figure for that industry's revenue change has no relevance. However, its revenue is likely to actually experience a significant drop since refineries usually burn five to ten percent of refined petroleum products as auto-consumption.

TABLE 2 HERE

As stressed above, production costs increase should be examined together with international exposure to competitive products in order to assess the impact on competitiveness. Therefore I have defined a very basic criterion of international exposure: sectors that export more than ten percent of their production outside the EU *and* of which the revenue decreases by more than five percent are said to be in jeopardy; sectors of which the outside-EU exports amount to more than five percent of production *and* of which the revenue decreases by more than three percent are named 'threatened'. Table 3 displays these sectors.

The analysis shows that several manufacture sectors undergo a severe loss of international competitiveness. They combine energy-intensive production structure and high exportation rate. It is the case for refineries, steel and iron factories and chemical factories, as well as glass and ceramic factories to a lesser extent. It turns out that, among these sectors that take part to the European emission trading scheme, situations are contrasted. Some some of them, like cement production, are much less affected than

[12] Cumulative employment per sector is estimated as $\mathbf{l}'\left(\mathbf{I}-\mathbf{A}\right)^{-1}\widehat{\mathbf{Y}}$ where $\mathbf{l}$ is the n-vector of sectoral employment.

others because they mainly export inside the EU. Being able to distinguish between sectors is especially important when it comes to deciding wether some sectors should be grandfathered their emission permits to avoid a loss of competitiveness.

It also appears that the competitiveness of textiles and food-processing sectors is threatened. This new result was not really expected, even though the food industry is notably energy-guzzling, but should provide food for thought to policy makers.

Eventually, note that, although satisfying the exposure criterion, transportation sectors are a special case as competitors whose headquarters are located in a non-constrained area would also face emissions taxation when operating in constrained areas. However, increased transport prices further penalize exports, which is not accounted for here.

TABLE 3 HERE

Eventually, cumulative employment for each sector gives an idea of how many jobs are directly and indirectly concerned by the impact that emission constraints have on competitiveness. This analysis' estimations show that the affected sectors account for about three hundred thousand jobs, making up more than five percent of Belgian GDP.

Note the competitiveness side of the analysis is very basic as it only rests on expression (14) and the simple exports criterion the $\frac{\sum_{z\in NC} e_{iz}}{y_i}$ where NC is the group of non-constrained areas z. It should be refined by accounting for competitive imports with a criterion of the type $\frac{\sum_{z\in NC}\sum_j m_{ijz}}{\sum_j m_{ij}+x_{ij}}$. Another interesting approach would be to assume that domestic output and competitive products from non-constrained areas are imperfect substitutes and use estimated price elasticities of demand to infer volume variation from price change computed from (13). This is still work in progress.

3.3 Limits

They are a few conceptual limits inherent to I-O modeling, which prompts to some cautiousness with the interpretation of the results.

As mentioned earlier, the method is about assessing the impact in the short-run only. Indeed, in the longer term, the tax-induced relative prices change produces inputs substitution –which is the very objective of emissions taxation–, therefore invalidating I-O fundamental hypothesis of constant input coefficients.

Furthermore, the carbon tax concept, although convenient, probably overstates the sectoral costs increase for economies where energy-efficiency is low. Indeed, it is assumed that all emissions are paid for and none are abated in the short-run. While this is likely to be the case in developed economies where industries are energy-efficient and where energy demand is inelastic in the short-term, there is probably room for immediate cheap abatements in less developed economies.

More problematic is the asymmetry between domestic and imports inputs markets implied by the modeling method. Indeed, it is implicitly assumed that the tax burden is fully shifted towards demand for domestic output, hence domestic producers are pricemaker[13]. In contrast, imports embodiment in carbon dioxide, henceforth potential import prices increase due to carbon taxation, is ignored. Therefore, foreign producers are assumed to be price-takers[14].

4 Conclusion

The purpose of this paper has been the assessment of the impact of emission constraints on sectors international competitiveness. To this end, novel per se, I have developed an original, flexible I-O based method. Its application to Belgium found that the international competitiveness of refinery, chemical and steel industry is badly affected as expected, but it also showed that food-processing and textiles are severely hit too, which is a new result. The method has also allowed to estimate that about three hundred thousand jobs are concerned by loss of competitiveness due to emission constraints.

