A decomposition analysis of the emission of CO2

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Abstract:
In 1997 many countries, including the Netherlands, signed the Kyoto treaty. According to this protocol, the emission of CO2 in the Netherlands in the years 2008-2012 should be on average 6% below the level of 1990. However, the emission still shows an increasing pattern. Part of the increase may be compensated by supporting projects abroad, hence the goals may still be reached if domestic emission does not increase too far. All in all, it is not sure whether the Netherlands will meet the goals of this protocol.

Several factors contribute to changes in the emission of CO2. The figures of CO2 emission only show the net effect. In order to see whether technological changes decreases the emission of CO2 and whether the increase in CO2 is mainly due to economic growth, this paper uses a decomposition analysis to compute the effect of these factors.

In order not to complicate the analysis too much, it was decided to focus on the emissions of CO2 and ignore the other greenhouse gasses. The emission of CO2 is the most important issue, because CO2 is the most important greenhouse gas and because the emission of the other greenhouse gasses is decreasing whereas the emission of CO2 is increasing. Policy is therefore likely to be most effective if it focuses on CO2. Further, the decomposition method can only be used to analyse the emission of producers. Emission by consumers is therefore ignored.

Keywords:
input-output analysis, decomposition analysis, indirect effects, , CO2 emission

1. Introduction

In 1997 many countries, including the Netherlands, signed the Kyoto treaty. According to this protocol, the emission of CO2 in the Netherlands in the years 2008-2012 should be on average 6% below the level of 1990. However, the emission still shows an increasing pattern. Part of the increase may be compensated by supporting projects abroad, hence the goals may still be reached if domestic emission does not increase too far. All in all, it is not sure whether the Netherlands will meet the goals of this protocol.

The question who (*i.e.* which sector) emitted CO2 is much easier to answer than the question who is responsible for the emission. For example, if the electricity produces CO2 in order to satisfy the demand for electricity for an other producer, both sectors are at least for a part responsible for the emission. Likewise, both sectors are able to decrease the amount of CO2 emitted in this case: the electricity company can switch to new technologies or less CO2 intensive inputs to generate electricity, while the other producer can adopt a less energy intensive technology. In order to find out who and what causes CO2 emission, this paper uses two methodologies, both based on input-output analysis. First, the direct and indirect emissions of each sector are analysed, in order to answer the question who emits the CO2 and for who this CO2 was emitted. After this, a decomposition analyses is used to analyse which factors contributed in which sectors to changes in the emission of CO2.

The structure of the paper is as follows. Section 2 describes the goals set in the Kyoto protocol for the Netherlands. Then, Section 3 describes the method used to compute the effects of several factors on the emission of CO2, and Section 4 describes the data used in the analysis. The results of the analyses are discussed in Section 5, after which Section 6 compares the outcomes with the goals and the instruments of the climate change policy. Section 7 concludes.

In order not to complicate the analysis too much, it was decided to focus on the emissions of CO2 and ignore the other greenhouse gasses. The emission of CO2 is the most important issue, because CO2 is the most important greenhouse gas and because the emission of the other greenhouse gasses is decreasing whereas the emission of CO2 is increasing. Policy is therefore likely to be most effective if it focuses on CO2. Further, the decomposition method can only be used to analyse the emission of producers. Emission by consumers is therefore ignored.

2. The Kyoto protocol

In 1997 the Kyoto protocol was signed. For the Netherlands, this means that the average emission of greenhouse gasses in the years 2008-2012 has to be at least 6% lower than the emission in 1990, which comes down to an emission of 199 Mtonnes (millions of kilograms) CO2 equivalents. Since the expected emission in 2010 is 239 Mtonnes CO2 equivalents, the emission has to be reduced by 40 Mtonnes. The EU countries agreed that the reduction achieved abroad may be at most 50% percent of the total reduction. Further, about 30% of the reduction will be achieved by reducing the emission of non-CO2 greenhouse gasses. All in all, this means that the domestic reduction of emission of CO2 gas in the Netherlands has to be at least 14 Mtonnes[1].

Between 1995 and 2000, the emission of greenhouse gasses has increased. Since the emission in 1995 was already higher than the emission in 1990, goals set by the government to reach the 1990 level in the year 2000 were not met. Furthermore, most progress was made by the reduction of the emission of non-CO2 greenhouse gasses whereas the emission of CO2 increased substantially. These developments raise doubt about the possibilities to reach the targets in the Kyoto protocol. In order to see whether they can still be reached and where policy may have the most effect, this paper analyses which factors caused the emission of CO2 to increase and which factors decreased the CO2 emission. Answering this question gives insights in the effects of policy measures and may help to develop new policy to reach the Kyoto goals.

[1] The figures in this section are obtained from Ministry of Housing, Spatial Planning and Environment (2002).

3. Decomposition methods

The questions put in the section above will be answered by a decomposition analysis, which shows how much changes in certain factors contributed to changes in a specific variable. Decomposition analyses are widely used in energy studies; Ang (1995) provides an extensive literature review. Hoekstra and Van den Bergh (2003) summarise fundamental differences between different decomposition methods. The most important difference shows the existence of two different types of methods: Index Decomposition Analysis (IDA) and Structural Decomposition Analysis (SDA). The main difference between these two methods is the model used: SDA uses a full input-output table, whereas IDA uses indexes, generally computed at a sectoral level. Due to the data it uses, SDA is able to include technological effects and indirect effects. However, since the data are more difficult to obtain, IDA is more easy to apply and better capable of using more refined methods and more detailed data.

Generally, decomposition analyses use sectoral time data to explain which factors contributed how much to the total change in a certain variable. For example, increases in the emission of CO2 can be attributed to increased energy levels, increased emission per unit of energy generated and changes in the composition of the produced goods in a country. Some studies, however, use the methodology in a different approach. Sun (1999) does not use sectoral data, but uses country data. Hence, he cannot compute the composition effect of the goods produced in the countries, but since he includes many countries his analysis includes a large part of world-wide emissions and he can analyse the consequences of shifts in the production of certain goods between countries. To reduce the level of CO2 emissions, a country can simply start importing goods that cause a lot of the emissions. Although this reduces the emissions of a country, the world as a whole will not be better off. Analyses that focus on one country may suffer from this drawback; an intercountry study as the one of Sun (1999) does not have this disadvantage and even enables the analysis of the consequences of such shifts.

Another way to include intercountry effects is by substituting the time-dimension for a region-dimension. Schipper, Murtishaw, and Unander (2001) use sectoral data of different countries. This analysis shows how differences in countries lead to different levels of emissions, which may open the possibility to get the best of all worlds and reduce the levels in all countries by adapting the factors (such as technologies) which lead to lowest emissions. Luukkanen and Kaivo-oja (2002) include all dimensions: they analyse changes over time in sectoral data of several countries. Since the decomposition method is not suited to include three dimensions, they can only compare the outcomes of each country without analysing the reasons for the differences between countries.

