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Quantifying environmental leakage for Belgium

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Abstract – This paper illustrates the deficiency of the production approach as a tool to measure a country's responsibility for international environmental impacts. A use approach is presented as a more suitable tool. The difference between the two approaches is determined by a better grasp of international trade, which can lead to environmental leakage when a country specialises in the production of environmentally friendly products and has the environmentally unfriendly products which it consumes produced abroad. We show that in the period 1995-2002 Belgium was on average a provider of air emission intensive products for the rest of the world. Environmental leakage was mostly negative. However, the evolution of the Belgian environmental terms of trade shows that by 2002 its imports had become considerably more air emission intensive with respect to its exports than in 1995. There are indications that this evolution is due to a considerable increase of extra-EU imports of air emission intensive products. This in turn could point to environmentally inspired offshoring. However, the currently available data do not allow us to test this hypothesis.

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Executive Summary

Several international environmental problems, of which the most well-known is global warming, are tackled by means of production linked emission abatement targets, like the ones specified in the Kyoto protocol with respect to the reduction of greenhouse gas emissions. A possible problem that may arise with such production linked emission abatement targets is that some industries in countries involved in such policies might consider the costs of these policies too much of a burden and choose to move environmentally harmful production processes (or parts thereof) to countries where environmental commitments are less binding.

In order to control as much as possible for such an environmentally inspired offshoring of productive activities, one could embrace a use approach, and consider the emissions linked to domestic use, instead of calculating emissions linked to domestic supply, as it is currently done. We calculate air emissions linked to domestic use for Belgium in the period 1995-2002, and compare these emissions with air emissions linked to production as available in the NAMEA Air for Belgium. The difference between both approaches is equal to the balance of embodied emissions in trade (BEET). The BEET is also equal to the difference between emissions linked to imports and emissions linked to exports. Values for the emissions linked to trade are obtained by means of input-output analysis.

Dividing the balance of embodied emissions in trade by the emissions linked to production results in percentage values for environmental leakage (EL)[1]. When EL for a particular country is positive this implies that the products used in this country are more environmentally harmful to produce than the entire spectrum of products it produces itself. When EL is negative the opposite is true. Our calculations show that environmental leakage was quite important for Belgium during the observation period. Values varied considerably across the different pollutants and over the years, with a low of -18% for lead in 2001 and a high of +23% for NH_3 in 2002. The majority of the values for the balance of embodied emissions in trade, and thus of environmental leakage, were negative. This implies that Belgium acted as a producer of environmentally harmful products for the rest of the world.

The input-output analysis enables us to pinpoint the industries of which the output was responsible for environmental leakage, be it negative or positive. The few cases of positive leakage were mainly caused by industries such as agriculture and forestry. Turning to the pollutants for which the environmental leakage was negative, we first focus on the pollutant that has received the broader media coverage across all pollutants, CO_2. The average negative leakage of 6% was mainly caused by four industries, the basic metals industry, the chemical industry, the

1 In political circles the term "environmental leakage" is often used when in fact "environmentally inspired offshoring" is the subject of the discussion. Environmental leakage refers to a state of the production and trade pattern, while environmentally inspired offshoring refers to a movement of productive activities.

other non-metallic mineral products industry, and land transport. The exports of these four industries contain more CO_2 than is embodied in the imports from their foreign competitors. As concerns the fluorinated greenhouse gases which are also considered in the context of the Kyoto protocol, we notice that for SF_6, the other non-metallic mineral products industry determined the negative environmental leakage for Belgium. For HFCs the most important industries were the trade sector (NACE 50-52), land transport, and the chemical industry. As for the negative environmental leakage of the fluorinated gases which are controlled by the Montreal Protocol, the most important industries were the recycling industry for CFCs, and the rubber and plastic products industry for HCFCs. As regards the acidifying emissions for which a negative environmental leakage was registered, we remark that for NO_x land transport was the most important industry. For SO_x the industries determining the negative Belgian environmental leakage were mainly the coke, refined petroleum and nuclear fuel industry, the other non-metallic mineral products industry, and the basic metals industry. As concerns the photochemical emissions other than NO_x, for NMVOCs the chemical industry was the most important determinant of the negative environmental leakage. For CO the basic metals industry was the determining factor. The latter was also the case as concerns emissions into the air of lead.

During the period 1995-2002 Belgium was on average a producer of "dirty" goods for the rest of the world. However, over the observation period a distinct change has taken place. By 2002 the picture had changed, and environmental leakage turned positive for more types of air pollution than before. An analysis of the Belgian environmental terms of trade, showing the relative air emission intensiveness of exports with respect to imports, shows that whereas earlier Belgian exports were in general more air emission intensive than imports, in 2002 this was no longer true. There is a clear tendency for Belgian imports to become more air emission intensive. This evolution is accompanied by a succinct increase in the share of extra- EU imports in total imports. This might be interpreted as an indication of environmentally inspired offshoring, with air emission intensive activities moving to places outside of the EU, where environmental rules are less stringent. However, the available data do not allow us to check whether environmental concerns are indeed the driver behind the change in the import composition or whether the change in air emission intensiveness is just the result of changes in trade patterns driven by other motivations. In order to substantiate the environmentally inspired offshoring interpretation import figures ought to be disaggregated further according to their geographical origin, and changes in the import composition ought to be confronted with a quantitative database on environmental regulation by country.[2] Furthermore, more recent data are necessary in order to confirm that the observed increase of the emission intensiveness of imports was not just a temporary phenomenon, as rather a stable trend.

2 A database comparable to the one created by the European Bank for Reconstruction and Development in order to track market reforms and liberalisation in Eastern European countries seems highly desirable for this purpose.

Contents

List of tables

Introduction

It is common knowledge that many environmental problems are not limited by national boundaries. The most well known example is global warming, mainly caused by carbon dioxide emissions.[1] In order to tackle this problem a lot of countries have signed the 1997 Kyoto protocol, and taken up the obligation to decrease their emissions of greenhouse gases. In order to monitor the progress with respect to this objective the Kyoto greenhouse gas index was created. This indicator shows the amount of greenhouse gases emitted within the boundaries of a particular country. As concerns emissions by industries it is thus linked to production. This production-based approach refers to the emissions associated to the domestically produced commodities and services, whether to be used domestically or to be exported. A similar approach is used for other air pollutants, like the acidifying and photochemical pollutants, for which abatement targets have been agreed in the Convention on Long-range Transboundary Air Pollution (the 1999 Gothenburg protocol), and for which the European Union has set equally or more ambitious targets in the 2001 National Emission Ceilings directive.

A possible problem that may arise with such production linked emission abatement targets is that some industries in countries involved in such policies choose to move environmentally harmful production processes (or parts thereof) to countries where environmental commitments are less binding.[2] This might lead to changes in imports and exports of the home country of these companies. Since they are no longer produced within the confines of the home country's own territory, the from a production viewpoint environmentally harmful products now have to be imported in order to satisfy domestic demand, while at the same time exports in order to satisfy foreign demand for such products decrease, as foreign consumers will need to turn to the country to which production has been relocated. These changes in the trade pattern lead to changes in the level and possibly the sign of what is known as "environmental leakage" (EL), or in the context of the Kyoto protocol "carbon leakage".[3] This so-called EL is, in fact, the subject of the present analysis. EL shows if and to what extent there is a difference between the environmental impact of a country's production on the one hand and of its domestic use on the other.

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1 Besides global warming, there also are other environmental concerns of an international nature such as acid rain or ozone layer depletion, for instance.

2 Evidently, if all countries in the world would sign up to the international emission reduction agreements no such evasive behaviour would be possible, unless it would be allowed by the agreement itself. At present such worldwide participation is not a reality. A recent survey by Point Carbon consequently showed that 17% of European companies had relocated or were considering doing so because of the cost of carbon emissions. Source: ENDS Europe Daily 2502 of 11/03/2008 on the report "Carbon 2008 – Post-2012 is now" by Point Carbon. In addition, Cole (2004) shows that sector pollution abatement costs are found to be a determinant of the increasing share of imports in domestic consumption in the United States.

3 Relocation of environmentally harmful production activities as a consequence of domestic firm production location choices, whether it be by means of delocalisation or by means of outsourcing, is not the only source of changes in environmental leakage. Such changes can also be the consequence of the demise of environmentally harmful production activities in the home country, with domestic firms simply going bankrupt, and their place in the domestic market being taken over by foreign firms.

Environmentally inspired offshoring of productive activities is a matter of serious concern to EU politicians currently discussing the legislative proposals on climate and energy which are to guide the EU countries through the third phase of the EU's greenhouse gas emission trading scheme running from 2013 to 2020. Indeed, various studies have raised the possibility that greenhouse gas emission policies implemented in industrialized countries and countries in transition bound by the Kyoto Protocol (the so-called Annex I countries) could lead to an increase in "carbon leakage".[4] The Kyoto commitments of these countries could then be less effective or totally ineffective in stabilizing global emissions. This would happen, for instance, if industries of the Annex I countries reduce their greenhouse gas emissions "artificially" by simply stopping to produce carbon-intensive goods and import them from countries that have not taken up any strictly binding commitments to reduce their greenhouse gas emissions.

