PROJECT N. 037033

EXIOPOL

A NEW ENVIRONMENTAL ACCOUNTING FRAMEWORK USING EXTERNALITY DATA AND INPUT-OUTPUT TOOLS FOR POLICY ANALYSIS

Using the EE detailed global Input-Output database to calculate external costs

A tutorial for using CMLCA with the EXIOBASE data

October 2011

EXIOPOL project

Executive Summary

This report is not a formal deliverable of the EXIOPOL project, but it is a tutorial for using the CMLCA software with the EXIOBASE data to calculate external costs and other relevant indicators. As such, it presents an important document to disseminate the central results – IO-data, externalities, and tools for analysis – to a permanent audience of policy officials, employees of statistical offices, and researchers.

The central elements are the EXIOBASE data, the external cost factors, and the CMLCA software. EXIOBASE, together with some of the external cost factors, will be made available through the website http://www.exiobase.eu/. The CMLCA software can be downloaded from http://www.cmlca.eu/.

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1 Introduction

1.1 EXIOBASE, CMLCA, and their relation

In the EXIOPOL project, a large number of external cost factors have to be combined with a huge input-output table, to provide policy-support on environmentally relevant issues. This sections discusses the role of EXIOBASE and CMLCA in doing this.

1.1.1 EXIOBASE

To be able to host and systematically process the input-output data, the EXIOBASE software has been developed. EXIOBASE is three things:

- it is a relational data model for environmentally extended multi-region supply-use tables and additional information;
- it is software to import, process, and export these data;
- it is a large number of data sets on supply-use tables, satellite tables, trade, and auxiliary data.

For the database part, implementation in Microsoft Access, MySQL, and Derby have been developed. The software for import, processing, and export has been written as a Java program. The datasets are available as Microsoft Excel worksheets.

The overall architecture of EXIOBASE is shown in Figure 1.

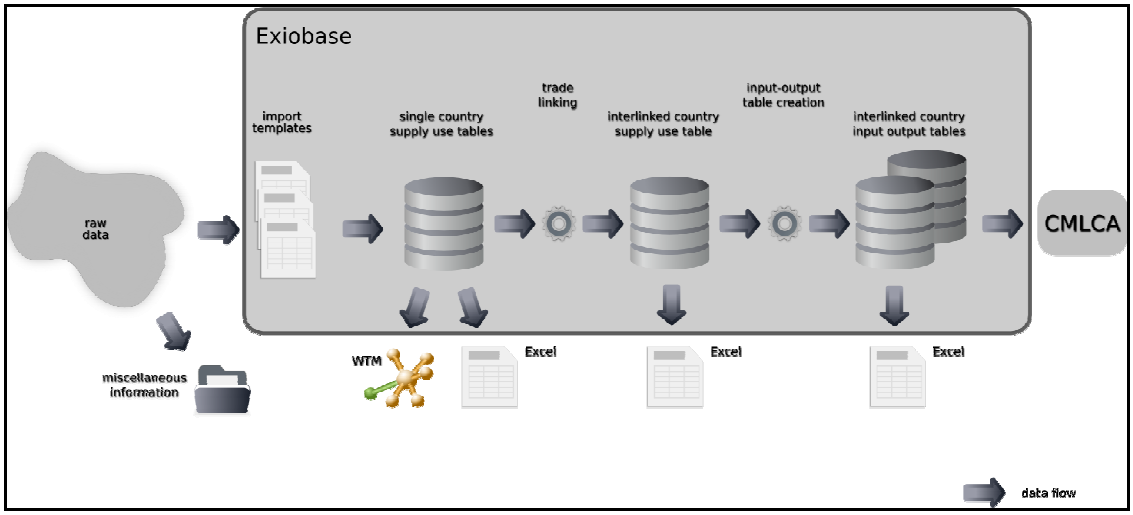


Figure 1: Overall design of EXIOBASE.

Although the EXIOBASE software contains routines to do calculations (primarily for trade linking and creating input-output tables), it focuses on the data, not on the analysis of the data, and not on the analysis of scenarios. For analysis, the CMLCA program is used, and an exchange facility between EXIOBASE and CMLCA has been developed within the EXIOPOL project.

EXIOBASE is an important end result of the EXIOPOL project, and it will not be updated as such because the project has ended. However, many of the ideas that have been explored will continue to be used, in new projects and tools, such as CREEA, EUREAPA and WIOD.

EXIOBASE, as a program, has not been developed for a broad audience, because it is not intended to be used by the public in general. The IO-data it produces are available in a format that can be imported by CMLCA, and as a consequence CMLCA is the vehicle for doing IOA and calculating external costs.

1.1.2 CMLCA

The CMLCA has program has been around for more than ten years, primarily as software to do calculations and analysis for LCA. It had already been extended with facilities for input-output analysis, to support EIO-LCA and hybrid analysis. It has also been used for pure EIOA studies, such as the EIPRO project. Within the EXIOPOL project, CMLCA has been adapted for enabling multi-region IOA and EIOA, and a more powerful IO interface has been developed. Today, you will explore the EXIOBASE data using the CMLCA software.

CMLCA has been programmed in Delphi, and is available from a separate website, http://www.cmlca.eu/. It is a Windows application, but in our experience, users of Linux or MacOS are often be able to get it running as well, although perhaps without some less important functions.

CMLCA does not contain supply-use tables, but starts with the input-output tables that EXIOBASE produces. In fact, importing the result of EXIOBASE will feed CMLCA with an input-output table, a satellite matrix, and final demand vectors.