Both the method and the application could be refined. Regarding the method, further research should tackle the issue of the asymmetry between domestic and foreign inputs markets. From the application side, the international exposure criterion should definitely be improved to account for exposure to competitive imports, which could be easily implemented using standard I-O tables.

Despite these limits, I hope this paper demonstrates that meaningful information about sectors competitiveness can be derived by an I-O analysis of emission constraints. This should be of definite relevance for economic policy.

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[13] As already mentioned, this depends on international exposure to competitive products. This is the reason why I use an imports/exports-based criterion together with expression (14) for industries revenue change in order to reckon the impact on competitiveness.

[14] Again, the extend to which imports prices would increase if facing carbon taxation depends on exposure to competitive products. The question of whether they face carbon taxation depends on where the inputs come from, namely a constrained or non-constrained area.

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Table 1. Sectors revenue change, cumulative employment and other statistics : gross results for Belgium.

FPB	Industry	$\Delta c / v$	Exports outside EU	Direct empl.	Cumul. empl.	Gross Product
		%	*% output*	*jobs*	*jobs*	*% GDP*
01A1	Agriculture and hunting	1,57 %	1,68 %	98 018	39 057	1,41 %
02A1	Forestry and logging	1,24 %	5,46 %	2 456	880	0,07 %
05A1	Fishing and fish farms	11,43 %	1,12 %	1 057	696	0,03 %
10A1	Mining of coal and lignite	0,80 %	0,27 %	60	44	0,00 %
11A1	Extraction of crude petroleum and natural gas	0,00 %	0,00 %	0	0	0,00 %
12A1	Mining of uranium ores	-	0,00 %	0	0	0,00 %
13A1	Mining of metal ores	5,79 %	16,76 %	145	232	0,00 %
14A1	Other mining and quarrying	5,19 %	28,21 %	5 140	4 492	0,22 %
15A1	Production, processing and preserving of meat	3,12 %	6,45 %	18 099	67 997	0,40 %
15B1	Processing and preserving of fish	4,50 %	4,98 %	1 319	2 608	0,03 %
15C1	Processing and preserving of fruit and vegetables	3,00 %	10,54 %	6 159	13 572	0,17 %
15D1	Manufacture of oils and fats	1,49 %	8,56 %	636	5 446	0,03 %
15E1	Manufacture of dairy products	2,92 %	7,88 %	6 363	24 703	0,15 %
15F1	Manufacture of grain mill and starch products	2,66 %	9,42 %	1 686	8 225	0,05 %
15G1	Manufacture of animal feeds	0,71 %	2,67 %	2 828	4 032	0,09 %
15H1	Manufacture of bread, pastry, biscuits and cakes	1,70 %	3,78 %	33 047	41 325	0,46 %
15I1	Manufacture of sugar, cocoa, chocolate and sugar confectionery	2,19 %	9,92 %	6 003	12 774	0,28 %
15J1	Manufacture of pasta and farinaceous products; tea and coffee	1,50 %	4,46 %	6 843	9 629	0,21 %
15K1	Manufacture of beverages, except water and soft drinks	1,84 %	6,36 %	6 075	8 263	0,30 %