An important question for European policy makers is thus what steps ought to be taken to prevent Europe's energy- and carbon-intensive industries from relocating (part of) their production activities to countries that do not take on any obligation to decrease emissions in the context of a new climate agreement.[5] One answer could be to question the way in which countries' environmental performance is measured, in the sense that the net impact of international trade on the environment ought to be integrated in the evaluation of their performance.[6] From a macroeconomic standpoint this latter issue is crucial since international trade is the channel through which importing countries may transfer the environmental load of producing environmentally harmful goods to exporting countries. Hence, instead of calculating emissions linked to domestic production, as it is currently done, one could consider the emissions linked to domestic use instead. Domestic use includes both the use of domestically produced products and of imported products, while it excludes exports. This implies that emissions linked to all exports need to be deducted from and emissions linked to all imports need to be added to emissions linked to final demand for domestic products. When emission targets are formulated along this domestic use approach it will thus no longer be possible to achieve these targets by simply moving production to countries which have less stringent environmental rules. What's more, linking emissions to domestic use may even provide an incentive for governments to stimulate enterprises and households to buy products from the least polluting source. In turn this might provide an incentive to producers worldwide to apply the most environmentally friendly production process, and search themselves for the most environmentally friendly suppliers of intermediate

4 See for instance Ahmad & Wyckoff (2003) and Ghertner & Fripp (2007).

5 Recently European Commission president Barroso stated that the text of the revised EU emission trading scheme directive will include clear safeguards against increased carbon leakage (See: ENDS Europe Daily 2505 of 14/03/2008)

6 As stressed by Machado & al. (2001), the net impact of international trade is basically the outcome of three different environmental impacts associated with international trade: (i) the scale effect, which is related to positive impacts of international trade on economic growth, and as such increases environmental damage; (ii) the composition effect, which is related to positive / negative impacts of international trade on the industrial structure due to the choices in terms of trade specialization of countries; (iii) the technical effect, which is related to the positive impacts of international trade on production efficiency, and as such is anticipated to reduce environmental damages. In the context of our analysis the composition effect is most relevant.

goods. As such the domestic use approach could be the basis of a virtuous circle of environmentally friendly competition.[7]

The concept of environmental leakage (EL) is intimately intertwined with the domestic use approach. The difference between emissions calculated by means of the domestic use approach and emissions obtained by means of the production approach is equal to the balance of embodied emissions in trade (BEET), that is to say, the difference between emissions embodied in imports and emissions embodied in exports.[8] The ratio between the BEET and air emissions based on the production approach then gives the percentage value for EL.

The present analysis calculates EL of air emissions for Belgium over the period 1995-2002. The level of this indicator tells us whether and to what extent Belgium was a net exporter of different types of air pollution. A sectoral analysis pinpoints the industries the output of which determined EL for Belgium.

In order to determine whether international shifts of polluting activities have taken place during the period under consideration another concept is introduced, namely the environmental terms of trade (eTT). The eTT are an expression of the relative emission intensiveness of exports with respect to the emission intensiveness of imports. In order to interpret changes in the eTT as being caused by international shifts of polluting activities it is necessary to exclude other sources of change than changes in trade flows. This implies that emissions embodied in exports and imports both need to be calculated on the basis of the same production structure and pollution coefficients. Since data on the domestic production structure and pollution coefficients can be expected to be most readily available, the obvious choice to make is to apply the latter not only to exports but also to imports. As such calculated emissions embodied in imports can be interpreted as avoided domestic emissions. This avoided emissions approach, as a special case of the domestic use approach, makes it possible to interpret the evolution of the eTT of a country as an indicator of the degree to which environmental offshoring is taking place. This environmental offshoring might, amongst other factors, be stimulated by differences in environmental legislation in different parts of the world. Because in general environmental legislation concerning air emissions outside of the EU can be considered to be more lenient than within the EU, we use the difference in the evolution of extra- EU imports on the one hand and of intra- EU imports on the other, as an indication of whether this has indeed been the case.

The remainder of the paper is organized as follows. Part 1 reviews the theoretical framework. Part 2 describes the data. In part 3 the results for the BEET and EU in Belgium are discussed. As for part 4, it analyses the results concerning the eTT.

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7 In order to apply this method in practice one would need to have both input output tables and emission coefficients for all countries in the world, plus the political acceptance of these statistical tools by all countries. Presently, these conditions are clearly not fulfilled. This is one of the main reasons why the objectives formulated in the context of the existing international emission reduction agreements are of a territorial nature.

8 This is in accordance with the definition provided by Muradian et al. (2002)

1. Theoretical Framework

The first section briefly sketches the background of environmental input-output analysis. Section two shows how this technique can be used to allocate emissions to exports and imports.

1.1. Background

The production of goods and services in a given economy triggers the emission of a certain amount of air pollutants. In order to determine which products are responsible for which part of these emissions, basically two types of analysis are used. A first type is Life Cycle Analysis (LCA). This kind of analysis dissects the life cycle of certain products in a detailed way, registering all emissions linked to the production process, the use and the disposal of the product. However, due to the level of detail involved it is impossible to perform this kind of analysis for an entire economy. Furthermore, LCA studies are unable to take into account the whole chain of indirect environmental effects instigated by the need to produce intermediate goods in order to obtain the final good which is the subject of the LCA. In each LCA study specific boundaries have to be drawn up determining the limits of the indirect effects taken into account. The second kind of analysis, Input-Output (IO) analysis, is used to overcome these limitations. It enables researchers to perform calculations for the entire economy and to trace all indirect environmental effects throughout the economy. Of course, the comprehensiveness of the analysis comes at the price of a loss of detail, as the level of detail of the supply and use tables which underpin the IO-analysis is generally inferior to what can be achieved in LCA studies. Furthermore, the pollutants emitted during the use phase of a product's life cycle are not in general included.[9] Emissions during the disposal phase are included in IO-analysis as far as the product is disposed of properly instead of being entrusted to Mother Nature directly by its user. When it is disposed of through official waste disposal channels, the emissions linked to this action will be part of the emissions by the waste disposal industry.

Environmental Input – Output (EIO) analysis thus displays the convenient possibility to estimate the economy wide environmental impacts due to a particular level of final demand for all products used in an economy. This means that, based on the knowledge of all production activities induced by a particular level and composition of final demand and the emission intensities of these activities, one can attribute both direct and indirect impacts to the very ultimate source of final demand, which provides us with the opportunity to single out the products engendering the largest environmental impact throughout the economy, or alternatively the industries which produce these products. As shown in Wyckoff and Roop (1994) this also creates the possibility of looking at the emissions of a country from the viewpoint of what this country consumes instead of from the vantage point of what it produces. In fact, this boils down to taking

9 It is of course possible to link use phase emission coefficients to the input-output tables.

into account the fact that countries tend to have comparative advantages in the production of particular goods and trade these goods internationally. Wyckoff and Roop (1994) is a seminal contribution attempting to develop this approach. Using a monetary IO analysis and greenhouse gas emissions data, the authors estimate the amount of CO_2 emissions embodied in the imports of the manufactured goods in 6 OECD countries. A key finding of this paper is that, compared to total CO_2 emissions, some countries could have up to 40% of CO_2 embodied in imports of manufactured goods. Wyckoff and Roop (1994) highlight the weakness of common measures of carbon emissions based on domestic production. On the basis of this paper a flourishing literature emerged.[10] The general conclusion drawn by these international trade-oriented studies is that as the world economy is becoming more and more open, the impact of international trade is becoming ever more important, in particular in terms of environmental impacts. Hence, in terms of policy purposes, the role of foreign trade in considering environmental responsibility – at a country level as well as at the level of the world as a whole - can no longer be ignored.

The following section shows how production linked air emissions that are available by industry can be transformed into air emissions linked to final demand by product.

1.2. From the supply and use tables to the allocation of air emissions

In this section we first explain the choice of the input-output model and how air emissions are linked up with final demand. A second subsection shows how emissions are allocated more specifically to exports and imports.

1.2.1. Linking air emissions and final demand

All goods and services produced in a given economy are ultimately devoted to satisfy a certain final demand. When one wants to find out how much pollution is generated as a consequence of the demand for any particular good, one should then not only consider the pollution generated during the production process of this particular good, but also the pollution generated during the production process of intermediate goods, as well as the pollution generated during the production process of the intermediate goods necessary to produce these intermediate goods, as well as....[11] Hence, in order to link air pollutants emitted by domestic producers to final demand, the present paper follows the standard approach of making use of an IO framework (IO tables and the underlying supply and use tables). Based on national annual accounts, the IO framework provides an accurate overview of the supply and the use of goods and services in the economy. As explained by Avonds et al. (2007), the supply and use tables are two matrices, with products populating the rows and industries populating the columns describing in detail

10 See for instance Schaeffer & Sá (1996), Kondo et al. (1998), or Muradian et al. (2002)

11 See NAMEA Air Report for Belgium (1990/1994-2002). Including pollution generated during the production process of investment goods would complete the picture. However, in order to achieve this, a dynamic input-output model needs to be used. Currently the data necessary to be able to use such a model are not available in Belgium.

the domestic production processes of and the domestic and international transactions regarding all the products produced and/or used in an economy. In the *supply table*, the supply of goods and services is broken down by product and by origin, making a distinction between domestic output by industry or the make table on the one hand, and imports on the other. The *use table* details the use of goods and services by product and by type of use, namely intermediate and final consumption, gross capital formation, changes in stocks, and exports. Moreover, the use table reports the industry breakdown of gross value added by component, namely compensation of employees, other net taxes on production, net operating surplus and consumption of fixed capital.

The use and make tables can be used to construct a domestic direct requirements matrix, denoted A^d. This can be done in several ways, depending on whether one wants to compile product by product tables or industry by industry tables. Product by product tables can be constructed on the basis of commodity technology or industry technology. The commodity technology assumption says that the input structure used to produce a certain commodity is the same, no matter by which industry it is produced. The industry technology says that the input structure is identical for every commodity produced by a given industry. Industry by industry tables can be constructed on the basis of a fixed product sales structure or a fixed industry sales structure. The fixed product sales structure assumption implies that all products are sold in fixed proportions to the buyers, or in other words that the distribution of product use is fixed for all industries. The fixed industry sales structure implies that all products of an industry are sold in the same proportion to each buyer, or in other words that the distribution of product supply is fixed for each industry.