The external cost factors from EXIOPOL have been processed manually into CMLCA. In addition, some other frequently used impact system have been inserted manually, including:

- the EUROSTAT NAMEA impact categories GWP, ACID and POMF;
- the LCA baseline impact categories from CML-IA;
- a number of footprints for water, land and energy.

On top of these impact data, the results of EXIOBASE can be added. In its ultimate form, one obtains a system with the following features:

- 44 countries;
- 129 industries (for an i*i table) or commodities (for a p*p table);
- 196 air pollutants;
- 16 factor inputs;
- several hundreds of land use types, energy use types, water use types, resource use types, and other extensions;
- 7 final demand categories;
- 308 final demand vectors;
- 122 impact categories;

- 7 impact assessment methods.

Altogether, this gives the following matrices:

- a technology matrix with input-output coefficients of 5676 rows and columns;
- a satellite matrix with environmental and economic coefficients of 15144 rows and 5676 columns;
- a final demand matrix of 5676 rows and 308 columns;
- a direct extensions matrix of 15144 rows and 308 columns;
- a characterisation matrix of 308 rows and 122 columns.

This is a system size for which Microsoft Excel is no longer useful, and which also in Matlab or GAMS can be cumbersome. Problems with memory overflow and performance can be expected. Moreover, although some of the computational steps are straightforward (e.g., calculating a Leontief inverse), some other routines and types of analyses require a careful implementation (e.g., doing a Monte Carlo analysis). It is for this purpose that CMLCA has been optimized in the light of the EXIOPOL project.

1.1.3 Purpose of this tutorial

This tutorial is on getting started with CMLCA using the EXIOPOL data on input-output and external costs. It focuses on the most important functions in EIOA: loading the data, viewing the different types of data, calculating emissions, resource use, and impacts, and analyzing emissions, resource use, and impacts in terms of contributions, multipliers, etc. This tutorial does not give a full explanation of CMLCA. The program itself is pretty intuitive, has a help facility (in almost all screens you may press F1), also including tutorials, and demo project files are available from the CMLCA website.

Because the full EXIOBASE data is quite huge, this tutorial concentrates on two smaller datafiles that been derived from the full EXIOBASE data.

- One is a file for 18 regions instead of 44: it has aggregated all EU countries into one country. For the rest, the data set is complete, it includes extensions, final demand vectors, external cost factors, etc.
- The other one is a file for 2 regions: all EU countries together, and all non-EU countries together. This file also contains some impact factors, but no external cost factors.

Most of the examples in this document are on the two-country version: it is light and fast, and still sufficiently rich to show what's in the EXIOBASE data and CMLCA.

1.2 Basics of CMLCA

CMLCA is a Windows program that has all the features of what you expect from such a program: menu-driven, visual controls (buttons, checkboxes, etc.), context-sensitive help, intuitive interface.

In this section, we will explore the main screen and the logic of the architecture of most important screens.

1.2.1 The main screen

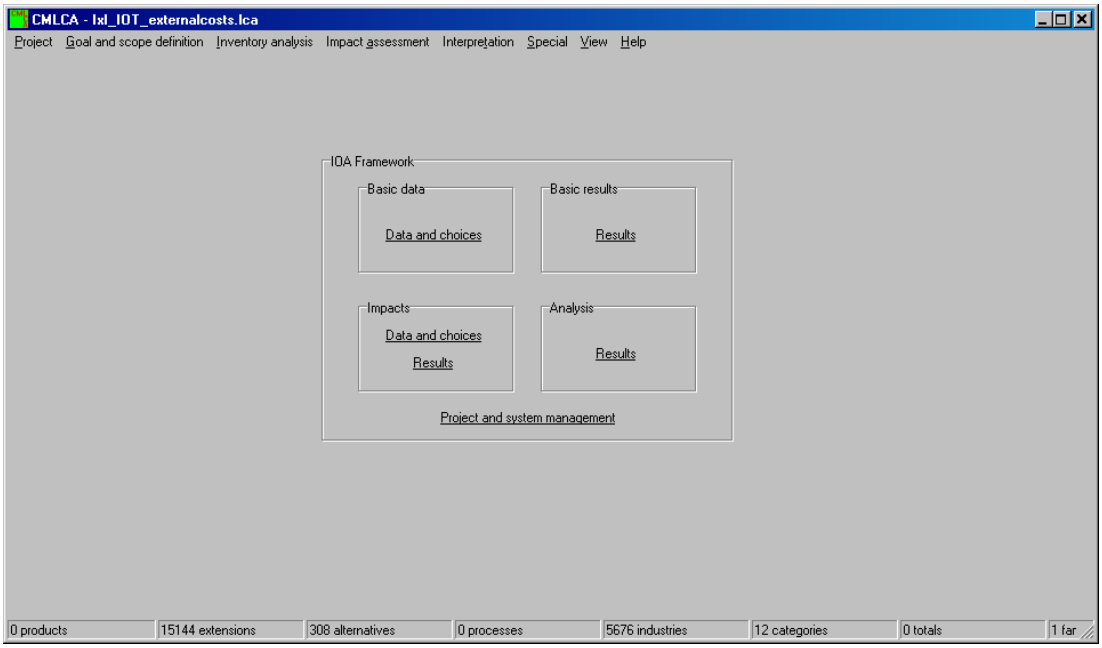


Figure 2: Main screen of CMLCA when the EXIOBASE data have been loaded.