15L1	Production of water and soft drinks	2,17 %	10,97 %	3 742	7 380	0,14 %
16A1	Manufacture of Tobacco products	0,95 %	1,18 %	1 185	3 005	0,05 %
17A1	Preparation, spinning, weaving and finishing of textiles	3,00 %	18,63 %	19 267	19 842	0,40 %
17B1	Manufacture of textiles, except apparel	2,21 %	22,25 %	21 639	32 956	0,41 %
18A1	Manufacture of wearing apparel and fur	1,66 %	8,57 %	9 344	14 576	0,13 %
19A1	Manufacture of leather, luggage and footwear	1,43 %	12,55 %	2 650	2 795	0,04 %
20A1	Manufacture of wood and wooden products	1,31 %	5,14 %	15 135	11 056	0,31 %
21A1	Manufacture of pulp, paper and paper products	2,04 %	7,25 %	16 296	17 428	0,57 %
22A1	Publishing of recorded media	1,15 %	1,99 %	9 727	15 797	0,38 %
22B1	Printing and reproduction of recorded media	0,45 %	1,20 %	26 606	7 270	0,62 %
23A1A	Manufacture of coke products	20,21 %	16,36 %	54	80	0,00 %
23A1B	Manufacture of refined petroleum products	74,10 %	13,86 %	3 048	14 276	0,31 %
23A1C	Processing of nuclear fuel	0,32 %	17,39 %	780	1 291	0,07 %
24A1	Manufacture of basic chemicals	12,55 %	21,80 %	22 719	53 182	1,90 %
24B1	Manufacture of pesticides and agro-chemical products	1,87 %	17,94 %	1 039	3 515	0,05 %
24C1	Manufacture of paints, varishes, printing ink and mastics	0,72 %	19,88 %	3 782	4 174	0,14 %
24D1	Manufacture of pharmaceuticals	1,04 %	21,08 %	13 296	23 400	0,79 %
24E1	Manufacture of soap and detergents; cosmetics	2,25 %	16,11 %	5 454	9 523	0,18 %
24F1	Manufacture of other chemical products	4,48 %	19,98 %	12 652	15 493	0,68 %
24G1	Manufacture of man-made fibres	3,15 %	20,14 %	2 027	2 579	0,06 %
25A1	Manufacture of rubber products	3,09 %	13,76 %	3 392	4 639	0,10 %
25B1	Manufacture of plastic products	2,26 %	11,46 %	26 730	27 960	0,73 %
26A1	Manufacture of glass and glass products	4,26 %	9,44 %	11 222	14 047	0,34 %
26B1	Manufacture of ceramic products	4,85 %	5,13 %	4 766	2 534	0,10 %
26C1	Manufacture of cement, lime and plaster	6,24 %	3,87 %	2 516	1 867	0,20 %
26D1	Manufacture of concrete, plaster, cement and stone products	1,42 %	3,29 %	16 125	7 650	0,38 %
27A1	Manufacture of basic iron and steel and ECSC ferro-alloys	15,01 %	12,29 %	21 162	38 022	0,84 %
27B1A	Other first processing of iron and steel and non-ECSC ferro-alloys	2,76 %	9,68 %	3 981	4 691	0,17 %

27B1B	Manufacture of non-ferrous metals	2,12 %	12,16 %	8 325	17 512	0,33 %
27B1C	Casting of metal	0,00 %	0,00 %	1 237	0	0,07 %
28A1	Man. of structural met.; forging, pressing, stamping and roll forming	0,90 %	3,81 %	32 571	22 204	0,69 %
28B1	Treatment and coating of metal	0,00 %	0,00 %	15 552	13	0,27 %
28C1	Manufacture of cutlery, tools, general hardware and other	2,10 %	9,25 %	17 071	17 759	0,40 %
29A1	Man. of machinery for the prod. and use of mechanical power	1,06 %	29,28 %	6 805	14 073	0,38 %
29B1	Manufacture of other général purpose machinery	1,40 %	19,87 %	15 907	22 922	0,41 %
29C1	Manufacture of agricultural and forestry machinery	2,20 %	19,55 %	26 430	49 930	0,68 %
29D1	Manufacture of domestic appliances	3,51 %	14,63 %	2 556	4 242	0,06 %
30A1	Manufacture of office machinery and computers	1,38 %	14,28 %	4 746	10 892	0,23 %
31A1	Man. of elec. motors, gen. and transf., distrib. and contr. app., wire	0,95 %	10,66 %	13 040	12 381	0,39 %
31B1	Man. of accus, primary cells and batteries, lighting equip., lamps	1,43 %	16,26 %	18 234	19 229	0,50 %
32A1	Man. of radio, télévision and communication equip. and app.	1,01 %	27,09 %	11 975	26 003	0,50 %
33A1	Man. of medical, precision and optical instr.; watches and clocks	1,19 %	12,62 %	9 790	11 699	0,21 %
34A1	Manufacture of motor vehicle	1,09 %	15,66 %	32 822	79 309	0,96 %
34B1	Manufacture of parts and accessories for motor vehicles	0,84 %	13,47 %	15 543	20 426	0,43 %
35A1A	Building and repairing of ships and boats	0,87 %	8,56 %	1 007	942	0,06 %
35A1B	Manufacture of railway and tramway locomotives and rolling stock	2,47 %	4,49 %	1 889	3 812	0,00 %
35A1C	Manufacture of aircraft and spacecraft	0,98 %	26,96 %	7 135	9 431	0,22 %
35B1	Manufacture of motorcycles and bicycles	2,69 %	15,10 %	547	775	0,01 %
36A1	Manufacture of furniture	2,04 %	18,12 %	22 336	27 349	0,40 %
36B1	Manufacture of jewellery	0,33 %	42,79 %	3 072	4 293	0,06 %
36C1	Man. of musical instr., sport goods, games, toys; miscellaneous	3,86 %	15,44 %	3 563	2 316	0,08 %
37A1	Recycling	-	0,00 %	0	0	0,00 %
40A1A	Electric power generation	9,82 %	0,05 %	16 264	12 151	1,95 %
40A1B	Manufacture of gas	0,95 %	0,22 %	1 799	2 299	0,41 %
41A1	Collection, purification and distribution of water	0,95 %	0,00 %	6 337	3 566	0,28 %
45A1	Site preparation	0,89 %	0,49 %	5 383	960	0,16 %