Since the environmental data we use are available by industry, we opt to construct industry by industry domestic direct requirement matrices. This will allow us to analyse EL by industry.[12] We apply the fixed product sales structure assumption, because next to the fact that it is more realistic than the fixed industry sales assumption, this also avoids the presence of negative inputs in the domestic direct requirement matrix. Negative values in this matrix are far from desirable. In the context of environmental IO analysis they could cause negative pollution coefficients. Such negative pollution coefficients imply that the environmental impact of the demand for a particular commodity (or industry output) will decrease, the higher demand for this commodity (or industry output) rises.[13] Obviously, this is not a very desirable property.

In our case the domestic direct requirements matrix A^d thus describes the domestic inputs from industries $i = 1, \ldots, n$ needed to produce domestically one unit of output in industries $j = 1, \ldots, n$.

Using the fixed product sales assumption the industry x industry direct domestic requirements matrix of dimension (n x n) can be calculated as follows:

12 Ghertner and Fripp (2007) use product x product tables with industry technology. They do not analyse the difference between the production and the use approach on a product level however.

13 By making use of industry by industry tables emissions are allocated to (final demand for) industry output, instead of to final demand for a particular product.

$$A^d = Z^t * (\hat{q})^{-1} \quad * \quad U^d * (\hat{g})^{-1} \quad = \quad D * B^d \tag{1.1}$$

with

m	*number of products*
n	*number of industries*
$U^d\,(mxn)$	*domestic intermediate use matrix*
$Z^t\,(nxm)$	*transpose of the make matrix*
$(\hat{q})^{-1}\,(mxm)$	*inverse of diagonalised domestic output by product*
$(\hat{g})^{-1}\,(nxn)$	*inverse of diagonalised domestic output by industry*
$B^d\,(mxn) = U^d * (\hat{g})^{-1}$	*domestic direct product requirements matrix by industry*
$D\,(nxm) = Z^t * (\hat{q})^{-1}$	*market share matrix*

This expression for the domestic direct requirements matrix is obtained in the following way. Since final demand in the use table is only available by product, total demand for domestic output is also, at first instance, expressed in terms of products. Total demand for domestic output by product, q (mx1), is equal to the sum of demand for intermediate use by product, u^d (mx1), and final demand by product, f^d (mx1). In order to convert the demand vectors expressed in terms of products, into a vector expressed in terms of industries we need to multiply them by the market share matrix D:

$$D * q = D * u^d + D * f^d \tag{1.2}$$

The left hand side of expression (1.2) is equal to the vector of output by industry, g (nx1). We also know that there is a matrix B^d containing the direct domestic intermediate input requirements by product for each industry. Above it was already shown that B^d is equal to $U^d * (\hat{g})^{-1}$. Multiplying both sides by $\hat{g}$, and undiagonalising the latter, we find that u^d is equal to B^d*g. Substituting on the left and the right hand side of equation (1.2), we obtain:

$$g = D * B^d * g + D * f^d \tag{1.3}$$

Solving this equation for g, with I being the identity matrix, we obtain the following expression, showing the relationship between final demand for products and output by industries:

$$(I - D * B^d)g = D * f^d \quad \Rightarrow \quad g = (I - D * B^d)^{-1} * D * f^d \tag{1.4}$$

The expression $(I - DB^d)^{-1}$ is the domestic Leontief inverse. This shows that $D*B^d$ is equal to A^d, the domestic direct requirements matrix. The domestic Leontief inverse allows to calculate both direct and indirect output effects induced by a change in domestic final demand f^d.

In order to quantify the direct and indirect environmental impacts of economic activity, a link is needed between these environmental impacts (such as air emissions) and economic transactions. This link is provided by the NAMEA Air, which contains air emissions (P) by industry coherent with national accounts. Dividing air emissions by total output of each industry (g) provides the industry pollution coefficients matrix, *PC*.

$$PC = P * \left(\hat{g}\right)^{-1} \tag{1.5}$$

Once the industry pollution coefficient matrix *PC* is obtained, direct and indirect emissions can be linked to final demand by multiplying equation (1.4) with *PC*. The following model is obtained:

$$P = PC * g = PC * (I - A^d)^{-1} D * f^d \tag{1.6}$$

1.2.2. Allocation of air emissions to exports and imports

In order to determine the degree of environmental leakage (EL) one needs to calculate the amount of emissions generated by exports on the one hand, and the amount of emissions engendered by imports on the other. For exports the calculation is straightforward, since exports are part of f^d. As concerns imports a set of extra assumptions are necessary due to a lack of data on the production structures and the pollution coefficient matrices of Belgium's trade partners. A standard way of calculating the pollution embodied in imports is to assume that the countries whose goods and services are imported, all use the same technology as the importing country, such that they display the same industrial input structure and pollution coefficients matrix as the domestic one.[14]

As export demand for domestic commodities, denoted by X^d, generates an intermediate demand for domestic commodities, domestic output for exports by industry, denoted by g_X, is linked to export demand by product by means of the domestic Leontief inverse as follows:

$$g_X = (I - A^d)^{-1} D * X^d \tag{1.7}$$

Replacing g in equation (1.6) by the latter expression for g_X, pollution generated by the demand for exports by industry is obtained:

$$P_X = PC * (I - A^d)^{-1} D * X^d \tag{1.8}$$

14 What is really calculated in this way is the amount of emissions a country avoids (which it does not need to emit) because other countries produce the goods and services in its place. This "avoided emissions approach" thus is a special case of the more general "domestic use approach". A convenient corollary of this approach is that it makes it possible to use the changes in the environmental terms of trade to assess environmental offshoring (see section 4.1).

By considering the imports as a hypothetical category of final demand for domestic goods, an equivalent calculation for imports can be implemented, leading to the following expression for pollution generated for the production of imports by industry:

$$P_M = PC * (I - A^d)^{-1} D * M^d \qquad (1.9)$$

M^d stands for imports by product destined for domestic demand, as opposed to imports that are directly re-exported. These re-exports should not be taken into account, because their production and the corresponding emissions are not linked to domestic use. The expression $(I - A^d)^{-1} D * M^d$ is equal to foreign output by industry for the production of domestic imports, g_m.

Since we not only want to determine the degree of EL for Belgium, but also want to determine which are the main industries responsible for this EL, we need to allocate emissions to these industries. This allocation can be done according to a demand approach or according to a supply approach.[15]

The demand approach consists in allocating emissions to final demand for industry output. This is done by diagonalising the outcome of the multiplication of the market share matrix D with demand for exports and imports by product (X^d and M^d). The multiplication with the Leontief inverse in equations (1.8) and (1.9) then serves to attribute indirect emissions due to the production of intermediate goods to final demand for the industry output making use of these intermediate goods.

The supply approach consists in allocating emissions to industry output itself. This is achieved by diagonalising g_x and g_m. In this case the Leontief inverse, and consequently the indirect effects, are comprised in the output calculations. As a consequence, the emissions by a particular industry necessary to produce total output are directly linked to the industry emitting them.

Because the EL production approach emission data for Belgium are directly available according to the supply approach we will perform all calculations according to this approach. This implies that all emissions are allocated to industry output. This approach is necessary if one wants to pinpoint the industries the output of which is responsible for EL. Furthermore, if one wants to study the offshoring of polluting activities, one also needs to be able to identify the industries that perform these activities. If one were to make use of the demand approach, one would determine the responsibility for EL of final demand for the different industries' output, thus attributing emissions by other industries to produce the intermediate goods necessary to satisfy this final demand to the industry the output of which is used as part of final demand.

15 One should take care not to confuse the difference between the demand and the supply approach concerning the responsibility of industries with the difference between the production and the use (or avoided emissions) approach as concerns the responsibility of countries. The latter is determined by international trade, the former by the choice of the variable to be diagonalised in equations (1.8) and (1.9).

2. Data

This section presents the datasets that have been exploited for the needs of the present analysis. The fundamental methodological principle to assess the emissions embodied (EE) in international trade is to multiply direct and indirect output for exports and imports by total pollutant intensity coefficients. This implies that we need two data sets, one dataset showing the domestic as well as international economic relationships of a country, and another dataset presenting the emissions according to the same economic classification.

The present analysis mainly uses two datasets for Belgium for the period 1995-2002: supply and use tables (SUTs) and the NAMEA-Air. The SUTs we used are the constant price versions calculated by the Belgian Federal Planning Bureau in the context of the EUKLEMS project.[16]

The pollution data are provided by the NAMEA Air database for Belgium. The NAMEA Air is part of the Belgian environmental accounts, and as such a satellite account of the national accounts. It contains among others data on air pollution by industry (according to the NACE classification also used in the economic accounts). Data on 15 pollutants are available, namely the greenhouse gases CO_2, N_2O, and CH_4, the acidifying gases NO_x, SO_x, and NH_3, the photochemical gases NMVOCs and CO, fine particulates PM_{10}, the heavy metal Pb, and the fluorinated gases, HFCs, PFCs, SF_6, HCFCs and CFCs. Apart from PFCs all these pollutants are articulated by industry. The current analysis was performed for these 14 pollutants.

The 14 pollutants in the NAMEA Air are available for a very particular aggregation level of the NACE classification of industries. Total pollution is distributed across a set of 34 industries.[17] The economic data, which are available at a more disaggregated level, were aggregated in order to achieve the same level of aggregation as used in the NAMEA Air. The emission data in the NAMEA Air are equal to the emissions allocated to industry output according to the EL production approach.