Figure 2 shows the main screen after loading the EXIOBASE data. There are four areas of interest:

- the title bar shows the name of the program and the data file.
- the menu bar at the top contains many commands;
- the central area gives a number of quick access short-cuts to the mostly-used menu commands;
- the status bar at the bottom shows the main contents.

The quick access part is divided into four areas of activity:

- Basic data, viewing and editing the IO-data including the extensions and the final demand vectors;
- Basic results, calculating the activity levels and extensions for a certain final demand vector, and showing the Leontief inverse;
- Impacts, an optional part for calculating the impacts related to the extensions, e.g., in terms of climate change impact or external costs;
- Analysis, offering more advanced types of results, such as a multiplier analysis.

Almost all commands open a new form, with buttons, tables, etc.

1.2.2 More details or less details

Many of the forms of CMLCA can contain a lot of information or options, too much for a beginning analyst. CMLCA therefore offers a way to reduce the loads of controls, and to restrict the forms to what really matters. For that purposes, most forms have a button with the title More or Less.

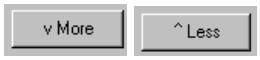


Figure 3: The button with caption More or Less to reveal or hide less-used functions.

If you cannot find what you're looking for, try this.

More generally, the Program options (use the menu View, the quick access Project and system management, or the F11 button from the main screen) helps you to set the level of detail that corresponds to your situation.

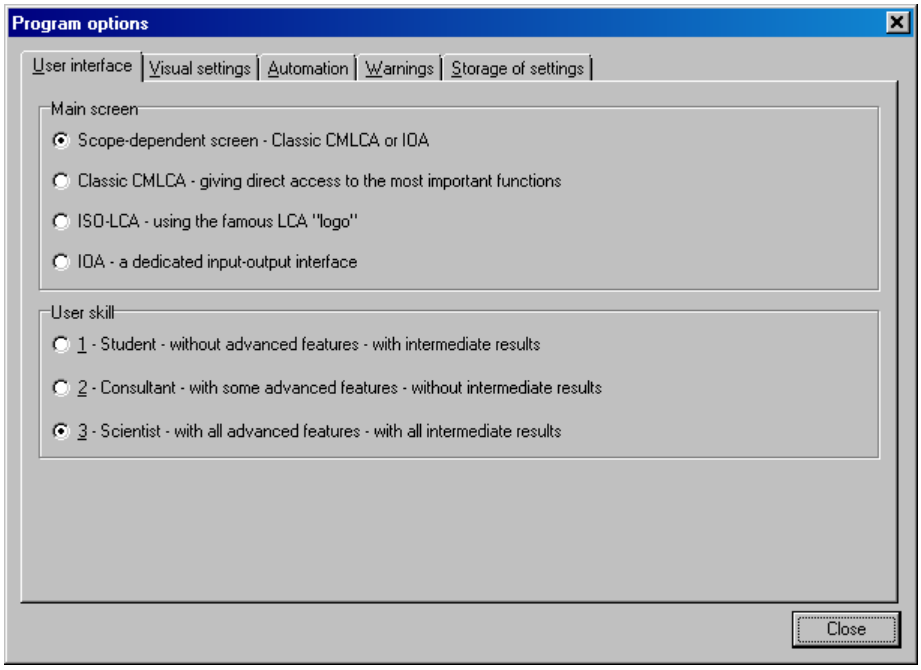


Figure 4: The form with program options, allowing you to define your user skill.

1.2.3 Program and data

CMLCA does not know anything by itself. It doesn't know that there is an industry with the name Cultivation of wheat, that there is a country with name UK, that CO_2 is a pollutant, and that kg is a unit. All this information is in EXIOBASE, and EXIOBASE has produced an XML-file that has been imported into CMLCA. CMLCA has stored this information as a *.lca file. Such files are referred to as project files. They contain data, names, and settings, but not results.

Starting CMLCA will not automatically load the information from EXIOBASE, just like starting Word will not automatically load what you've already typed the day before. You need to open the one of the *.lca files, like you open a *.doc file

in Word. You can use Project – Open project from the menu, or ctrl-o to open a *.lca file. You can only open one such file at a time.

You can view what is inside and do calculations. You can also make changes to the data. These changes are in the temporary memory, so doing calculations will then work on the modified data. As long as you don't save the data, all changes will be non-permanent. Use Project – Save project from the menu or ctrl-s to keep changes in a new or modified project file.

2 Exploring the contents of the EXIOBASE data in CMLCA

2.1 Starting CMLCA and opening the EXIOBASE data

CMLCA is downloadable from its website, http://www.cmlca.eu/. Go to the download page, and download version 5.2.

This will yield a file cmlca52.zip. Unzip to a suitable folder, e.g., C:\Program Files\CMLCA. This will produce a number of files and folders. The file CMLCA.exe is the application. Run it, for instance by double-clicking. No installation is needed.

The CMLCA package does not contain the EXIOBASE data. The zip file in which this tutorial was found also contains two datafiles:

- PxP_ita_no_src_two_region.lca;
- IxI_fpa_eu_aggr_31august2011.lca.

Go back to the CMLCA program. On starting, it you will see a small welcome screen.