45B1A	Building of complete constructions or parts; civil engineering	3,29 %	0,52 %	88 987	172 398	1,80 %
45B1B	Erection of roof covering and frames	0,74 %	0,02 %	8 970	4 665	0,27 %
45C1A	Construction of highways, roads, airfields and sport facilities	2,66 %	0,16 %	20 459	20 296	0,51 %
45C1B	Construction of water projects	3,88 %	6,94 %	4 282	4 444	0,14 %
45C1C	Other construction	0,82 %	0,89 %	16 585	4 212	0,20 %
45D1	Building installation	0,45 %	0,11 %	49 919	20 540	1,17 %
45E1	Other building completion	0,92 %	0,13 %	48 587	28 318	1,06 %
50A1	Vente, entretien, rép. de véhicules auto, équipements, motocycles	2,85 %	2,71 %	83 051	88 856	1,66 %
50B1	Vente au détail de carburants	4,93 %	0,00 %	7 714	11 762	0,11 %
51A1.A	Vente en gros de combustibles	2,34 %	14,00 %	16 118	29 656	0,74 %
51A1.B	Autres commerces de gros	1,27 %	8,47 %	209 161	180 887	6,78 %
52A1	Ventes au détail et réparation d'articles domestiques	2,61 %	0,00 %	274 547	328 152	2,74 %
55A1	Services d'hôtellerie et d'hébergement	1,72 %	7,13 %	21 159	23 473	0,47 %
55B1	Restaurants, cafés, cantines, traiteurs	1,91 %	0,78 %	129 352	126 297	1,37 %
60A1	Transports ferroviaires	1,21 %	1,51 %	33 438	25 133	0,68 %
60B1	Transports réguliers de voyageurs, taxis et autres	3,89 %	0,16 %	27 805	19 715	0,52 %
60C1	Transp. routiers de march., déménagements, transp. par conduites	5,17 %	6,83 %	62 820	36 350	1,46 %
61A1	Transports maritimes et côtiers	6,10 %	40,86 %	2 124	9 008	0,04 %
61B1	Transports fluviaux	5,54 %	12,10 %	2 783	977	0,04 %
62A1	Transports aériens	13,61 %	21,74 %	10 317	14 562	0,06 %
63A1	Service d'agences de voyage et tour opérateurs	7,45 %	0,02 %	8 478	25 669	0,14 %
63B1	Serv. de manutention et entrep., org. du transp. de fret et autres	2,98 %	12,74 %	33 743	48 847	1,19 %
64A1	Activités postales	0,40 %	5,42 %	53 322	12 540	0,87 %
64B1	Télécoms	1,12 %	4,50 %	29 132	25 886	1,73 %
65	Intermédiation financière	0,58 %	0,67 %	56 532	77 718	*n.d .*
66	Assurance	0,72 %	1,70 %	27 263	46 623	1,24 %
67	Services d'auxiliaires financiers et d'assurance	0,38 %	5,38 %	58 624	33 063	2,09 %
70	Services immobiliers	0,44 %	0,15 %	14 044	35 891	10,62 %