16 This project aims at obtaining a better insight in the evolution of European productivity. In order to provide constant price tables, a sequential approach – as proposed by the UN Handbook on Input Output Table compilation and analysis - was implemented to deflate the current price tables.

17 See Annex 1 for a description of the 34 industries.

3. Balance of embodied emissions in trade and environmental leakage

This section presents the results of the method implemented for calculating the balance of embodied emissions in trade (BEET) for the Belgian economy from 1995 to 2002. Computing the ratio between the BEET and emissions based on the production approach provides the environmental leakage (EL), highlighting the relative importance of embodied emissions (EE) in trade of the various pollutants under examination.

Following Muradian et al. (2002), the BEET is defined as EE in imports minus EE in exports. In order to compute the BEET, it is assumed that commodities are featured by a constant environmental intensity whether they are produced in Belgium or elsewhere. Because the exports share the same production process as the rest of the national production, the environmental intensity of exports is equal to the environmental intensity of domestic production. As concerns the imports, in order to circumvent the international data shortage problem, and as to enable us to interpret changes in the environmental terms of trade as environmental offshoring, their environmental intensity is assumed to be equal to the environmental intensity of domestic production such that equal environmental intensity across countries is assumed. This assumption is standard in international IO analysis, and as mentioned before, implies that emissions embodied in imports are equal to emissions avoided in the importing country. The BEET is then defined as follows:

$$BEET = r_m M^d - r_x X^d = r(M^d - X^d) \qquad (3.1)$$

with

r_m = environmental intensity of imports

r_x = environmental intensity of exports

$r_m = r_x = r = PC^* (I-A^d)^{-1} * D$

A positive value of the BEET means that pollution embodied in imports exceeds domestic emissions associated with exports.[18] If this is the case one can say that the country is a net exporter of emissions. If the country would have to produce the imported goods itself, instead of obtaining them in exchange for exports, its emissions as measured by the production approach would be higher.[19] Table 1 shows the BEET for the Belgian economy. As one can see, NH_3, CH_4 and PM_{10}

18 Remark that equation (3.1) does not imply that the BEET is positive as soon as the trade balance is negative. Md, Xd and r are matrices. Consequently, the composition of exports and imports will play an important role in the determination of the sign of the BEET.

19 Saying that a certain country C is an exporter of emissions when emissions embodied in its imports are superior to emissions embodied in its exports might seem contradictory. However, the emissions themselves are not traded. The emissions embodied in exports are emitted in country C, the emissions embodied in its imports are emitted in

were the only pollutants that were exported by Belgium during each single year of the investigated period. N_2O was exported in 1995, 1997 and 2002, and imported in all the other years. For the other ten pollutants Belgium acted as a net importer during the entire period, by producing more of the pollutant than it consumed. The global outlook seems to be such that Belgium produces "dirty" goods for the rest of the world, and thus is a net importer of emissions. For comparison, Hettige & al (1994) and Ghertner & Fripp (2007) analyzing the BEET for the US during the periods 1974-2001 and 1998-2004 respectively, find positive values for the BEET throughout the period and the majority of pollutants under consideration.[20]

Table 1: Balance of embodied emissions in trade for Belgium *(1995-2002, in tons, except CO_2 in 1000 tons)*

	1995	1996	1997	1998	1999	2000	2001	2002
CO_2	-4954	-5849	-6649	-6897	-8898	-4790	-5575	-3710
N_2O	1097	-88	44	-835	-2097	-696	-102	304
CH_4	67177	55036	55740	39515	35684	55517	64853	81062
HFCs	-1	-1	-2	-2	-2	-2	-3	-4
SF6	-0	-1	-1	-1	-1	-0	-0	-0
NO_x	-16064	-18184	-22050	-21078	-24208	-16809	-18376	-11079
SO_x	-5544	-8381	-8547	-8208	-11279	-7507	-8218	-6946
NH_3	16981	13457	14366	9550	8613	11805	14100	17465
NMVOC	-12804	-13799	-14470	-12782	-13585	-10802	-11639	-10300
CO	-110887	-118476	-98911	-104961	-93629	-103588	-106525	-99624
PM_{10}	4682	3160	2789	1546	689	3248	3298	4890
CFCs	-244	-274	-233	-157	-127	-116	-94	-89
HCFCs	-109	-250	-269	-311	-263	-148	-99	-62
Pb	-25	-32	-31	-21	-22	-17	-16	-11

As already mentioned, the BEET also shows the difference between emissions calculated according to a production approach and emissions calculated according to the avoided emissions approach. When this difference is shown as a percentage of emissions according to the production approach, we obtain the environmental leakage (EL).

$$EL = BEET / ePA \qquad (3.2)$$

with

ePA = emissions by production approach

Table 2 shows the environmental leakage for the Belgian economy in the period 1995-2002.

trade partner countries. The emissions are the mirror image of the embodied emissions. Importing more, implies a higher level of emissions in the trade partner countries. Therefore if a country is a net importer of embodied emissions it can be considered to be an exporter of emissions proper.

20 Hettige H., Martin P., Singh M; & Wheeler D. (1994), "The industrial Pollution Projection System", World Bank, Washington, DC; is quoted in Cole (2004). Hettige & al (1994) consider five different categories of pollutants: sulphur dioxide, total particulates, carbon monoxide, nitrogen dioxide and volatile organic compounds. As concerns Ghertner & Fripp (2007), they consider four categories of environmental impact: global warming potential, energy use, toxic release, and the criteria air pollutants (sulphur dioxide, particulate matter<10μm, carbon monoxide, nitrogen oxides, lead and volatile organic compounds).

Table 2: Environmental leakage for Belgium *(1995-2002, in %)*

	1995	1996	1997	1998	1999	2000	2001	2002
CO_2	-5.1	-6.2	-7.0	-6.9	-8.7	-4.8	-5.9	-3.9
N_2O	2.6	-0.2	0.1	-1.9	-4.8	-1.8	-0.3	0.8
CH_4	12.9	10.7	10.9	7.8	7.3	12.0	15.2	19.6
HFCs	-3.9	-4.5	-5.3	-4.1	-4.2	-4.3	-4.6	-4.4
SF_6	-10.4	-12.1	-12.0	-13.4	-11.9	-7.2	-7.1	-7.3
NO_x	-5.2	-6.2	-7.5	-7.1	-8.8	-5.8	-6.7	-4.3
SO_x	-2.4	-3.9	-4.2	-4.3	-7.4	-4.9	-5.7	-5.1
NH_3	18.0	14.5	15.6	10.3	9.3	14.8	18.1	23.0
NMVOC	-7.6	-8.7	-9.7	-8.8	-10.1	-8.5	-9.5	-8.9
CO	-14.4	-16.5	-14.6	-16.0	-15.4	-14.1	-15.6	-14.4
PM_{10}	6.6	4.5	4.1	2.3	1.1	5.3	5.5	7.9
CFCs	-6.3	-8.2	-8.8	-7.9	-8.6	-8.6	-9.2	-9.9
HCFCs	-4.4	-10.0	-9.9	-10.9	-9.8	-6.0	-4.9	-6.2
Pb	-13.9	-17.5	-15.6	-16.8	-17.9	-16.2	-18.2	-16.8

On average, across all the years and all the pollutants, the EL equalled -4%. There exists a wide variation across the different pollutants though. The pollutant for which the EL was most negative was lead (Pb), with an average of -17% over the period 1995-2002. On the other side of the spectrum the average EL for NH_3 was equal to +15% on average. For comparison, Ahmad & Wyckoff (2003), in their study about OECD countries, find that the carbon leakage ranged between -17% for Japan and +20% for the Czech Republic. As for Ghertner & Fripp (2007), they exhibit positive EL for all the classes of pollutants they consider for the US over the period 1998-2004, with a minimum of +2% on average for VOCs (volatile organic compounds) and a maximum of +24% on average for lead. The observed importance of the difference between emissions according to the production approach and the avoided emissions approach provides an understanding of the limitations of the standard indicators used to evaluate the pollution mitigation policies such as the Kyoto Protocol.

As already mentioned above, Belgium turns out to be a country which produces a relatively large amount of 'dirty' goods for other countries. When we compare the situation in 1995 to the one in 2002, we see that EL had increased for half of the pollutants, while for the other half it had decreased. The increase was strongest for CH_4, with a rise of almost 7 percentage points. Significant increases are also observed for NH_3 and SF_6 (+5 and +3 percentage points, respectively). For CO_2 we observe an increase of the EL of just over 1 percentage point. The largest decreases are observed for CFCs (-4 percentage points), followed by lead and SO_x (both -3 percentage points).

A sector analysis of the BEET is shown in table 3. This table shows the average share of each industry in the BEET for each of the fourteen pollutants.[21] Starting with the three pollutants for which Belgian trade generated a positive EL over the entire 1995-2002 period (CH_4, NH_3 and PM_{10}), it is immediately clear that the EL was due to the agricultural and forestry industries (NACE 01-02). It is perfectly normal that the agricultural and forestry industries are by far the most impor-

[21] For a lot of industry-pollutant combinations the share is negative, due to the fact that trade in the products of these industries has the opposite effect on environmental leakage than is the case for total Belgian trade.

tant industry as concerns EL of these three pollutants. Their share in total emissions according to the production approach during the period 1995-2002 was equal to 97% for NH_3, 70% for CH_4 and 54% for PM_{10}. And since EL was positive their share in emissions according to the avoided emissions approach was even higher (98%, 73% and 60% respectively).[22]

The high percentages for the shares in the BEET are only possible if other industries offer an important counterweight. This is especially true for the chemical industry (NACE 24), the second most important industry as concerns emissions of PM_{10} with a share of 14% according to the production approach, which had a negative share in the BEET of almost 100% for this pollutant. This means that as concerns fine particles the products exported by the Belgian chemical industry contain a lot more of them than is embodied in imports from foreign chemical industries. It also means that with 11% the share of the chemical industry according to the avoided emissions approach was lower than its share according to the production approach.