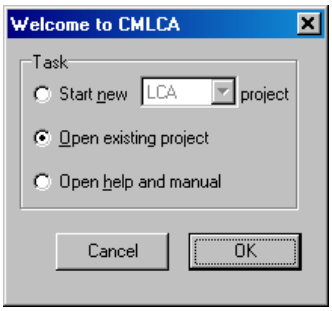


Figure 5: The welcome form of CMLCA.

Choose Open exiting project to open a project file. You will see a file dialog. Navigate to the EXIOBASE project files, and select the file PxP_ita_no_src_two_region.lca. Now, CMLCA will open this file and read its contents into memory. After a while it will show the main screen. The title bar will now show the name of the datafile, and the status bar will show what data elements are now in the program.

The main screen's quick access part with Basic data provides access to the most important elements of the opened project.

2.2 Exploring the main settings

First, go to Basic data – Scope. This shows the main settings of the project. For instance, it is an IOA, not an LCA, it has several types of extensions, etc. The scope definition controls the main settings of the project. Switching certain options on or off will also affect which buttons are visible in other forms. For instance, switching off the direct extensions of the final demand will hide them, and will neglect them in the calculation as well.

Question 1: Is it an industry-by-industry table or a commodity-by-commodity table? And is it a coefficient matrix or a transactions matrix?

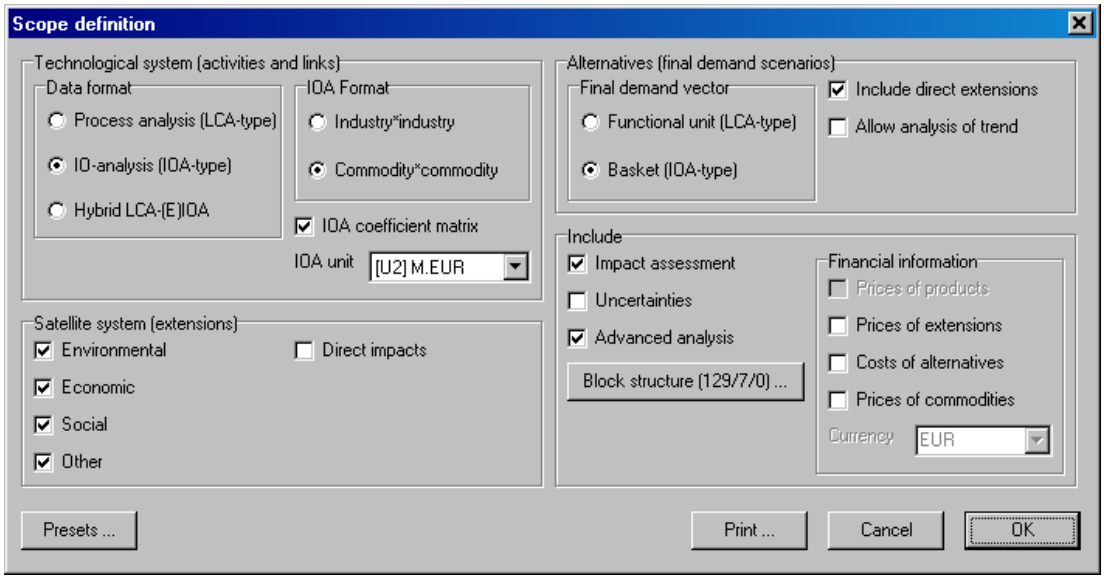
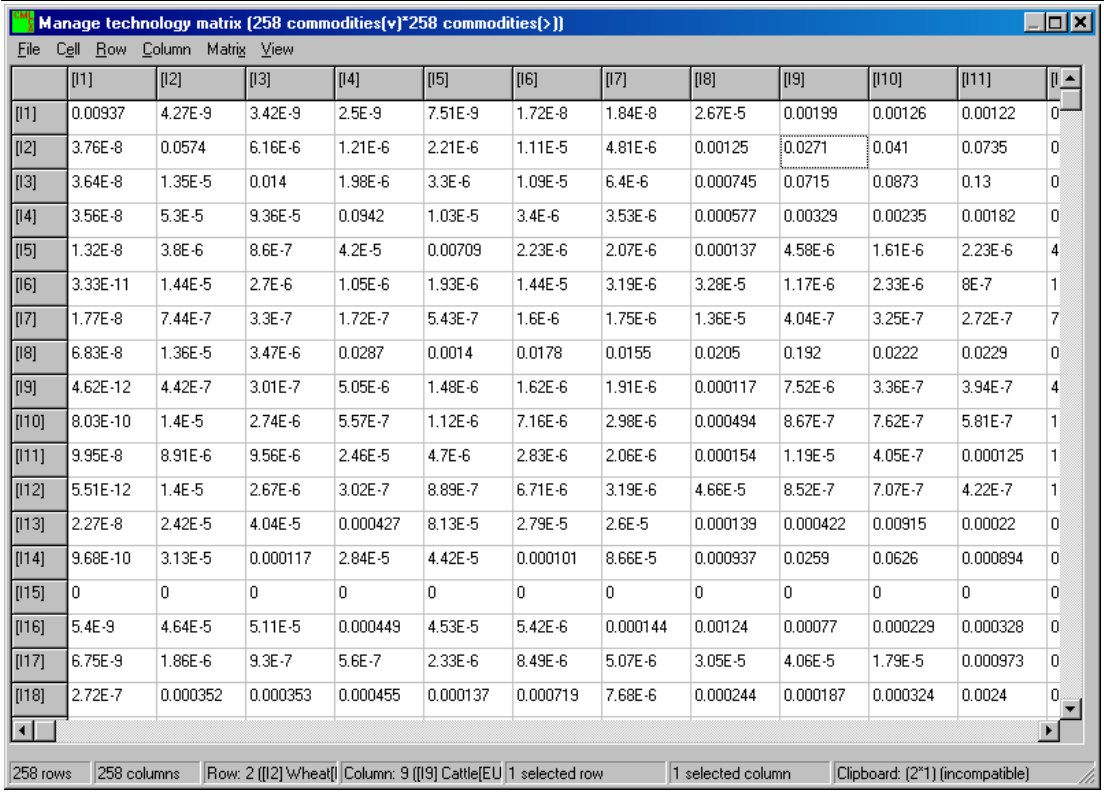


Figure 6: The scope definition form of CMLCA.