An important difference, also recognised by Hoekstra and Van den Bergh (2003), between decomposition methods is whether or not they are complete. An incomplete method does not assign the entire change in a variable to the factors included in the analysis. The result is a residual which sometimes is substantial. For most methods, a revised version can be derived which attributes the residual to the other factor and turns an incomplete method into a complete method (see, *e.g.,* Ang and Choi, 1997). Zhang and Ang (2001) apply several (complete and incomplete) decomposition methods to the same data. They choose an intercountry approach instead of a, more usual, intertemporal approach, which generally worsens the problem of the residual since intercountry data have greater variation than intertemporal data. Indeed, they find that for a specific incomplete method 'the results (…) contain residuals that are so large that this effectively makes the method unsuitable for cross-country / region decomposition analysis' (Zhang and Ang, 2001, p. 185). Although the residuals of an other incomplete method are much smaller, they remain considerable. The comparison of different methods shows that they lead to different outcomes. However, the methods do find the same order of importance of the different factors and they generally (although not always) agree on the signs of the factors.

There has been some debate in decomposition analyses referring to the emission of CO2 as to whether the actual emission of CO2 or energy intensity should be the variable that is decomposed (Ang, 1999). Both variables are important for understanding the developments in the emission of CO2. New technologies may change the energy intensity in production process as well as the CO2 intensity of energy, although the former may be more likely than the latter. Since our focus will be on technological changes and whether or not these changes happen fast enough to reach the Kyoto goals, we choose a specification that will fit our need best. The Kyoto goals are stated in terms of CO2 emission. Therefore, we choose a method that uses the emission of CO2 a the prime variable, and we include the effects of changes in energy intensity in one of the explanatory factors.

This brings us to the question of which factors we want to include in the analysis and what specification we choose. Clearly, the nature of the problem we want to analyse is intertemporal: it tries to explain which factors and sectors contributed to changes in the emission over time for one country (The Netherlands). As mentioned above, we want to explicitly include the effects of technological changes. Further, we want to include the effects of economic growth, since most analyses show that this factor is responsible for most of the changes in CO2 emission (see, *e.g.*, Sun, 1999, Schipper, Murtishaw, and Unander, 2001, Albrecht, J., D. François, and K. Schoors, 2002). All these requirements can be reached by applying an SDA. We are aware, however, that the exact specification of the SDA influences the results. In order to neutralise this effect, we choose a complete method that leads to results which are most likely to be close to the average of several different decomposition methods (Dietzenbacher and Los, 1998).

The general form of an SDA is described by, among others, Skolka (1989). The principle can best be described by a relation with two factors, but it is easily extended to more factors. Suppose that a variable **x** depends on two variables **L** and **f** in a multiplicative relation:

$\mathbf{x} = \mathbf{Lf}$.

Changes in variable x can now be expressed as follows:

$$\Delta\mathbf{x} = \mathbf{x}_{t+1} - \mathbf{x}_t = \mathbf{L}_{t+1}\mathbf{f}_{t+1} - \mathbf{L}_t\mathbf{f}_t = \Delta\mathbf{L}\mathbf{f}_t + \mathbf{L}_{t+1}\Delta\mathbf{f}$$

Which shows how much changes in variables **L** and **f** contributed to changes in variable **x**. This relation, however, is not unique, since it can also be written as

$$\Delta\mathbf{x} = \mathbf{x}_{t+1} - \mathbf{x}_t = \mathbf{L}_{t+1}\mathbf{f}_{t+1} - \mathbf{L}_t\mathbf{f}_t = \Delta\mathbf{L}\mathbf{f}_{t+1} + \mathbf{L}_t\Delta\mathbf{f}$$

or as

$$\Delta\mathbf{x} = \mathbf{x}_{t+1} - \mathbf{x}_t = \mathbf{L}_{t+1}\mathbf{f}_{t+1} - \mathbf{L}_t\mathbf{f}_t = \Delta\mathbf{L}\mathbf{f}_{t+1} + \mathbf{L}_{t+1}\Delta\mathbf{f} - \Delta\mathbf{L}\Delta\mathbf{f}$$

or as

$$\Delta\mathbf{x} = \mathbf{x}_{t+1} - \mathbf{x}_t = \mathbf{L}_{t+1}\mathbf{f}_{t+1} - \mathbf{L}_t\mathbf{f}_t = \Delta\mathbf{L}\mathbf{f}_t + \mathbf{L}_t\Delta\mathbf{f} + \Delta\mathbf{L}\Delta\mathbf{f}$$

The last factor in the last two equations is interpreted as an interaction effect. The main differences between the decomposition equations are the weights of the factors and the interaction effect. The first two equation show inconsistent weights, since one factor is weighted with year *t*+1 and the other factor with year *t*. The last two methods have consistent weights, but they also have interaction effects. If the number of factors increases, the number of possible decomposition methods increases even further. Although theoretically none of the methods is preferred to the other methods, the outcomes my differ substantially. To solve this problem, usually an average of several methods is used. Dietzenbacher and Los (1998) try several methods and averages of these methods. They find that the average of two special cases, the so-called polar decomposition methods, are close to the overall results. Since this method keeps the number of necessary computations within reasonable limits and is likely to lead to meaningful results, this paper will also use the average of the polar decomposition methods.

A polar decomposition method is an equation in which all weights on the right hand side of each factor are from the same year, and all weights on the left hand side of each factor are from the other year. In the example with only two factors above, the first two possibilities are the polar decomposition methods.

The analysis of the CO2 emission in this paper is based on SDA, which uses input-output tables to separate the effects of economic growth from technological effects on changes in CO2-emission. Both factors are relevant for climate change policy: economic growth is often named as the most important reason why the emission of greenhouse gasses keeps increasing, and technological changes are often suggested for decreasing the emissions (see, *e.g.*, Ministry of Housing, Spatial Planning and Environment, 2002). Therefore, the derivation of the decomposition equation stars with the input-output model. Input output analysis establishes a direct relation between total output and final demand[2]:

$$\mathbf{x} = \mathbf{Lf},$$

in which
x = a vector with total output per sector,
L = the Leontief inverse matrix,
f = a vector with total final demand per sector.

The Leontief inverse is calculated as

$$\mathbf{L} = (\mathbf{I} - \mathbf{A})^{-1}$$

in which
I = an identity matrix
A = the matrix with inputcoefficients: each element a_{ij} denotes total intermediate deliveries from sector *i* to sector *j* divided by total input of sector *j*, and can be interpreted as the amount of product *i* needed to produce one unit of the product of sector *j*.