Table 3: Average 1995-2002 share in total Belgian *(in %)*

		CO_2	N_2O	CH_4	HFCs	SF_6	NO_x	SO_x	NH_3	NMVOC	CO	PM_{10}	CFCs	HCFCs	Pb
A	01-02	-9	280	97	-3	0	-14	-17	103	-3	-1	231	-1	-1	0
B	05	-4	0	0	0	0	-21	-4	0	-5	-3	57	0	0	0
	14	-2	-1	0	-2	0	-4	0	0	-1	-1	2	-1	0	0
	15-16	6	0	0	11	0	5	14	0	5	0	-5	5	3	1
	17-19	1	0	0	1	0	1	1	0	1	0	0	1	0	0
	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	21-22	0	0	0	0	0	0	0	0	-1	0	0	0	0	0
	23	10	-2	0	0	0	6	49	0	14	1	-8	0	0	1
	24	31	-158	0	29	1	19	34	-2	36	2	-94	15	10	0
	25	0	0	0	9	0	0	0	0	1	0	0	0	64	0
	26	32	-8	0	6	124	28	56	-1	5	4	-19	2	2	6
	27	50	-4	-1	3	0	25	48	0	7	76	-21	1	0	82
	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	29	-1	0	0	-13	0	-1	-1	0	0	0	0	-1	-3	0
	30-33	-1	0	0	-3	0	0	-1	0	0	0	0	-1	-1	0
	34-35	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	37	0	0	0	1	0	0	0	0	0	0	0	60	14	0
	40	-62	1	6	-53	-30	-34	-93	0	-6	-1	16	-22	-18	0
	41	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F	45	1	0	0	0	0	1	1	0	1	0	0	0	0	0
G	50-52	4	0	0	46	2	5	1	0	13	4	-2	20	16	2
H	55	0	0	0	-4	0	0	0	0	0	0	0	-2	-1	0
	60	26	-7	0	33	0	59	7	0	24	13	-44	6	3	7
	61	7	3	0	0	0	7	1	0	1	0	-3	0	0	0
	62	4	0	0	0	0	5	1	0	2	1	-1	0	0	0
	63	3	0	0	15	1	8	1	0	3	2	-4	5	4	1
	64	1	0	0	1	0	2	0	0	0	0	-2	0	0	0
J	65-67	0	0	0	0	0	0	0	0	0	0	0	0	0	0
K	70-74	2	-1	0	20	3	3	1	0	1	1	-2	11	6	0

22 See Annexes 2 and 3 for the shares of each industry in total 1995-2002 emissions of each of the fourteen pollutants, according to the production and the avoided emissions approach respectively.

	CO_2	N_2O	CH_4	HFCs	SF_6	NO_x	SO_x	NH_3	NMVOC	CO	PM_{10}	CFCs	HCFCs	Pb
L 75	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M 80	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N 85	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O 90-93	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0

For the one pollutant for which EL was positive in some years and negative in others, N_2O, the agricultural and forestry industries were also clearly the most important leakers of enviromental impact. Their average share in the BEET between 1995 and 2002 was almost equal to 300%. Once again the counterweight was provided by the chemical industry. These two industries were also the main emitters of N_2O in the period 1995-2002. Their share according to the production approach was equal to 49% for agriculture and 37% for the chemical industry. According to the avoided emissions approach these shares were equal to 57% and 30% respectively. This clearly illustrates the important difference which can occur between the two approaches as concerns the relative emission shares of different industries. While according to the production approach emissions of N_2O by the agriculture and forestry industries was only a third higher than emissions by the chemical industry, according to the avoided emissions approach it was almost double.

Turning now to the pollutants for which the EL was negative over the entire period, we first focus on the pollutant that has received the broader media coverage across all pollutants, CO_2. Obviously, the average negative leakage of 6% was mainly caused by four industries, the basic metals industry (NACE 27) with a share of 50% in the Belgian BEET, the chemical industry and the other non-metallic mineral products industry (NACE 26) both with a share of just over 30%, and land transport (NACE 60) with a share of just over a quarter. The exports of these four industries contain more CO_2 than is embodied in the imports of their foreign competitors. The most important counterweight was formed by the electricity and gas industry (NACE 40), with a share of 23% in emissions according to the production approach, which showed an opposite BEET equal to 62% of the Belgian total on average. As a consequence, the importance of the electricity and gas industry was even higher according to the avoided emissions approach, with a share of 29%. We noticed earlier that the evolution of EL of CO_2 showed a slight tendency to increase. The industry analysis shows that this is mainly due to air transport (NACE 62). The average share in the BEET over the entire period for this industry might have been equal to 4% of the Belgian total, in 2002 it turned negative and equalled no less than -18%. Making abstraction of 2002 the average share of the air transport industry was equal to 7%. The reason for this abrupt change and the corollary export of air emissions to foreign sources is of course the Sabena bankruptcy[23]. The difference in the evolution of the share of air transport between the avoided emissions and the production approach is quite revealing. According to the latter, its share in CO_2 emissions in 2002 was 18% lower than in 1995. However, according to the avoided emissions approach it was 4% higher.

[23] Sabena used to be the national Belgian aircraft carrier.

As concerns the fluorinated greenhouse gases which are also considered in the context of the Kyoto protocol, we notice that for SF_6, the other non-metallic mineral products industry determined the negative EL for Belgium. It is no wonder that this industry was the determining factor in emissions of SF_6, since according to the production approach the share of this industry in total 1995-2002 SF_6 emissions was equal to 71%. For HFCs the most important industries were the trade sector (NACE 50-52), with a share of 46% in the BEET, land transport with a share of a third of the Belgian total, and the chemical industry with a share just below 30%. The most important counterweight was once again provided by the electricity and gas industry with a negative share of over half of the Belgian total.

As for the negative EL of the fluorinated gases controlled by the Montreal Protocol, the most important industries were the recycling industry (NACE 37) for CFCs, and the rubber and plastic products industry (NACE 25) for HCFCs. These industries were indeed the main emitters of the respective pollutants in Belgium during the period 1995-2002, both according to the production and the avoided emissions approach.

As regards the acidifying emissions for which a negative EL was registered over the entire observation period, we remark that for NO_x land transport was the most important industry, with a share of almost 60% in the BEET. The other non-metallic mineral products industry and the basic metals industry both accounted for over a quarter of the Belgian total as well. Counterweight was once again provided by the electricity and gas industry with a negative share of -35%. A counterweight of equal size was provided by the combined share of the agriculture and forestry industry and the fishing industry. Land transport and the electricity and gas industry were the main emitters of NO_x in Belgium between 1995 and 2002. Their opposite influence on EL is also clearly illustrated by the difference in their relative shares in total emissions between the production and the avoided emissions approach. Whereas according to the former the share of land transport was 50% higher than the share of the electricity and gas industry, according to the latter their shares were almost equal. For SO_x the industries determining the negative Belgian EL were mainly the coke, refined petroleum and nuclear fuel industry (NACE 23), the other non-metallic mineral products industry, and the basic metals industry, all three with a share of around half of the Belgian total. A large counterweight of over 90% was provided by the electricity and gas industry.

As concerns the photochemical emissions other than NO_x, the table shows that for NMVOCs the chemical industry was the most important determinant of the negative EL, with a share of 36% in the BEET. Land transport was the second most important industry with a share of about a quarter. For CO over three quarters of the Belgian negative BEET was provided by the basic metals industry. The same industry was also responsible for the lion's share of the negative EL for lead. For these two pollutants the basic metals industry was by far the most important source of emissions in Belgium in the 1995-2002 period, with shares of 63% and 70% respectively according to the production approach.

4. Evolution of Belgian environmental leakage dissected

This section discusses the various factors assumed to affect the evolution of EL. Insight in these factors allows a better understanding of the behavior of Belgian EL. To this purpose, various indicators are computed. The first indicator is the difference between the environmental balance and the trade balance. This difference shows whether exports are more air pollutant intensive than imports, or whether it is the other way around. An alternative representation of this difference is the environmental terms of trade. Both indicators are perfectly substitutable. A third indicator is the relative environmental intensity of exports with respect to total output. This indicator helps to unravel the relationship between environmental leakage, the trade balance and the environmental terms of trade.

4.1. Relative environmental intensity of imports and the environmental terms of trade

By relocating abroad large shares of its highly polluting activities, a country influences its trade balance and therefore also the emissions embodied in trade. Hence, a very standard way to investigate the driving forces behind the evolution of the EL is to explore the relationship between the trade balance and the EL. In fact, the emissions incorporated in the trade balance correspond to the value of emissions left out by the production approach, but taken into account by the avoided emissions approach. In the case of a trade deficit, a positive EL is expected to take place. For instance, Ghertner & Fripp (2007) examine the extent to which trade increases consumption relative to production by computing the US trade deficit as a percentage of GDP from 1998 to 2004. The authors conclude that the fact that the US trade deficit has been steadily increasing relative to the US GDP during the period under examination is directly linked with the presence of the positive EL for all the environmental impacts they consider over the same period. Further, as trade deficits increase, Ghertner & Fripp (2007) anticipate EL to rise as well.