Because CMLCA can handle industry-by-industry tables as well as commodity-by-commodity tables,

2.3 Exploring the IO data and extensions

The command Basic data – IO matrices will bring up the matrix viewer/editor for the data from industries. It can show all sorts of matrices. By default, it starts with the technology matrix, but it can also be switched to the satellite matrix, the final demand matrix, the direct extensions matrix, the matrix of impact factors, etc.



	[I1]	[I2]	[I3]	[I4]	[I5]	[I6]	[I7]	[I8]	[I9]	[I10]	[I11]	[I
[I1]	0.00937	4.27E-9	3.42E-9	2.5E-9	7.51E-9	1.72E-8	1.84E-8	2.67E-5	0.00199	0.00126	0.00122	0
[I2]	3.76E-8	0.0574	6.16E-6	1.21E-6	2.21E-6	1.11E-5	4.81E-6	0.00125	0.0271	0.041	0.0735	0
[I3]	3.64E-8	1.35E-5	0.014	1.98E-6	3.3E-6	1.09E-5	6.4E-6	0.000745	0.0715	0.0873	0.13	0
[I4]	3.56E-8	5.3E-5	9.36E-5	0.0942	1.03E-5	3.4E-6	3.53E-6	0.000577	0.00329	0.00235	0.00182	0
[I5]	1.32E-8	3.8E-6	8.6E-7	4.2E-5	0.00709	2.23E-6	2.07E-6	0.000137	4.58E-6	1.61E-6	2.23E-6	4
[I6]	3.33E-11	1.44E-5	2.7E-6	1.05E-6	1.93E-6	1.44E-5	3.19E-6	3.28E-5	1.17E-6	2.33E-6	8E-7	1
[I7]	1.77E-8	7.44E-7	3.3E-7	1.72E-7	5.43E-7	1.6E-6	1.75E-6	1.36E-5	4.04E-7	3.25E-7	2.72E-7	7
[I8]	6.83E-8	1.36E-5	3.47E-6	0.0287	0.0014	0.0178	0.0155	0.0205	0.192	0.0222	0.0229	0
[I9]	4.62E-12	4.42E-7	3.01E-7	5.05E-6	1.48E-6	1.62E-6	1.91E-6	0.000117	7.52E-6	3.36E-7	3.94E-7	4
[I10]	8.03E-10	1.4E-5	2.74E-6	5.57E-7	1.12E-6	7.16E-6	2.98E-6	0.000494	8.67E-7	7.62E-7	5.81E-7	1
[I11]	9.95E-8	8.91E-6	9.56E-6	2.46E-5	4.7E-6	2.83E-6	2.06E-6	0.000154	1.19E-5	4.05E-7	0.000125	1
[I12]	5.51E-12	1.4E-5	2.67E-6	3.02E-7	8.89E-7	6.71E-6	3.19E-6	4.66E-5	8.52E-7	7.07E-7	4.22E-7	1
[I13]	2.27E-8	2.42E-5	4.04E-5	0.000427	8.13E-5	2.79E-5	2.6E-5	0.000139	0.000422	0.00915	0.00022	0
[I14]	9.68E-10	3.13E-5	0.000117	2.84E-5	4.42E-5	0.000101	8.66E-5	0.000937	0.0259	0.0626	0.000894	0
[I15]	0	0	0	0	0	0	0	0	0	0	0	0
[I16]	5.4E-9	4.64E-5	5.11E-5	0.000449	4.53E-5	5.42E-6	0.000144	0.00124	0.00077	0.000229	0.000328	0
[I17]	6.75E-9	1.86E-6	9.3E-7	5.6E-7	2.33E-6	8.49E-6	5.07E-6	3.05E-5	4.06E-5	1.79E-5	0.000973	0
[I18]	2.72E-7	0.000352	0.000353	0.000455	0.000137	0.000719	7.68E-6	0.000244	0.000187	0.000324	0.0024	0

Figure 7: The matrix editor, here for the technology matrix.

Question 2: What does the number in row 2 and column 9 mean? Use alt-enter to inspect the name of the active row and column. Alternatively, use from the menu View – Show names to display the names of all rows and columns.

Although IO tables are a frequently-used way of inspecting data, it is clear that an IO table of the present size is too big to handle. CMLCA has therefore also implemented another way. The command Basic data – IO data will bring up the viewer/editor for the data from industries.

Start this industry editor, and study it. Particularly note that there are a couple of tabsheets.