The columns with input coefficient are often interpreted as the technology to produce the product of the sector belonging to the column. Hence, changes in this matrix can be interpreted as technological changes. They may, however, also denote outsourcing or substitution of domestic production for imports.

The vector with total final demand, **f**, is often written as a matrix, **F**, with final demand split up in certain categories, usually private consumption, government consumption, investments, and exports. The row totals of this matrix correspond to the vector with total final demand. There is another way to obtain the vector with total final demand from the matrix with final demand per category. First, divide the elements of **F** by their column totals:

$$\mathbf{B} = \mathbf{F}\hat{\mathbf{y}}^{-1}$$

where a ^ above a variable indicates a matrix with the elements of the vector on its main diagonal and zeroes everywhere else, and
B = matrix with final demand coefficients,
y = vector with total final demand per category.

[2] For an excellent and thorough description of input-output analysis, the reader is referred to Miller and Blair (1985).

Then

f = **By**

With the use of this relation, total output can be computed as

x = **LBy**

The relation between CO2 and input-output analysis can be achieved by expressing the emission of CO2 per unit of total output:

$$\mathbf{c}' = \mathbf{co_2}'\,\hat{\mathbf{x}}^{-1}$$

in which a ` indicates a row vector instead of a column vector, and

$\mathbf{co_2}$ = vector with emission of CO2 per sector,
$\mathbf{c}$ = vector with emission of CO2 per sector divided by total output of that sector.

Total emission of CO2, co_2, can be obtained by summing over all sectors, or as

$$co_2 = \mathbf{c}'\mathbf{x} = \mathbf{c}'\mathbf{LBy}$$

With the last equation, changes in the total emission of CO2 can be attributed to changes in the factors **c**, **L**, **B** and **y**. Although changes in the input coefficient matrix can be interpreted as technological changes, changes in the Leontief inverse are more difficult to interpret. Therefore, the Leontief inverses of periods *t* and *t+1* are rewritten according to the following equations:

$$\mathbf{L_{t+1}} = \mathbf{L_{t+1}}(\mathbf{I} - \mathbf{A_t})\mathbf{L_t} = \mathbf{L_t}(\mathbf{I} - \mathbf{A_t})\mathbf{L_{t+1}}$$

and

$$\mathbf{L_t} = \mathbf{L_{t+1}}(\mathbf{I} - \mathbf{A_{t+1}})\mathbf{L_t} = \mathbf{L_t}(\mathbf{I} - \mathbf{A_{t+1}})\mathbf{L_{t+1}}$$

With these equation, the first polar decomposition expresses the relation as

$$\Delta co_2 = \Delta\mathbf{c}'\mathbf{L_{t+1}B_{t+1}y_{t+1}} + \mathbf{c_t}'\mathbf{L_t}\,\Delta\mathbf{A}\,\mathbf{L_{t+1}B_{t+1}y_{t+1}} + \mathbf{c_t}'\mathbf{L_t}\,\Delta\mathbf{B}\,\mathbf{y_{t+1}} + \mathbf{c_t}'\mathbf{L_tB_t}\,\Delta\mathbf{y}$$

and the second polar decomposition becomes

$$\Delta co_2 = \Delta\mathbf{c}'\mathbf{L_tB_ty_t} + \mathbf{c_{t+1}}'\mathbf{L_{t+1}}\,\Delta\mathbf{A}\,\mathbf{L_tB_ty_t} + \mathbf{c_{t+1}}'\mathbf{L_{t+1}}\,\Delta\mathbf{B}\,\mathbf{y_t} + \mathbf{c_{t+1}}'\mathbf{L_{t+1}B_{t+1}}\Delta\mathbf{y}$$

The average of these two methods yields the final equation of the decomposition method that will be used in the analysis:

$$
\begin{aligned}
&\Delta co_2 \\
&= \tfrac{1}{2}\,\Delta \mathbf{c}\left(\mathbf{L_{t+1}B_{t+1}y_{t+1}} + \mathbf{L_t B_t y_t}\right) \\
&+ \tfrac{1}{2}\left(\mathbf{c_{t+1}L_{t+1}}\ \Delta\mathbf{A}\ \mathbf{L_t B_t y_t} + \mathbf{c_t L_t}\ \Delta\mathbf{A}\ \mathbf{L_{t+1}B_{t+1}y_{t+1}}\right) \\
&+ \tfrac{1}{2}\left(\mathbf{c_{t+1}L_{t+1}}\ \Delta\mathbf{F}\ \mathbf{B_t} + \mathbf{c_t L_t}\ \Delta\mathbf{F}\ \mathbf{B_{t+1}}\right) \\
&+ \tfrac{1}{2}\left(\mathbf{c_{t+1}L_{t+1}B_{t+1}} + \mathbf{c_t L_t B_t}\right)\Delta\mathbf{y}
\end{aligned}
$$

This equation expresses the change in the emission of CO2 as the result of four factors, respectively:

- changes in CO2 intensity (emission coefficients)
- changes in input coefficients
- changes in the composition of final demand
- changes in the level of final demand (economic growth)

The first factor denotes the effects of technological changes that changed the emission of CO2 per unit of output. The second factor denotes the effects of technological changes that change the products needed as inputs in the production process of a certain sector. It reflects how much the emission of CO2 decreased due to a shift from CO2 intensive inputs to CO2 extensive inputs. However, this factor also reflects changes based on outsourcing and import substitution. The third factor denotes the effects on the emission of CO2 due to changes in the composition of final demand. If final demand of CO2 extensive inputs increased relative to demand of CO2 intensive products, it shows a decrease in the total emission of CO2, even if final demand of both sorts of products went up, since it only takes account of the composition of final demand. The effects of the level of final demand are denoted by the last factor.

4. Description of the data

The analysis uses input-output tables of 1995 and 2000. The data are obtained from the National Accounts of the Dutch national statistical office (Statistics Netherlands, 2002). The original 1995 table is issued at 105 sectors. Since CO2 emission data are issued at 36 sectors, the original tables were aggregated to these sectors. The transport and trade margins were added as the 37th sector. Since there are no emission data of this sector, the analysis starts with an emission by this sector of zero. Appendix A describes the aggregation scheme and the sector classification of the 37 sectors used in the analyses.