In the Belgian case, the findings are different. In fact, as one can notice from table 4, Belgium exhibited a trade surplus during the period 1995-2002. One could thus expect Belgium to show a negative EL. As shown earlier this was the case for most of the fourteen air pollutants.

Table 4: The Belgian trade balance (X-M) as % of GDP *(1995-2002)*

	1995	1996	1997	1998	1999	2000	2001	2002
Trade balance	1.50	1.63	1.93	1.67	1.78	1.77	2.00	2.40

The trade surplus was also increasing over the period under consideration. One would thus also expect the EL to have become more and more negative. Table 2 showed that this was clearly not the case. The fact that there is no one-to-one relationship between the evolution of the trade balance and the evolution of EL is caused by changes in the composition of exports and imports. To what extent such changes have taken place for Belgium is investigated in table 5 by means of a comparison between the evolution of the environmental balance and the evolution of the trade balance. The difference between both balances shows whether exports are more air pollutant intensive than imports, or whether it is the other way around. The environmental balance is defined as the ratio of the difference between emissions embodied in exports and emissions embodied in imports over emissions embodied in imports. This environmental balance is compared with the trade balance measured as the ratio between the value of the trade surplus over the value of imports. If the environmental balance exceeds the trade balance, this implies that exports are relatively air pollutant intensive. If the environmental balance is inferior to the trade balance imports are relatively air pollutant intensive.

Table 5: Environmental balance versus trade balance *(1995-2002, in %)*

	1995	1996	1997	1998	1999	2000	2001	2002
Trade bal.	6.1	6.6	7.8	6.7	7.3	6.6	7.6	9.3
CO_2	9.9	12.4	14.0	13.5	17.1	8.9	11.1	7.1
N_2O	-4.0	0.3	-0.2	2.9	7.8	2.8	0.4	-1.3
CH_4	-23.5	-19.5	-19.7	-14.4	-13.3	-20.1	-23.4	-28.5
HFCs	10.9	12.4	14.3	10.2	10.2	9.5	9.9	9.0
SF_6	27.2	33.1	32.7	36.6	31.3	15.2	15.1	15.7
NO_x	10.8	13.2	16.0	14.9	18.6	11.1	13.2	8.2
SO_x	4.4	7.4	8.1	8.4	14.3	8.5	10.1	8.8
NH_3	-25.9	-20.8	-22.0	-15.5	-14.0	-20.9	-24.4	-29.8
NMVOC	15.5	17.8	19.9	17.5	20.6	16.2	18.3	17.1
CO	23.7	29.3	24.7	27.2	27.1	23.3	26.5	23.7
PM_{10}	-10.6	-7.3	-6.6	-3.8	-1.7	-8.0	-8.1	-11.4
CFCs	13.6	18.6	19.3	16.9	17.9	17.8	19.9	21.0
HCFCs	6.6	16.7	16.7	18.2	16.0	9.6	8.1	13.1
Pb	26.7	32.5	26.1	28.1	27.1	23.4	27.2	24.7

As can be ascertained in table 5, for most of the pollutants exports were more air emission intensive than imports during almost the entire 1995-2002 period. For only four of the fourteen pollutants the opposite is true (N_2O, CH_4, NH_3 and PM_{10}). However, in 2002 this was no longer the case. In that year imports turned more emission intensive than exports for another four pollutants (CO_2, HFCS, NO_x and SO_x). There is thus clearly no one to one relationship between the trade balance and the environmental balance. That is to say, the composition of the trade balance of the country matters. And as concerns Belgium the change in this composition has been of such a nature as to lead to a higher air emission intensity of imports relative to exports. There are only three pollutants for which the opposite evolution took place between 1995 and 2002, namely SO_x, CFCs and HCFCs, and with respect to the former 1995 happens to be the only other year next to 2002 for which imports were more air emission intensive than exports. As a matter of fact, for

CFCs and HCFCs 1995 also seems to be a rather peculiar year. When 1996 is taken as the starting point the evolution of the relative air emission intensity of imports with respect to these three pollutants falls in line with all the other pollutants. The global picture that emerges quite distinctly is that Belgian imports have become more air emission intensive in comparison to Belgian exports.[24]

An alternative way to depict the relative environmental intensity of imports and exports is the environmental terms of trade.

The concept of the environmental terms of trade (eTT) was introduced by Antweiler (1996). The eTT is constructed in a comparable fashion as the monetary terms of trade, but obviously it focuses on environmental issues. The eTT are obtained by dividing the average environmental intensity of exports for pollutant i $\left(\overline{r_x} = \frac{P_{Xi}}{X^d}\right)$ by the average environmental intensity of imports for that same pollutant $\left(\overline{r_m} = \frac{P_{Mi}}{M^d}\right)$.

$$eTT = \left(\frac{\overline{r_x}}{\overline{r_m}}\right) \tag{4.1}$$

Values for the eTT exceeding one indicate that a thousand euros worth of exports of a certain country embody a higher amount of a particular pollutant than a thousand euros worth of its imports. Table 6 shows the eTT for the Belgian economy between 1995 and 2002. As expected, the majority of the values are superior to one, implying that Belgian exports were more air emission-intensive than Belgian imports. This corroborates with the findings of Antweiler (1996), who applied IO-analysis to industry level data for the US in 1987. He concluded that exports of highly industrialized countries are more environment-intensive than their imports, while the opposite holds for developing countries. In contrast, Ghertner & Fripp (2007), computing the US eTT for the period 1998-2008, find for most of the environmental impacts they consider that the eTT were below one. They conclude that the US import more environment-intensive goods than they export.

24 The fact that the evolution of the EL itself does not show a tendency for Belgium to displace the environmental impact of its domestic use abroad, with EL rising and falling between 1995 and 2002 for an equal amount of pollutants, is caused by a failure of this indicator to take into account the increasing trade surplus. In other words, the change in the EL is not an appropriate indicator when one wants to ascertain whether a country is displacing the environmental impact of its domestic use via offshoring. Offshoring has to be seen as an evolutionary concept, and the change in EL depends on too many variables to show a clear picture. The evolution of the relative emission intensity of imports and exports seems to offer a more distinct picture.

Table 6: Environmental terms of trade for Belgium *(1995-2002)*

	1995	1996	1997	1998	1999	2000	2001	2002
CO_2	1.04	1.05	1.06	1.06	1.09	1.02	1.03	0.98
N_2O	0.91	0.94	0.93	0.96	1.00	0.96	0.93	0.90
CH_4	0.72	0.76	0.75	0.80	0.81	0.75	0.71	0.65
HFCs	1.05	1.05	1.06	1.03	1.03	1.03	1.02	1.00
SF_6	1.20	1.25	1.23	1.28	1.22	1.08	1.07	1.06
NO_x	1.05	1.06	1.08	1.08	1.11	1.04	1.05	0.99
SO_x	0.98	1.01	1.00	1.02	1.06	1.02	1.02	1.00
NH_3	0.70	0.74	0.72	0.79	0.80	0.74	0.70	0.64
NMVOC	1.09	1.11	1.11	1.10	1.12	1.09	1.10	1.07
CO	1.17	1.21	1.16	1.19	1.18	1.16	1.18	1.13
PM_{10}	0.84	0.87	0.87	0.90	0.92	0.86	0.85	0.81
CFCs	1.07	1.11	1.11	1.10	1.10	1.10	1.11	1.11
HCFCs	1.01	1.09	1.08	1.11	1.08	1.03	1.00	1.04
Pb	1.19	1.24	1.17	1.20	1.18	1.16	1.18	1.14

Table 6 also shows the Belgian environmental terms of trade to exhibit a tendency to decline towards the end of the observation period. The fact that Belgian imports are becoming more emission intensive with respect to exports could be triggered by a move of emission intensive activities to countries where these industries meet less environmental constraints. Such countries would most probably be found outside of the EU, since countries within the EU have common environmental policies.[25] Our dataset enables us to make a distinction between intra- and extra-EU imports. With imports becoming more emission intensive with respect to exports we would thus expect a shift in imports towards extra-EU imports. In order to check this hypothesis we calculated the percentage point difference in the growth rate of emissions linked to extra-EU imports and emissions linked to intra-EU imports. Since we use the assumption that both types of imports are produced according to the same production technology with identical emission coefficients this difference is completely driven by shifts in the intra- and extra-EU shares of Belgian imports.

Table 7: Difference between growth of emissions linked to extra-EU imports and of emissions linked to intra-EU imports *(1995-2002, in %)*

CO_2	N_2O	CH_4	HFCs	SF_6	NO_x	SO_x	NH_3	NMVOC	CO	PM_{10}	CFCs	HCFCs	Pb
-0.8	18.8	6.4	76.4	18.1	-1.2	-1.9	9.2	10.2	-17.0	10.8	0.4	14.5	-9.6

Table 7 shows that for eight out of the fourteen pollutants there was a clear shift towards extra-EU imports. The growth of emissions linked to extra-EU imports outpaced the growth of emissions linked to intra-EU imports by at least 6 %. An important driver of this evolution is the agriculture and forestry industry. Between 1995 and 2002 output of its products necessary to produce intra-EU imports increased by 16%, but output necessary to produce extra-EU imports in-

25 A differentiation of environmental targets across industries among the EU-countries could also lead to the substitution of intra-EU imports for domestic production for particular industries.

creased by 27%.[26] This is the main reason why extra-EU emissions of N_2O, CH_4, NH_3 and PM_{10} increased faster than likewise emissions linked to intra-EU imports. Over the same period the domestic output of the agriculture and forestry industry increased by only 5%, while output devoted to exports rose by 12%. There is thus an indication that imports, and especially extra-EU imports, have replaced domestic output.[27] For N_2O and PM_{10} the shift towards extra-EU imports was supported by a comparable shift for the chemical industry. For the chemical industry domestic output growth (+45%) outpaced the growth of its output necessary for imports (+25%), but the chemical industry's output necessary to produce extra-EU imports nevertheless increased at a much faster pace (+76%). For CH_4 the shift towards extra-EU imports was partly compensated by an opposite shift for the other community, social and personal service activities industry (NACE 90-93), the second most important source of this pollutant. The main component of NACE 90-93 responsible for these emissions is of course the sewage, refuse disposal and sanitation services industry.