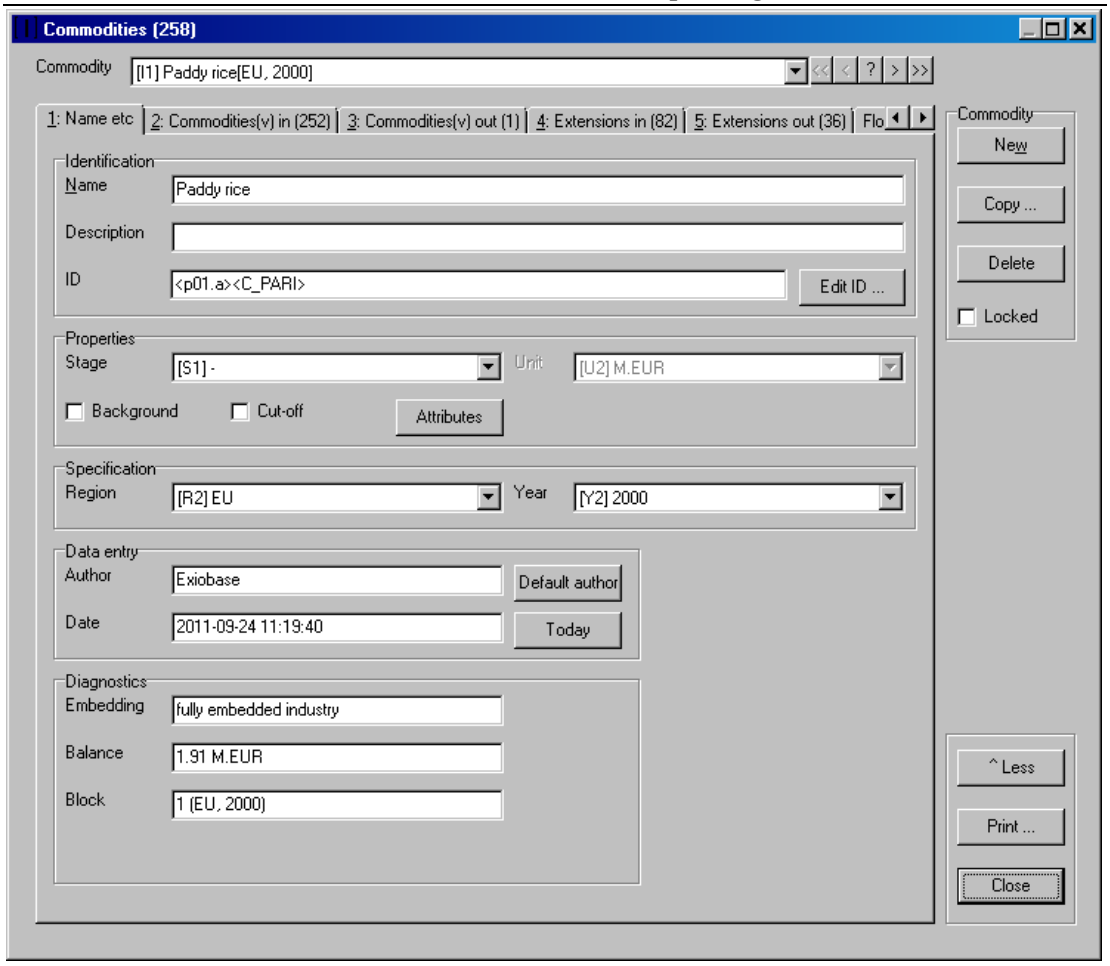


Figure 8: The data editor, here for the commodity Paddy rice[EU].

Question 3: In the scope definition above, we saw that the technology matrix is in coefficient form. Can we see that in the tabsheets as well?

EXIOBASE is an intrinsically multi-region system. In CMLCA, this means that every industry/commodity shows up for every region. In the data editor, we can see this by looking at the long list in the drop-down list at the top of the screen.

Question 4: How many blocks are there, and of what length are they?

The tabsheets refer to the inputs from other industries/commodities, the output of the industry/commodity itself, the inputs and the outputs in terms of extensions.

Question 5: The number that we studied in connection to the matrix editor, at row 2 and column 9, where can we find it in this view?

Question 6: How can you see that there is trade?

2.4 Exploring the final demands

With Basic data – Final demand, we can explore the final demand vectors that are in the EXIOBASE data. In CMLCA, such vectors are referred to as alternatives.

Question 7: Which seven types of final demand are there?