Statistics Netherlands issues all data in current prices and in prices of the former year. A series of these data for all years between 1995 and 2000 was used to express the 2000 table in 1995 prices with the use of chain indices. Since this deflation method yields inconsistent results with respect to the totals (totals deflated in this way differ from the aggregation of the deflated elements), the totals were recomputed by aggregating the deflated elements in the input-output tables. The figures for imports were aggregated with the import duties, subsidies and taxes. Then, deflated value added was computed as the difference between the row total of a sector, the total of the intermediate deliveries in its column and its imports. The figures for final demand were aggregated into four categories: private consumption, government consumption, investments and exports, according to the scheme in Appendix A. Deflation took place at the most disaggregated level, after which the data were aggregated to the 37 sectors.

Finally, two changes were made to the input-output table. First, for statistical reasons the transport and trade margins are recorded as final demand and primary costs. However, since these margins have important economic feedback effects, they should be included in the intermediate deliveries for the current analysis. The total of this sector is zero, which is caused by a negative main diagonal element equal to the total of all other elements in the row or column. Since this is unwanted in input-output analysis, the element on the main diagonal was put to zero. Second, the sector 'Electricity Supply' has a very high delivery to itself. Statistics Netherlands explained that this element contains the deliveries of all generated electricity to the electricity distribution sector, which delivers it to other sectors. However, in the input-output table the sectors Electricity Supply and Electricity Distribution are aggregated, by which all electricity is counted twice and ends up in the main diagonal element of the electricity sector. This large element leads to an overestimation of the use of electricity by the electricity sector. According to figures of Statistics Netherlands, the element should be about 5% of the current value. Hence the main diagonal element of the sector 'Electricity Supply' was divided by 20 for both 1995 and 2000.

Finally, it is important to note that the figures of the emission of CO2 are not yet final. They are estimates of Statistics Netherlands and will possibly change in future editions of the National Accounts. Former experiences with similar data allow for safely assuming that the conclusions of the analysis are robust to these changes.

5. Empirical results

Table 1 shows some basic features of the emission of CO2 per sector. The second column indicates how much Mtonnes CO2 each sector emitted in 2000 (the first column contains the names of the sectors). Not surprisingly, most CO2 is emitted by the electricity sector, transportation, the oil industry and the chemical industry. Column three of Table 1 shows the emission figures divided by total output of the sectors. Although Fishery now has the first place, the list does not change much. Again, the electricity sector, transportation, the oil industry and the chemical industry have most CO2-emission. Much of the emission of these sectors was done in order to produce intermediate goods. Hence, although the sectors did emit the CO2, the emission took place in order to enable another sector to produce its product. For example, electricity used by a farmer causes CO2 emission by the electricity sector for the agricultural sector. Indirectly, agriculture can be held responsible for this emission. Total CO2 emission may decrease if the buying sectors use inputs with low CO2 emissions instead of inputs with high CO2 emission.

Input-output tables allow for the computation of indirect effects. These indirect effects are included in the elements of the Leontief inverse. If demand for the product of a certain sector increases, the initial increase in total output of an economy is this increase in final demand. However, to produce the extra demand, the sector needs intermediate inputs produced by other sectors, which increases the demand of other sectors as well. This is called the direct effect of the initial increase in demand. In order to produce the intermediate inputs of the direct effect, these sectors also need inputs, which further increases demand, and so on. These effects are the indirect effects. The direct effect of the increase in demand can be seen in the columns of the matrix with input coefficients. The direct and indirect effects are included in the Leontief inverse: an element l_{ij} of the Leontief inverse denotes the total increase in total output of product *i* if the final demand of product *j* increase by exactly one unit. Hence, a column sum of the Leontief inverse denotes the increase in total output of the entire economic system due to an increase in final demand of product *j* by exactly one unit. This is also known as the backward total output multiplier of sector *j*. Since the vector **c** contains the emission per total output of each sector, the vector $\mathbf{c}'\mathbf{L}$ denotes the total extra emission of CO2 in the economic system, directly and indirectly, due to the increase in final demand of sector *j* with one unit. These figures are denoted in the fourth column of Table 1.

If the diagonalised matrix of the vector **c** were used, the result would be a matrix with elements denoting the extra emission of CO2 by sector *i* due to an increase of final demand of sector *j* with one unit. Therefore, the matrix $\hat{\mathbf{c}}\mathbf{L}\mathbf{f}$ shows how much CO2 was emitted by sector *i* due to final demand of sector *j*, or, in other words, how much CO2 was emitted *by* sector *i for* sector *j*. The row totals of this matrix add up to the total emission of each sector, the column totals show how much indirect CO2 emission the sector can be held responsible for, *i.e.* how much CO_2 is emitted *for* the sector instead of *by* the sector. These figures are displayed in column five of Table 1. Both column four and five of Table 1 show that the sectors with most indirect emission of CO_2 are about the same as the sectors with most direct emission, even though the direct emission of the electricity sector is about twice as large as the indirect emission. Interestingly, the transport and trade margins show up with large emissions, reflecting the fact that transportation is responsible for a large part of the CO_2 emission. Due to lack of data, however, this could not be seen in the direct emissions.

The analysis above actually assigns the emission of CO_2 to final demand of the sectors. After all, intermediary products are only used in order to fulfil the final demand to a sector's product. Hence, the analysis above registers how much CO_2 is emitted in the entire economic system in order to fulfil the final demand of a sector. Since final demand is distinguished at four categories, it is possible to calculate for each category how much CO_2 was emitted in order to produce it. This does not only depend on the share of the categories in total final demand, but also on the sectoral compositions of the four categories. The relevant figures can be obtained by using the final demand matrix rather than total final demand. The vector $\mathbf{c'LF}$ contains 4 numbers indicating how much CO_2 was emitted for private consumption, government consumption, investments and exports. This shows that exports generated most CO_2 emission: it is responsible for 55% of the entire emission of CO_2 in 2000. Private consumption is responsible for 28%, government consumption for 10% and investments for 8 %. The shares of the categories in final demand are respectively 39%, 29%, 18% and 13%.

Although much CO_2 is emitted for foreign users, imports have the opposite effect, since they generate CO_2 emission in foreign countries for Dutch users. With the National Accounts data, it is possible to compute the CO_2 trade balance, analogue to Machado, Schaeffer and Worrell (2001). In the case of the Netherlands, however, the result is predictable: since there is a trade surplus, exports contain more CO_2 than imports. A more interesting analysis is the computation of the CO_2 intensity per unit of export and import. If **e** denotes the export coefficients, *i.e.* exports per sector divided by total exports, and **m** the import coefficients, the CO_2 intensity of exports respectively imports can be computed as $\mathbf{cLe}$ and $\mathbf{cLm}$. This exercise shows that in 1995 every guilder of export generated 0.30 kilo CO_2 emission, whereas every guilder of import incorporates 0.28 kilo CO_2. Exports are not only larger than imports, they are also more CO_2 intensive. Hence, the trade balance position of the Netherlands is unfavourable for domestic CO_2 emission. In 2000, however, the numbers have changed: both exports and imports incorporated 0.24 kilo CO_2. The decrease in the CO_2 intensity of exports as well as the levelling of CO_2 intensity of imports and exports are favourable for the Dutch CO_2 trade balance, but the CO_2 trade balance will still show a surplus.