For HFCs the main industry responsible for the faster growth of emissions linked to extra-EU imports was the wholesale and retail trade sector, including repair of motor vehicles (NACE 50-52). This is due to the fact that an important source of emissions of HFCs is refrigerators. Output necessary to produce extra-EU imports of services provided by the trade sector increased by 78% between 1995 and 2002, while for intra-EU imports the increase was limited to 41%. Domestic output growth was limited to 31%, while output devoted to exports rose by 45%. For this industry as well there is thus an indication that extra-EU imports have been replacing domestic output. The fact that growth of SF_6 emissions linked to output for extra-EU imports exceeds growth linked to output for intra-EU imports is caused by the other non-metallic mineral products industry. Its output for extra-EU imports increased by 58% compared to a 20% increase for intra-EU imports. Total domestic output by the other non-metallic minerals products industry increased by a mere 4% between 1995 and 2002, while output devoted to exports increased by 18%. For this industry there is thus also a clear indication of a displacement of domestic output by imports, and more specifically extra-EU imports. As concerns HCFCs the fast growth of output for extra-EU imports by the rubber and plastics industry (42%) as opposed to a stabilization of its output for intra-EU imports was at the root of the superior growth of emissions linked to extra-EU imports over emissions linked to intra-EU imports.

As concerns NMVOCs no single industry stands out as the main cause of the faster growth of emissions linked to extra-EU imports. The chemical industry; the wholesale and retail trade sector, including repair of motor vehicles; the coke, refined petroleum products and nuclear fuel industry; as well as the paper and printing industry (NACE 21-22) all contributed to this observation.

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26 Annex 4 presents growth of output necessary to produce extra- and intra-EU imports by industry. The figures by industry are obtained from figures on imports by product, assuming market shares of foreign industries (in the production of each product) to be identical to those of Belgian industries.

27 If output devoted to exports were to fall or to rise at a slower pace than total domestic output, the rise in output for imports could just be an indication of brisk domestic demand. If output devoted to exports rises at a faster pace than domestic output this is probably not the case.

A distinct opposite shift towards intra-EU imports is only observed for two pollutants, namely CO and lead. In both cases this evolution is determined by the basic metals industry. Between 1995 and 2002 its output for intra-EU imports increased by 19%, the same increase as for domestic output. At the same time its output for extra-EU imports decreased by 11%. Domestic output by the basic metals industry for exports increased by 13%. For this industry there is clearly no indication of a replacement of domestic output by extra-EU imports.

For CO_2, NO_X, SO_x and CFCs the difference between extra- and intra-EU evolutions was less marked, with values below two percentage points. This apparent similarity in evolution hides quite important differences between the industries, however. For the largest emitters of CO_2 for instance, the electricity and gas industry and the basic metals industry, the share of intra-EU imports clearly augmented, but for other important industries, like the other non-metallic minerals industry and the chemical industry, the opposite evolution was observed.

As a conclusion to this section we can state that between 1995 and 2002 Belgian exports were on average found to be more air emission intensive than Belgian imports. However, the evolution of the environmental terms of trade reveals that by 2002 Belgian imports had become more air emission intensive relative to Belgian exports as was the case in 1995. This evolution has been accompanied by a change in the composition of Belgian imports as concerns the origin. During this period output for extra-EU imports by industries which have an important impact on air pollution have replaced output for intra-EU imports. In some cases there is also an indication that domestic output has been replaced by output for extra-EU imports.

4.2. Relative environmental intensity of exports with respect to total production

The previous section has shown that EL is not only governed by the trade balance but also by the composition of the commodities that are traded. It has been demonstrated that Belgian negative EL, for most of the environmental impacts considered, can be explained by the presence of both a substantial trade surplus and exports that are comparatively air emission intensive with respect to imports. Investigating whether exports are more environment-intensive compared to imports is an important issue, but another interesting issue is whether these exports are more environment-intensive compared to domestic production. In order to investigate this issue for Belgium we computed the relative environmental intensity of exports (REI_X) for each year and pollutant under examination. The REI_X is equal to the average environmental intensity of exports over the average environmental intensity of total production $\left(\overline{r_{prod}} = \frac{P_{prod}}{gdp}\right)$.

$$REI\_X = \left(\frac{\overline{r_x}}{\overline{r_{prod}}}\right) \tag{4.2}$$

When REI_X is greater than one, exports are more emission intensive than total production. Table 8 shows that this was indeed the case for Belgium for each single pollutant in each single year of the period 1995-2002. As Ghertner and Fripp (2007) indicate, this observation is quite normal, since the largest share of traded products are material goods, which are mostly more environmentally intensive than services, while the latter take a much larger share in domestic consumption than in international trade.

Table 8: Environmental intensity of exports with respect to environmental intensity of production

CO_2	N_2O	CH_4	HFCs	SF_6	NO_x	SO_x	NH_3	NMVOC	CO	PM_{10}	CFCs	HCFCs	Pb
1.95	2.33	2.42	1.72	1.64	1.85	2.03	2.73	1.84	2.14	2.43	1.66	1.65	2.39

Ghertner & Fripp (2007) also show how EL is related to the eTT and the REI_X. The formula is as follows:

$$EL = REI\_X * \frac{\left(\frac{M^d}{eTT} - X^d \right)}{gdp} \tag{4.3}$$

Hence, EL will be positive if $\frac{M^d}{X^d} > eTT$. A country will thus export its environmental impact if the extent to which imports exceed exports is more important than the extent to which the average emission intensity of exports exceeds the average emission intensity of imports. In the case of a trade surplus EL might be negative even if the average emission intensity of imports is higher than the average emission intensity of exports. This was the case for Belgium in 2002 for CO_2, HFCs, NO_x and SO_x. The magnitude of the EL, be it positive or negative, is augmented to the extent that exports are composed of a larger part of emission intensive goods than the overall economy. Table 8 showed that the latter was indeed the case in Belgium. EL of NH_3 is inflated most, with a REI_X equal to 2.73, while the lowest EL inflation factor is observed for SF_6, for which REI_X equalled 1.64.

5. Conclusions

This paper investigates the issue of environmental leakage with respect to air emissions for Belgium in the period 1995-2002. We find that during those years Belgium mainly was a net exporter of embodied emissions. In other words, Belgium produced more air emission intensive products than necessary to satisfy its domestic use. Belgium produced "dirty" goods for the rest of the world. However, we also notice that as time elapsed, the air emission intensiveness of its imports increased relative to the air emission intensiveness of its exports. As a matter of fact, by the end of the observation period imports had become more air emission intensive than exports for a majority of the fourteen pollutants under investigation. This change in the relative emission intensiveness was accompanied by a change in the composition of imports, in the sense that the growth rate of output necessary to produce imports from outside of the EU-15 clearly outpaced the growth rate of output necessary to produce intra-EU-15 imports. This might be interpreted as an indication of environmentally inspired offshoring, with air emission intensive activities moving to places outside of the EU, where environmental rules are less stringent. However, the available data do not allow us to check whether environmental concerns are indeed the driver behind the change in the import composition or whether the change in air emission intensiveness is just the result of changes in trade patterns driven by other motivations. In order to substantiate the environmentally inspired offshoring interpretation import figures ought to be disaggregated further according to their geographical origin, and changes in the import composition ought to be confronted with a database on environmental regulation by country.[28] Furthermore, more recent data are necessary in order to confirm that the observed increase of the emission intensiveness of imports was not just a temporary phenomenon, as rather a stable trend.

28 A database comparable to the one created by the European Bank for Reconstruction and Development in order to track market reforms and liberalisation in Eastern European countries seems highly desirable for this purpose.

6. References

Ahmad N. & Wyckoff A., 2003, "Carbon Dioxide Emissions Embodied in International Trade of Goods", OECD STI Working Paper 2003/15, OECD, Paris

Antweiller, 1996, "The pollution terms of trade", Economic systems research, 8, 361-365.

Avonds L., Hambye C & Michel B., 2007, "Supply and Use Tables for Belgium 1995-2002: Methodology of Compilation, Working 4-07", Federal Planning Bureau, Brussels

Battjes, Noorman & Beiesiot, 1998, "Assessing the energy intensities of imports", Energy economics, 20, 67-83

Cole M., 2004, "US environmental load displacement: examining consumption, regulation and the role of NAFTA", Ecological economics, 48, 439-450

Ghertner D.A. & Fripp M., 2007, "Trading away damage: Quantifying environmental leakage through consumption-based, life-cycle analysis", Ecological Economics, 563-577

Gilis S. & Vandille G., 2004, "The NAMEA Air for Belgium (1990/1994-2001)", Federal Planning Bureau, Brussels

Hamasaki H., 2007, "Carbon Leakage and a Post-Kyoto Framework", FRI, n°287, April 2007

Kondo Y., Moriguchi Y., Shimizu H., 1998, "CO_2 emissions in Japan: influences of imports and exports", Applied energy, 59, 163-174

Leontief W., 1970, "Environmental repercussions and economic structure: an input-output approach", The review of economics and statistics, 52(3):262-271.