71A1	Location de véhicules et autre matériel de transport	0,41 %	1,04 %	2 304	1 285	0,69 %
71B1	Location de machines et équipement et autres	0,50 %	0,86 %	7 146	821	0,65 %
72A1A	Conseil, programmation, implémentation, traitement des données	1,55 %	8,60 %	47 572	47 930	1,25 %
72A1B	Entretien et réparation de matériel informatique	0,34 %	3,47 %	6 367	2 459	0,32 %
73	Recherche et développement	2,73 %	15,79 %	10 680	15 322	0,30 %
74A1	Services juridiques, comptables, études de marché et sondages	0,44 %	3,66 %	84 088	21 069	1,73 %
74B1	Conseil business, gestion et administr. de holdings et c. de coord.	0,50 %	12,53 %	32 607	28 877	4,11 %
74C1	Conseil technique, architect., ingéniérie, essais et analyses techn.	0,60 %	8,64 %	67 707	43 333	0,80 %
74D1	Publicité	0,10 %	1,80 %	27 357	4 331	0,35 %
74E1	Sélection et fourniture de personnel	0,01 %	0,59 %	118 061	2 085	1,52 %
74F1	Enquêtes et sécurité, nettoyage industriel, divers	0,40 %	2,08 %	150 285	19 050	1,31 %
75	Services d'administration publique	1,66 %	0,00 %	396 090	439 604	7,79 %
80	Education	0,73 %	0,00 %	337 667	343 423	6,49 %
85	Services de santé et d'action sociale	1,50 %	0,65 %	379 357	426 576	6,80 %
90	Assainissement, voirie et gestion des déchets	2,13 %	0,22 %	9 433	5 435	0,34 %
91	Services fournis par les organisations associatives	2,08 %	0,00 %	35 419	27 608	0,62 %
92	Services récréatifs, culturels et sportifs	1,72 %	1,16 %	55 583	67 974	1,34 %
93	Services personnels	4,05 %	0,00 %	59 815	50 542	0,42 %
95	Services domestiques	0,00 %	0,00 %	82 982	82 982	0,54%
99	Services extra-territoriaux	-	-	-	-	-

Table 3. Sectors of which the international competitiveness is affected : Belgium.

FPB	Industry	Direct empl.	Cumul. empl.	Gross product.
		jobs	*jobs*	*% GDP*
	Sectors in jeopardy			
13	Mining of metal ores	145	232	0,00 %
14	Other mining and quarrying	5 140	4 492	0,22 %
23A1.A	Manufacture of coke products	54	80	0,00 %
23A1.B	Manufacture of refined petroleum products	3 048	14 276	0,31 %
24A1	Manufacture of basic chemicals	22 719	53 182	1,90 %
24F1	Manufacture of other chemical products	12 652	15 493	0,68 %
27A1	Manufacture of basic iron and steel	21 162	38 022	0,84 %
	Total	*64 920*	*125 777*	*3,94 %*
	Threatened sectors			
15A1	Production, processing and preserving of meat	18 099	67 997	0,40 %
15B1	Processing and preserving of fish	1 319	2 608	0,03 %
15C1	Processing and preserving of fruit and vegetables	6 159	13 572	0,17 %
15E1	Manufacture of dairy products	6 363	24 703	0,15 %
17A1	Preparation, spinning, weaving and finishing of textiles	19 267	19 842	0,40 %
24G1	Manufacture of man-made fibres	2 027	2 579	0,06 %
25A1	Manufacture of rubber products	3 392	4 639	0,10 %
26A1	Manufacture of glass and glass products	11 222	14 047	0,34 %
26B1	Manufacture of ceramic products	4 766	2 534	0,10 %
27B1.A	Other first processing of iron and steel	3 981	4 691	0,17 %
29D1	Manufacture of domestic appliances	2 556	4 242	0,06 %

35B1	Manufacture of motorcycles and bicycles	547	775	0,01 %
36C1	Man. of music. instr., sport goods, games, toys; misc.	3 563	2 316	0,08 %
45C1.B	Construction of water projects	4 282	4 444	0,14 %
	Total	*87 543*	*168 989*	*2,21 %*
	Total	**152 463**	**294 766**	**6,15 %**