Table 2 shows the results of the decomposition analysis. Technological and composition changes decreased the emission of CO_2 substantially, with 14 Mtonnes due to technological changes that influenced the emission coefficients directly, 3 Mtonnes due to technological changes that affected the input structures, and 12 Mtonnes due to changes in the composition of final demand. These effects are more than nullified by the effects of increasing economic growth: changes in final demand caused the emission of CO_2 to increase by almost 37 Mtonnes. The sectoral results in Table 2 show an interesting pattern for the changes in CO_2 emissions due to technological changes with respect to the emission coefficients. Most sectors developed cleaner technologies with less CO_2 emission per unit of output. However, a few sectors stand out with technologies that became more CO_2 extensive. The most important effects take place in the electricity sector and the oil industry. Although this seems to imply that the electricity sector switched to more emission generating techniques, the results may be due to data errors. To analyse whether this is the case, we checked the robustness of the results by repeating the analysis for the period 1995-1999. This showed that most conclusions did not change, except for the effect of changes in the CO_2 intensity for the electricity sector; instead of being responsible for 1 megaton extra CO_2, it decreased the emission of CO_2 with 2 megatons according to the 1999 figures. Clearly, the detailed sector specific results are not always very robust, which makes it dangerous to draw far-reaching conclusions on these data. The conclusion for the oil industry, however, was the same for the 1999 and the 2000 data. Table 3 displays the results of the 1999 analysis.

Since many decomposition analyses conclude that a decrease in the energy intensity contributes substantially to lower CO2 emission (see, *e.g.*, Ang, 1999, Sun, 1999, Schipper, Murtishaw, and Unander, 2001, Albrecht, J., D. François, and K. Schoors, 2002), it is interesting to take a look at the outcomes in Tables 2 and 3. The reduction in the input structure due to changes in inputs from the electricity sector are in both cases relatively large. Although it is tempting to conclude that these results confirm that the decreases in energy intensity is an important for reducing the emission of CO2, they may also be due to an increase in imported electricity. Indeed, a look at the import data shows that imports of electricity increased by 73% between 1995 and 2000.

Because the effect of final demand is by far the largest effect, it is split up in its four components. These figures are displayed in Table 4. It shows that most emission was generated by changes in exports. This is for a large part explained by the increase in exports (about 30%, against private consumption 20%). Again, emissions of CO2 in the Netherlands are for a large part caused by foreign users.

6. Policy implications

The Dutch climate change policy aims at reducing the emission of CO2. For the reduction of domestic CO2 emission, several policy measures were introduced which mainly concern the emission of CO2 by the electricity sector: an energy tax and fiscal advantages should decrease the use of energy, and generation of less CO2 intensive energy is supported (Ministry of Housing, Spatial Planning and Environment, 1999). Although the outcomes of the analysis above do not compute the effects of the climate change policy, it is possible to analyse whether the outcomes are in line with the desired developments. Table 2 shows that much reduction of CO2 emission has been achieved by decreasing the emitted CO2 per unit of output. This points at new technologies that are in line with the intentions of the climate change policy. However, the data per sector show that this has mostly been achieved in the industry, especially in the chemical sector. Whereas reductions due to less CO2 extensive technologies have also been achieved by many service sectors, agriculture and fishery, a few industries have become more CO2 intensive, among which the electricity sector and the oil industry. The result of the first sector is due to data problems, the negative effect of the oil industry is more robust.

Shifts in the input structure did cause a decrease in the emission of CO2 by the electricity sector. A closer look at the figures reveals that this may be due to an extreme increase in the imports of the electricity sector: between 1995 and 2000, imports increased by 73%. Since importing electricity decreases the emissions in the domestic country and increases the emission of CO2 in foreign countries, these observations mean that emission of CO2 by the Dutch electricity sector has been shifted to foreign countries rather than decreased by new technologies.

Other policy goals that have not been achieved concern the total emission of CO2 in years past 2000. According to the climate change policy before Kyoto, the emission of CO2 after 2000 should be 3% less than the emission in 1990 (Ministry of Housing, Spatial Planning and Environment, 1999). Since most increases in CO2 emission are due to economic growth, the reasons for the policy to fail may be that economic growth was higher than expected.

New policy measures that decrease the general level of CO2 emissions by taxing the emission or by selling emission rights, especially hurt sectors for which much CO2 is emitted. Since exports include much CO2, this kind of policy will probably hurt the Dutch export position.

7. Conclusions

Decomposition of CO2 data shows that already much progress has been made with reduction of CO2 emissions by changing to less CO2 intensive technologies. Changes in the composition of final demand show that demand also shifted to more products that may be produced with less CO2 emission. Further, shifts in the inputs needed in the production process also managed to decrease the CO_2 emissions. These effects, however, were more than compensated by increased CO_2 emission due to economic growth. Especially growth in exports led to substantial more CO_2 emission in 2000 than in 1995.

The Dutch climate change policy tries to reduce the emission of CO_2 mainly by reducing the demand for energy and by supporting the production of energy with methods that have lower CO_2 emissions. Of course, other sectors are also supported to shift to other production methods. The aggregate figures indicate that this policy works, since technological changes led to a reduction in CO_2 emissions by 18%.

Both the analysis of the indirect effect and the decomposition analysis showed that much of the CO_2 is emitted for exports. Hence, a strict CO_2 policy is likely to hurt the export positions of the sectors for relatively much CO_2 is emitted.

References

Albrecht, J., D. François, and K. Schoors, 2002, A Shapley Decomposition of Carbon Emissions Without Residuals, *Energy Policy*, vol. 30, pp. 727-736.

Ang, B.W., 1995, Decomposition Methodology in Industrial Energy Demand Analysis, *Energy*, vol. 20, no. 11, pp. 1081-1095.

Ang, B.W., 1999, Is the Energy Intensity a Less Useful Indicator than the Carbon Factor in the Study of Climate Change? *Energy Policy*, vol. 27, pp. 943-946.

Ang, B.W., and K-H Choi, 1997, Decomposition of Aggregate Energy and Gas Emission Intensities for Industry: A Refined Divisia Index Method, *The Energy Journal*, vol. 18, no. 3, pp. 59-73.