Machado G., Schaeffer R. & Worrell E., 2001, "Energy and carbon embodied in international trade of Brazil: an input-output approach", Ecological economics, 39, 409-424

Moll S., Villanueva A., Vrgoc M., Watson D., Gravgård Pedersen O. & Femia A., 2006, "Environmental Input-Output Analysis Based on NAMEA Data: a Comparative European Study on Environmental Pressures Arising from Consumption and Production Patterns", European Topic Centre on Resource and Waste Management, Working Paper 2007/2

Muradian R., O'Connor M. & Martinez-Alier J., 2002, "Embodied pollution in trade: estimating the environmental load displacement of industrialized countries", Ecological Economics, 41

Oliveira-Martins J., Burniaux J-M & Martin J.P., 1992, "Trade and the Effectiveness of Unilateral CO_2-Abatement Policies: Evidence from GREEN", OECD Economic Studies, n°19

Schaeffer R. & Sá A.L., 1996, "The Embodiment of carbon associated with Brazilian imports and exports", Energy conversation and Management, 37 (6-8), 955-960

Tukker & Jansen, 2006, "Environmental impacts of products: a detailed review of studies", Journal of industrial ecology, 159-182

Watson D. & Moll S., 2008, "Environmentally benefits and disadvantages of economic specialization within global markets, and implications for SCP monitoring", Paper for the SCORE! Conference, 10-11 March 2008, Brussels, Belgium

Wyckoff A. & Roop, 1994, "The embodiment of carbon in imports of manufactured products – implications for international agreements on greenhouses gas emissions", Energy policy, 22(3):187-194.

7. Annex

Annex 1: Industry classification, based on NACE rev. 1

A	**01-02**	**Agriculture, hunting and forestry**
B	**05**	**Fishing**
	14	Other mining and quarrying
	15-16	Manufacture of food, beverages and tabacco products
	17-19	Manufacture of textiles, wearing apparel, tanning and leather products
	20	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and manufacture plaiting materials
	21-22	Manufacture of paper, publishing and printing
	23	Manufacture of coke, refined petroleum products and nuclear fuel
	24	Manufacture of chemicals and chemical products
	25	Manufacture of rubber and plastic products
	26	Manufacture of other non-metallic mineral products
	27	Manufacture of basic metals
	28	Manufacture of fabricated metal products, except machinery and equipment
	29	Manufacture of machinery and equipment n.e.c.
	30-33	Manufacture of office and electrical machinery, communication equipment, medical instruments and clock
	34-35	Manufacture of motor vehicles and other transport equipment
	36	Manufacture of furniture; manufacturing n.e.c.
	37	Recycling
	40	Electricity, gas, steam and hot water supply
	41	Collection, purification and distribution of water
F	**45**	**Construction**
G	**50-52**	**Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and**
H	**55**	**Hotels and restaurants**
	60	Land transport; transport via pipelines
	61	Water transport
	62	Air transport
	63	Supporting and auxiliary transport activities; activities of travel agencies
	64	Post and telecommunications
J	**65-67**	**Financial intermediation**
K	**70-74**	**Real estate, renting and business activities**
L	**75**	**Public administration and defence; compulsory social security**
M	**80**	**Education**
N	**85**	**Health and social work**
O	**90-93**	**Other community, social and personal service activities**

Annex 2: Share in total 1995-2002 emissions (production approach)

		CO_2	N_2O	CH_4	HFCs	SF_6	NO_x	SO_x	NH_3	NMVOC	CO	PM_{10}	CFCs	HCFCs	Pb
A	01-02	3	49	70	1	0	5	5	97	1	1	54	1	0	0
B	05	0	0	0	0	0	1	0	0	0	0	1	0	0	0
	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15-16	3	1	0	3	0	2	4	0	3	0	1	3	2	1
	17-19	1	0	0	1	0	0	1	0	1	0	0	1	0	0
	20	0	0	0	0	0	1	0	0	1	0	1	0	0	0
	21-22	1	0	0	1	0	1	2	0	8	0	0	0	0	0
	23	5	2	0	0	0	4	19	0	11	2	2	0	0	1
	24	9	37	0	7	0	6	8	1	17	2	14	7	3	0
	25	0	0	0	5	0	0	0	0	1	0	0	0	58	0
	26	11	1	0	2	71	10	14	1	3	3	4	1	1	6
	27	16	3	1	1	0	8	11	0	3	63	4	0	0	70
	28	0	0	0	1	0	0	0	0	2	0	0	1	0	0
	29	0	0	0	5	0	0	0	0	0	0	0	0	2	0
	30-33	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	34-35	0	0	0	1	0	0	0	0	5	0	0	1	0	0
	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	37	0	0	0	1	0	0	0	0	0	0	0	26	5	0
	40	23	0	5	17	19	14	28	0	4	1	4	15	8	1
	41	0	0	0	1	0	0	0	0	0	0	0	0	0	0
F	45	2	0	0	1	0	2	2	0	5	3	1	1	0	0
G	50-52	2	0	0	16	1	2	0	0	9	4	1	13	7	3
H	55	0	0	0	4	0	0	0	0	0	0	0	4	2	0
	60	9	2	0	9	0	21	2	0	12	11	7	3	1	7
	61	1	0	0	0	0	1	0	0	0	0	0	0	0	0
	62	4	0	0	0	0	6	1	0	3	2	0	0	0	2
	63	1	0	0	5	1	4	0	0	2	2	1	4	2	1
	64	1	0	0	1	0	2	0	0	1	0	1	1	0	0
J	65-67	0	0	0	1	0	0	0	0	0	0	0	1	0	0
K	70-74	2	0	0	11	4	3	0	0	2	2	1	11	5	1
L	75	1	0	0	3	1	1	0	0	1	1	0	2	1	1
M	80	1	0	0	1	0	0	0	0	0	0	0	1	0	0
N	85	1	2	0	1	0	1	0	0	0	0	0	1	0	0
O	90-93	2	1	23	2	0	2	1	1	3	1	1	2	1	3

Annex 3: Share in total 1995-2002 emissions (avoided emissions approach)

		CO_2	N_2O	CH_4	HFCs	SF_6	NO_x	SO_x	NH_3	NMVOC	CO	PM_{10}	CFCs	HCFCs	Pb
A	01-02	4	57	73	1	0	6	5	98	2	1	60	1	0	0
B	05	0	0	0	0	0	2	0	0	1	1	3	0	0	0
	14	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	15-16	2	0	0	3	0	2	4	0	3	0	1	3	1	1
	17-19	1	0	0	0	0	0	0	0	1	0	0	0	0	0
	20	0	0	0	0	0	1	0	0	1	0	1	0	0	0
	21-22	1	0	0	1	0	1	2	0	9	0	0	1	0	0
	23	5	2	0	0	0	3	18	0	11	2	2	0	0	1
	24	8	30	0	5	0	5	7	1	15	2	11	6	3	0
	25	0	0	0	5	0	0	0	0	1	0	0	0	57	0
	26	9	0	0	1	66	9	12	0	2	3	3	1	1	6
	27	14	2	0	1	0	7	10	0	3	60	3	0	0	69
	28	0	0	0	1	0	0	0	0	2	0	0	1	0	0
	29	0	0	0	6	0	0	0	0	0	0	0	0	2	0
	30-33	0	0	0	1	0	0	0	0	0	0	0	1	0	0
	34-35	0	0	0	1	0	0	0	0	6	0	0	1	0	0
	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	37	0	0	0	0	0	0	0	0	0	0	0	23	4	0
	40	29	1	5	20	24	18	33	0	5	1	4	18	10	1
	41	0	0	0	1	0	0	0	0	0	0	0	0	0	0
F	45	2	0	0	1	0	2	2	0	6	4	1	1	0	0
G	50-52	1	0	0	14	1	2	0	0	8	4	1	12	7	3
H	55	0	0	0	5	0	0	0	0	0	0	0	4	2	0
	60	8	2	0	8	0	19	1	0	11	11	6	3	1	7
	61	1	0	0	0	0	1	0	0	0	0	0	0	0	0
	62	4	0	0	0	0	6	1	0	3	3	0	0	0	2
	63	1	0	0	4	1	3	0	0	2	2	1	3	2	1
	64	1	0	0	1	0	2	0	0	1	0	1	1	0	0
J	65-67	0	0	0	1	0	0	0	0	0	0	0	1	0	0
K	70-74	2	0	0	11	4	3	0	0	2	2	1	11	5	1
L	75	1	0	0	3	1	1	0	0	1	1	0	3	1	1
M	80	1	0	0	1	0	1	0	0	0	0	0	1	0	0
N	85	1	2	0	1	0	1	0	0	0	0	0	1	0	0
O	90-93	2	1	21	2	0	2	1	1	3	1	1	2	1	4

Annex 4: Percentage growth of output necessary to produce extra- and intra-EU imports by industry *(1995-2002)*

		Extra-EU	Intra-EU
A	01-02	27	16
B	05	-29	-19
	14	-21	-16
	15-16	26	21
	17-19	22	-10
	20	14	26
	21-22	31	11
	23	20	2
	24	76	13
	25	42	0
	26	58	20
	27	-11	19
	28	57	28
	29	32	-2
	30-33	56	26
	34-35	20	5
	36	18	-16
	37	22	19
	40	21	44
	41	-17	-25
F	45	69	60
G	50-52	78	41
H	55	119	47
	60	44	46
	61	53	93
	62	27	37
	63	3	20
	64	255	182
J	65-67	-4	69
K	70-74	114	72
L	75	80	76
M	80	121	22
N	85	-18	-32
O	90-93	36	63