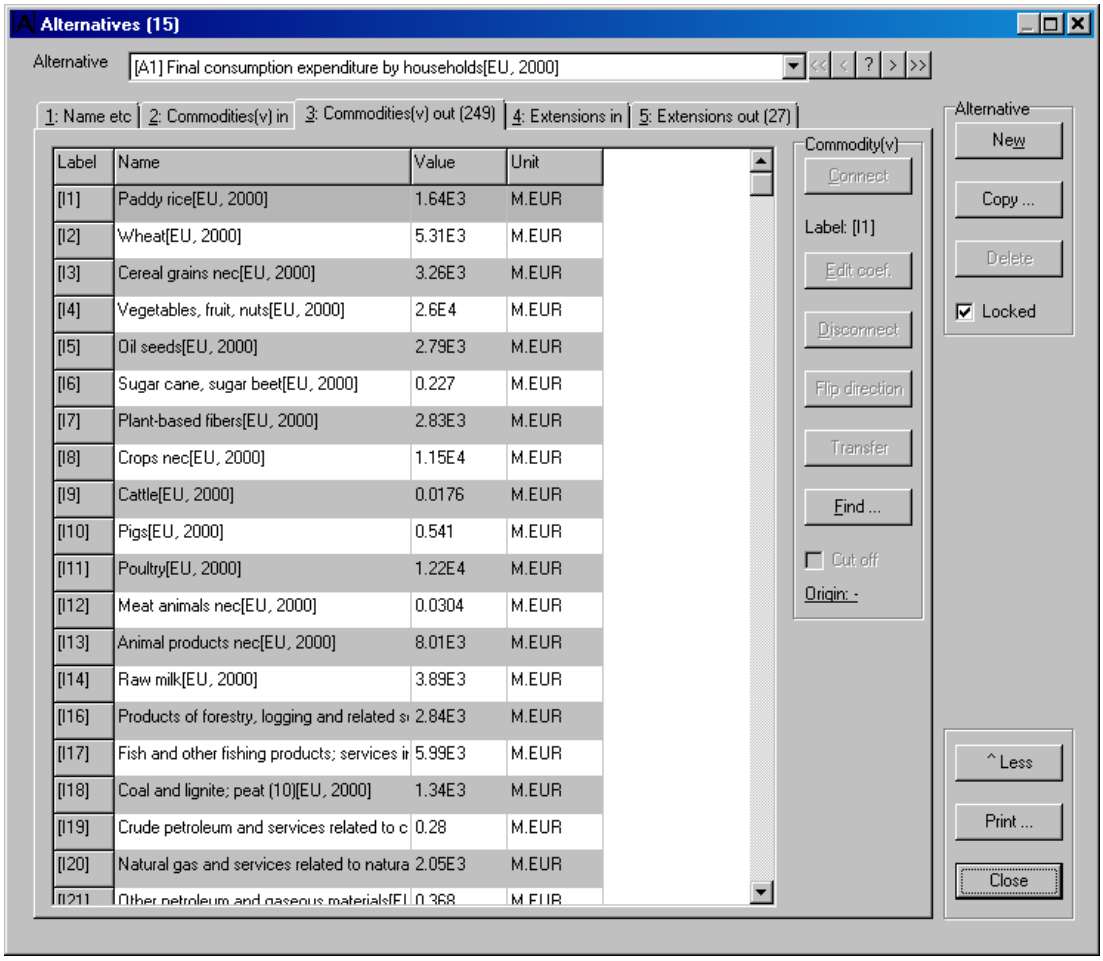


Figure 9: The final demand editor, here for the household consumption in the EU.

Question 8: On what commodity do the European households spend most? Hint, you can sort by double-clicking in the column header Value.

An important aspect of EXIOBASE is that the final demand vector may have extensions as well. This corresponds to the fact that households buy product that give emissions during use. Examples are natural gas and motor vehicles.

Question 9: Why don't we see these example products in the list?

As we see, many final demand vectors are part of the data system. Sometimes too many. CMLCA allows to select one or a few final demand vectors for the calculations. Use Basic data – Select final demand to do this.

By default, everything is selected. Click Unselect all, and select the total final demand in the EU, and in XX.

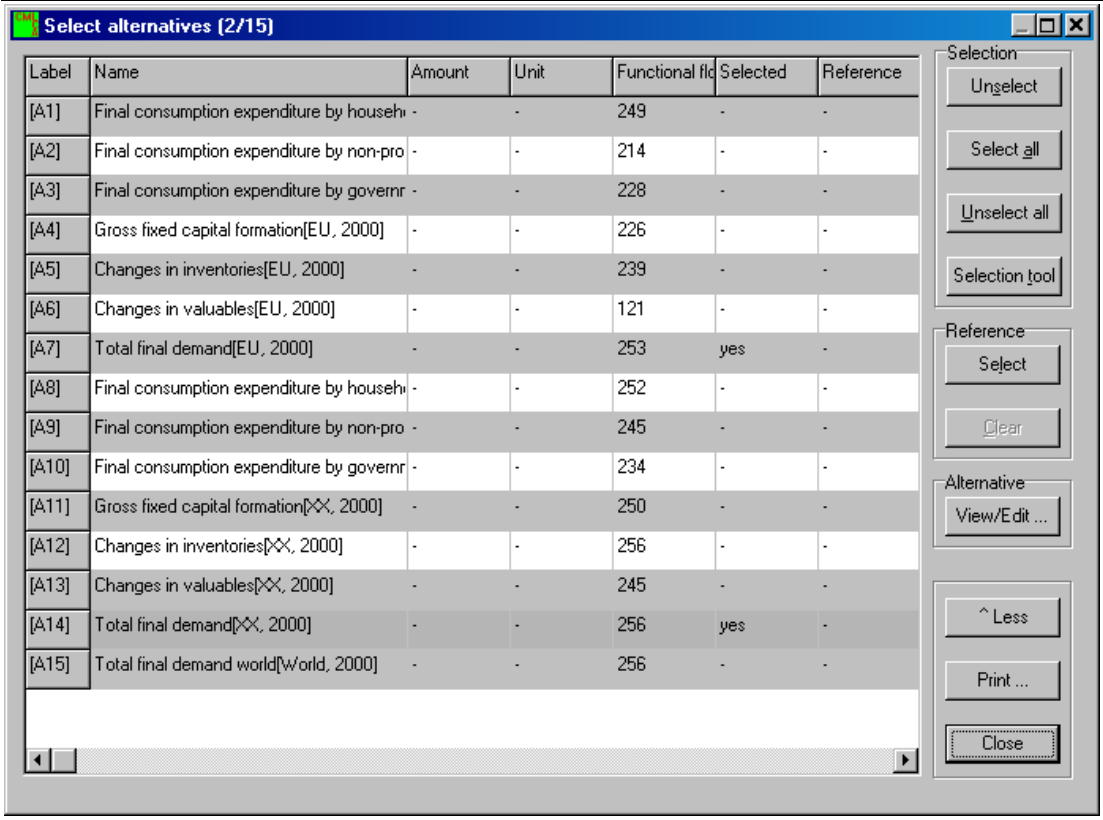


Figure 10: The selection of final demand vectors.