Dietzenbacher, E. and B. Los, 1998, Structural Decomposition Techniques: Sense and Sensitivity, *Economic Systems Research*, vol. 10, pp. 307-323.

Hoekstra R., and J.J.C.J.M Van der Bergh, 2003, Comparing Structural and Index Decomposition Analysis, *Energy Economics*, vol. 25, pp. 39-64.

Luukkanen, J. and J. Kaivo-oja, 2002, ASEAN Tigers and Sustainability of Energy Use - Decomposition Analysis of Energy and CO2 Efficiency Dynamics, *Energy Policy*, vol. 30, pp. 281-292.

Machado, G., R. Schaeffer and E. Worrell, 2001, Energy and Carbon Embodied in the International Trade of Brazil: An Input-Output Approach, *Ecological Economics*, vol. 39, pp. 409-424.

Miller, J.E. and P.D. Blair, 1985, *Input-Output Analysis, Foundations and Extensions*, Prentice Hall, Englewood Cliffs.

Ministry of Housing, Spatial Planning and Environment, 1999, *Uitvoeringsnota Klimaatbeleid, deel 1: Binnenlandse Maatregelen*, Ministerie van Volkshuisvesting, Ruimtelijks Ordening en Milieubeheer, Den Haag, ***only in Dutch***.

Ministry of Housing, Spatial Planning and Environment, 2002, *The Progress of the Netherlands Climate Change Policy: An Assessment at the 2002 Evaluation Moment*, Ministry of Housing, Spatial Planning and Environment, Den Haag.

Schipper, L., S. Murtishaw, and F. Unander, 2001, International Comparisons of Sectoral Carbon Dioxide Emissions Using a Cross-Country Decomposition Technique, *The Energy Journal*, vol. 22., no. 2, p. 35-75.

Skolka, J., 1989, Input-Output Structural Decomposition Analysis for Austria, *Journal of Policy Modeling*, vol. 11, pp. 45-66.

Statistics Netherlands, 2002, *National Accounts of the Netherlands 2001*, Statistics Netherlands, Voorburg.

Sun, J.W., 1999, Decomposition of Aggregate CO2 Emissions in the OECD: 1960-1995, *The Energy Journal*, vol. 20, no. 3, pp. 147-155.

Zhang, F.Q., and B.W. Ang, 2001, Methodological Issues in Cross-Country / Region Decomposition of Energy and Environment Indicators, *Energy Economics*, vol. 23, pp. 179-190

Table 1: Basic emission data, 2000, prices of 1995

Sector	CO2 emission *by* sectors Mtonnes	CO2 emission / total output kg / guilder	Indirect CO2 emission / final demand kg / guilder	CO2 emission *for* sectors Mtonnes
Agriculture and foresty	8.9	0.19	0.35	7.6
Fishing	2.7	2.89	3.01	2.3
Crude petroleum and natural gas production	1.9	0.10	0.12	1.1
Other mining and quarrying	0.3	0.15	0.27	0.3
Manufacture of food products, beverages and tobacco	4.6	0.05	0.18	12.7
Manufacture of textille and leather products	0.4	0.04	0.11	0.8
Manufacture of paper and paper products	2.0	0.17	0.25	1.7
Publishing and printing	0.3	0.01	0.05	0.5
Manufacture of petroleum products	12.0	0.67	0.74	8.9
Manufacture of chemical products	22.2	0.33	0.45	23.6
Manufacture of rubber and plastic products	0.3	0.02	0.11	0.8
Manufacture of basic metals	6.5	0.49	0.62	5.1
Manufacture of fabricated metal products	0.8	0.03	0.13	1.8
Manfacture of machinery n.e.c.	0.4	0.01	0.07	1.5
Manufacture of electrical equipment	0.4	0.01	0.06	1.8
Manufacture of transport equipment	0.3	0.01	0.06	1.5
Recycling industries	0.4	0.23	0.38	0.2
Manufacture of wood and wood products	0.2	0.03	0.09	0.1
Manufacture of construction materials	3.0	0.23	0.34	1.1
Other manufacturing	0.2	0.02	0.07	0.9
Electricity supply	48.0	1.91	2.00	22.9
Gas and water supply	0.0	0.01	0.09	0.2
Construction	1.8	0.02	0.09	6.0
Wholesale trade	0.7	0.03	0.07	0.6
Retail trade, repair (excl motor vehicles)	2.1	0.02	0.06	0.5
Hotels and restaurants	2.4	0.03	0.10	2.1
Land transport	8.3	0.29	0.36	4.5
Water transport	7.4	0.79	0.85	7.0
Air transport	12.0	0.83	0.91	10.1
Supporting transport activities	0.4	0.02	0.16	2.3
Financial, business services and communication	4.2	0.01	0.04	6.3
Public administration and social security	3.0	0.03	0.11	8.5
Educaton	0.9	0.03	0.06	2.0
Health and social work activities	1.6	0.02	0.07	4.2
Sewage and refuse disposal services	6.6	0.55	0.81	1.7
Other services	1.1	0.02	0.09	2.5
Trade and transport margins	0.0	0.00	0.11	12.6
Total	168.1	0.10	0.17	168.1

Source: Statistics Netherlands (2002) and own computations

Table 2: Decomposition of changes in CO2 emission between 1995 and 2000, Mtonnes

	emission coefficients	input coefficients	composition final demand	level of final demand	Total
Agriculture and foresty	-1.8	-0.5	-1.1	2.4	-1.0
Fishing	-0.5	-0.4	-0.8	0.8	-0.9
Crude petroleum and natural gas production	0.3	-0.3	-0.2	0.4	0.2
Other mining and quarrying	0.1	0.0	0.0	0.1	0.2
Manufacture of food products, beverages and tobacco	-0.6	-0.1	-0.7	1.2	-0.2
Manufacture of textille and leather products	0.0	0.0	-0.1	0.1	0.0
Manufacture of paper and paper products	-0.2	0.0	-0.2	0.5	0.1
Publishing and printing	0.0	0.0	0.0	0.1	0.0
Manufacture of petroleum products	0.8	-0.9	-2.0	2.9	0.9
Manufacture of chemical products	-6.6	-0.2	-2.1	6.2	-2.7
Manufacture of rubber and plastic products	-0.1	0.0	0.0	0.1	0.0
Manufacture of basic metals	-1.4	-0.1	-0.8	1.8	-0.5
Manufacture of fabricated metal products	0.0	0.0	0.0	0.2	0.1
Manfacture of machinery n.e.c.	-0.1	0.0	0.0	0.1	0.0
Manufacture of electrical equipment	-0.3	0.0	0.1	0.1	-0.1
Manufacture of transport equipment	-0.2	0.0	0.0	0.1	-0.1
Recycling industries	0.2	0.1	0.0	0.0	0.4
Manufacture of wood and wood products	0.0	0.0	0.0	0.0	0.0
Manufacture of construction materials	-0.7	0.2	-0.1	0.7	0.0
Other manufacturing	0.0	0.0	0.0	0.0	0.0
Electricity supply	1.0	-2.3	-4.2	9.1	3.6
Gas and water supply	0.0	0.0	0.0	0.0	0.0
Construction	-0.1	0.0	0.0	0.4	0.2
Wholesale trade	-0.3	0.0	0.0	0.1	-0.1
Retail trade, repair (excl motor vehicles)	-0.4	0.2	0.1	0.4	0.3
Hotels and restaurants	-0.9	-0.1	0.1	0.5	-0.4
Land transport	-0.1	0.0	-0.3	1.6	1.2
Water transport	0.3	-0.1	-0.5	1.7	1.4
Air transport	-0.5	0.4	0.3	2.6	2.9
Supporting transport activities	-0.4	0.0	0.0	0.1	-0.3
Financial, business services and communication	-0.7	0.3	0.4	0.7	0.7
Public administration and social security	-0.1	0.0	0.0	0.3	0.2
Educaton	0.0	0.0	0.0	0.1	0.1
Health and social work activities	-0.3	0.0	0.0	0.2	-0.1
Sewage and refuse disposal services	-0.2	1.1	0.0	0.9	1.8
Other services	-0.1	0.0	0.0	0.2	0.1
Trade and transport margins	0.0	0.0	0.0	0.0	0.0
Total	-13.8	-2.7	-12.2	36.8	8.1

Source: own computations based on Statistics Netherlands (2002)

Table 3: Decomposition of changes in CO_2 emission between 1995 and 1999, Mtonnes

	emission coefficients	input coefficients	composition final demand	level of final demand	Total
Agriculture and foresty	-1.7	-0.3	-0.7	1.6	-1.0
Fishing	-0.4	-0.2	-0.5	0.6	-0.4
Crude petroleum and natural gas production	0.2	-0.1	-0.2	0.3	0.2
Other mining and quarrying	0.0	0.0	0.0	0.0	0.1
Manufacture of food products, beverages and tobacco	-0.1	0.0	-0.5	0.8	0.2
Manufacture of textille and leather products	-0.1	0.0	-0.1	0.1	-0.1
Manufacture of paper and paper products	-0.7	0.0	-0.1	0.3	-0.5
Publishing and printing	0.0	0.0	0.0	0.0	0.0
Manufacture of petroleum products	0.9	-0.5	-1.6	2.0	0.8
Manufacture of chemical products	-2.6	0.5	-2.4	4.3	-0.2
Manufacture of rubber and plastic products	0.0	0.0	0.0	0.1	0.0
Manufacture of basic metals	-0.9	0.2	-0.7	1.2	-0.2
Manufacture of fabricated metal products	0.0	0.0	0.0	0.1	0.1
Manfacture of machinery n.e.c.	0.0	0.0	0.0	0.1	0.0
Manufacture of electrical equipment	-0.3	0.0	0.0	0.1	-0.2
Manufacture of transport equipment	-0.2	0.0	0.0	0.1	-0.1
Recycling industries	0.2	0.1	0.0	0.0	0.3
Manufacture of wood and wood products	0.0	0.0	0.0	0.0	0.1
Manufacture of construction materials	-0.6	0.2	-0.1	0.5	0.0
Other manufacturing	-0.1	0.0	0.0	0.0	0.0
Electricity supply	-2.0	-1.4	-4.1	6.8	-0.7
Gas and water supply	0.0	0.0	0.0	0.0	0.0
Construction	-0.1	0.0	0.0	0.3	0.2
Wholesale trade	-0.3	0.0	0.0	0.1	-0.1
Retail trade, repair (excl motor vehicles)	-0.4	0.2	0.0	0.3	0.1
Hotels and restaurants	-1.1	-0.1	0.1	0.4	-0.8
Land transport	-0.4	0.1	-0.1	1.2	0.8
Water transport	-0.5	0.0	-0.2	1.1	0.4
Air transport	-0.6	0.5	0.5	1.7	2.1
Supporting transport activities	-0.4	0.0	0.0	0.1	-0.3
Financial, business services and communication	-0.7	0.3	0.3	0.6	0.4
Public administration and social security	0.3	0.0	0.0	0.3	0.6
Educaton	-0.1	0.0	0.0	0.1	0.0
Health and social work activities	-0.5	0.0	0.0	0.2	-0.3
Sewage and refuse disposal services	0.4	1.0	0.0	0.7	2.1
Other services	-0.1	0.0	0.0	0.1	0.0
Trade and transport margins	0.0	0.0	0.0	0.0	0.0
Total	-12.6	0.3	-10.2	26.2	3.7

Source: own computations based on Statistics Netherlands (2002)

Table 4: Changes in CO_2 emission due to final demand between 1995-2000, Mtonnes

	Private consumption	Government consumption	Investments	Exports	Total
Agriculture and foresty	0.3	0.0	0.1	2.0	2.4
Fishing	0.1	0.0	0.0	0.6	0.8
Crude petroleum and natural gas production	0.1	0.0	0.0	0.3	0.4
Other mining and quarrying	0.0	0.0	0.0	0.0	0.1
Manufacture of food products, beverages and tobacco	0.2	0.0	0.0	0.9	1.2
Manufacture of textille and leather products	0.0	0.0	0.0	0.1	0.1
Manufacture of paper and paper products	0.0	0.0	0.0	0.4	0.5
Publishing and printing	0.0	0.0	0.0	0.0	0.1
Manufacture of petroleum products	0.3	0.0	0.1	2.6	2.9
Manufacture of chemical products	0.2	0.1	0.1	5.8	6.2
Manufacture of rubber and plastic products	0.0	0.0	0.0	0.1	0.1
Manufacture of basic metals	0.0	0.0	0.2	1.5	1.8
Manufacture of fabricated metal products	0.0	0.0	0.0	0.1	0.2
Manfacture of machinery n.e.c.	0.0	0.0	0.0	0.1	0.1
Manufacture of electrical equipment	0.0	0.0	0.0	0.1	0.1
Manufacture of transport equipment	0.0	0.0	0.0	0.1	0.1
Recycling industries	0.0	0.0	0.0	0.0	0.0
Manufacture of wood and wood products	0.0	0.0	0.0	0.0	0.0
Manufacture of construction materials	0.1	0.0	0.3	0.3	0.7
Other manufacturing	0.0	0.0	0.0	0.0	0.0
Electricity supply	4.4	0.4	0.8	3.4	9.1
Gas and water supply	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.3	0.0	0.4
Wholesale trade	0.1	0.0	0.0	0.1	0.1
Retail trade, repair (excl motor vehicles)	0.1	0.0	0.1	0.2	0.4
Hotels and restaurants	0.2	0.0	0.1	0.2	0.5
Land transport	0.5	0.1	0.1	0.9	1.6
Water transport	0.1	0.0	0.0	1.6	1.7
Air transport	0.3	0.0	0.1	2.2	2.6
Supporting transport activities	0.0	0.0	0.0	0.1	0.1
Financial, business services and communication	0.3	0.0	0.1	0.3	0.7
Public administration and social security	0.0	0.3	0.0	0.0	0.3
Educaton	0.0	0.1	0.0	0.0	0.1
Health and social work activities	0.1	0.1	0.0	0.0	0.2
Sewage and refuse disposal services	0.1	0.4	0.1	0.3	0.9
Other services	0.1	0.0	0.0	0.1	0.2
Trade and transport margins	0.0	0.0	0.0	0.0	0.0
Total	7.9	1.7	2.7	24.5	36.8

Source: own computations based on Statistics Netherlands (2002)

Appendix A: Sector classifications

Sectors according to the 106 sector classification:

1 Arable farming
2 Horticulture
3 Live stock
4 Other Agriculture
5 Service activities related to agriculture
6 Forestry and hunting
7 Fishing
8 Crude petroleum and natural gas production
9 Other mining and quarrying
10 Manufacture of meat
11 Manufacture of fish products
12 Manufacture of vegetable and fruit products
13 Manufacture of dairy prod.
14 Manufacture of animal feeds
15 Manufacture of other food products
16 Manufacture of coffee and tea
17 Manufacture of beverages
18 Manufactuure of tobacco products
19 Manufacture of textiles
20 Manufacture of wearing apparel
21 Manufacture of leather and leather products
22 Manufacture of wood and wood products
23 Manufacture of paper
24 Manufacture Paper products
25 Publishing and printing
26 Manufacture of recorded media
27 Manufacture of petroleum products; cokes and nuclear fuel
28 Manufacture of other basic chemicals and man-made fibres
29 Manufacture of inorganic basic chemicals
30 Manufacture of petrochemicals
31 Manufacture of fertilisers and nitrogen compounds
32 Manufacture of chemical products
33 Manufacture of rubber and plastic products
34 Manufacture of other non-metallic mineral products
35 Manufacture of basic metals
36 Manufacture of fabricated metal products
37 Manufacture of other machinery and equipment
38 Manufacture of domestic appliances
39 Manufacture of office machinery and computers
40 Manufacture of electrical machinery n.e.c.
41 Manufacture of radio, television and communication equipment
42 Manufacture of medical and optical equipment
43 Manufacture of motor vehicles
44 Manufacture of ships and boats
45 Manufacture of trains, trams and aircraft
46 Manufacture of other transport equipment
47 Manufacture of furniture
48 Manufacturing n.e.c.
49 Recycling
50 Electricity supply
51 Gas, steam and hot water supply

52 Collection, purification and distribution of water
53 Site preparation
54 Construction of buildings
55 Other civil engineering
56 Building installation
57 Building completion
58 Renting of construction equipment
59 Wholesale trade of motor vehicles/cycles
60 Retail trade of motor vehicles/cycles
61 Repair of motor vehicles/cycles; retail sale of fuel
62 Wholesale trade (excl. motor vehicles/cycles)
63 Retail trade and repair (excl. motor vehicles/cycles)
64 Hotels and restaurants
65 Passenger transport by road; railway transport
66 Freight transport by road
67 Transport via pipelines
68 Sea transport
69 Inland water transport
70 Air transport
71 Other supporting transport activities
72 Supporting water transport activities
73 Supporting air transport activities
74 Activities of travel agencies
75 Post and telecommunications
76 Banking
77 Insurance and pension funding
78 Activities auxiliary to financial intermediation
79 Letting services for leeses and own property
80 Other real estate activities
81 Renting of movables
82 Computer and related activities
83 Research and development
84 Legal and economic activities
85 Architectural and engineering activities
86 Advertising
87 Activities of employment agencies
88 Building-cleaning activities
89 Other business activities n.e.c.
90 Public administration; central government
91 Public administration; communities
92 Other public administration; compulsory social security activities
93 Defence activities
94 Subsidized education, universities
95 Subsidized education on a religious basis
96 Other subsidized education
97 Human health and veterinary activities
98 Social work activities
99 Sewage and refuse disposal services; corporations
100 Sewage and refuse disposal services; government
101 Other recreational, cultural and sporting activities
102 Lotteries and the like
103 Other service activities n.e.c.
104 Private households with employed persons
105 Manufacturing and services n.e.c.
106 Trade and transport margins

Sectors according to the 37 sector classification:

		Included sectors
1	Agriculture and foresty	1:6
2	Fishing	7
3	Crude petroleum and natural gas production	8
4	Other mining and quarrying	9
5	Manufacture of food products, beverages and tobacco	10:18
6	Manufacture of textille and leather products	19:21
7	Manufacture of paper and paper products	23:24
8	Publishing and printing	25:26
9	Manufacture of petroleum products	27
10	Manufacture of chemical products	28:32
11	Manufacture of rubber and plastic products	33
12	Manufacture of basic metals	35
13	Manufacture of fabricated metal products	36
14	Manfacture of machinery n.e.c.	37:38
15	Manufacture of electrical equipment	39:42
16	Manufacture of transport equipment	43:46
17	Recycling industries	49
18	Manufacture of wood and wood products	22
19	Manufacture of construction materials	34
20	Other manufacturing	47:48
21	Electricity supply	50:51
22	Gas and water supply	52
23	Construction	53:58
24	Wholesale trade	59:61
25	Retail trade, repair (excl motor vehicles)	62
26	Hotels and restaurants	63:64
27	Land transport	65:67
28	Water transport	68:69
29	Air transport	70
30	Supporting transport activities	71:74
31	Financial, business services and communication	75:89
32	Public administration and social security	90:93
33	Educaton	94:96
34	Health and social work activities	97:98
35	Sewage and refuse disposal services	99:100
36	Other services	101:105
37	Trade and transport margins	106

Final demand categories included in the analysis

Private consumption	Final consumption expenditure of households
	Non-profit institutions serving households
Government consumption	Final consumption expenditure of general government
	Social security in kind by the government
Investments	Fixed capital formation (gross)
	Changes in inventories (incl. acquisitions less disposals of valuables)
Exports	Exports of goods (fob) and services