2.5 Exploring the external cost factors

Another of CMLCA is that it can further process emissions with the aid of external cost factors (or other characterisation factors) into environmental impacts. In the EXIOPOL project, such factors have been developed for a number of damage categories, such as carcinogenic effects, respiratory effects, and climate change. External cost factors are available per country, so within the EU for AT, BE, BG, etc., and for outside the EU for CH, US, JP, etc. There is also an average EU-value, but there is not an average XX-value. As a consequence, no external cost factors can be appended to the two-country datafile studied so far.

In order to illustrate the idea of impacts, another family of impact categories have been added to the two-country datafile. It is the standard values for climate change (GWP), acidification (ACID) and tropospherical ozone formation (TOFP) that have been adopted by EUROSTAT in their NAMEA Manual.

Go to Impacts – Categories, and look at the first category.

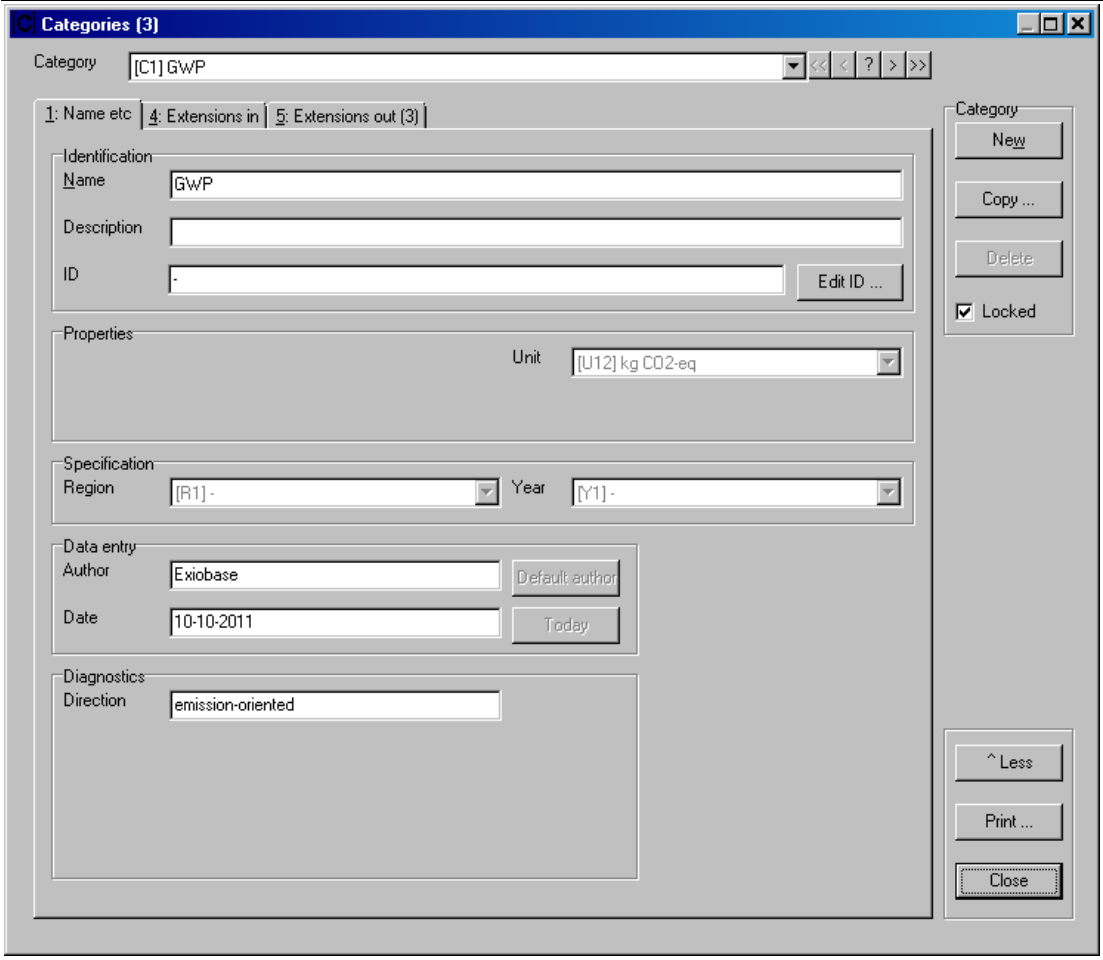


Figure 11: The characterisation factors for the impact category climate change.

Question 10: What are the characterisation factors?

In a similar, the NAMEA family has defined factors for the other two impacts.

Question 11: There are two substances that contribute to two categories. Which substances and which categories are these?

3 Calculating with CMLCA

3.1 Calculating activity levels, factor inputs, and emissions

With Basic results – Activity levels, one computes the output levels. In IO mathematics, this amounts to

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

where **y** is the final demand vector, **A** the technology matrix, and **x** the output vector.

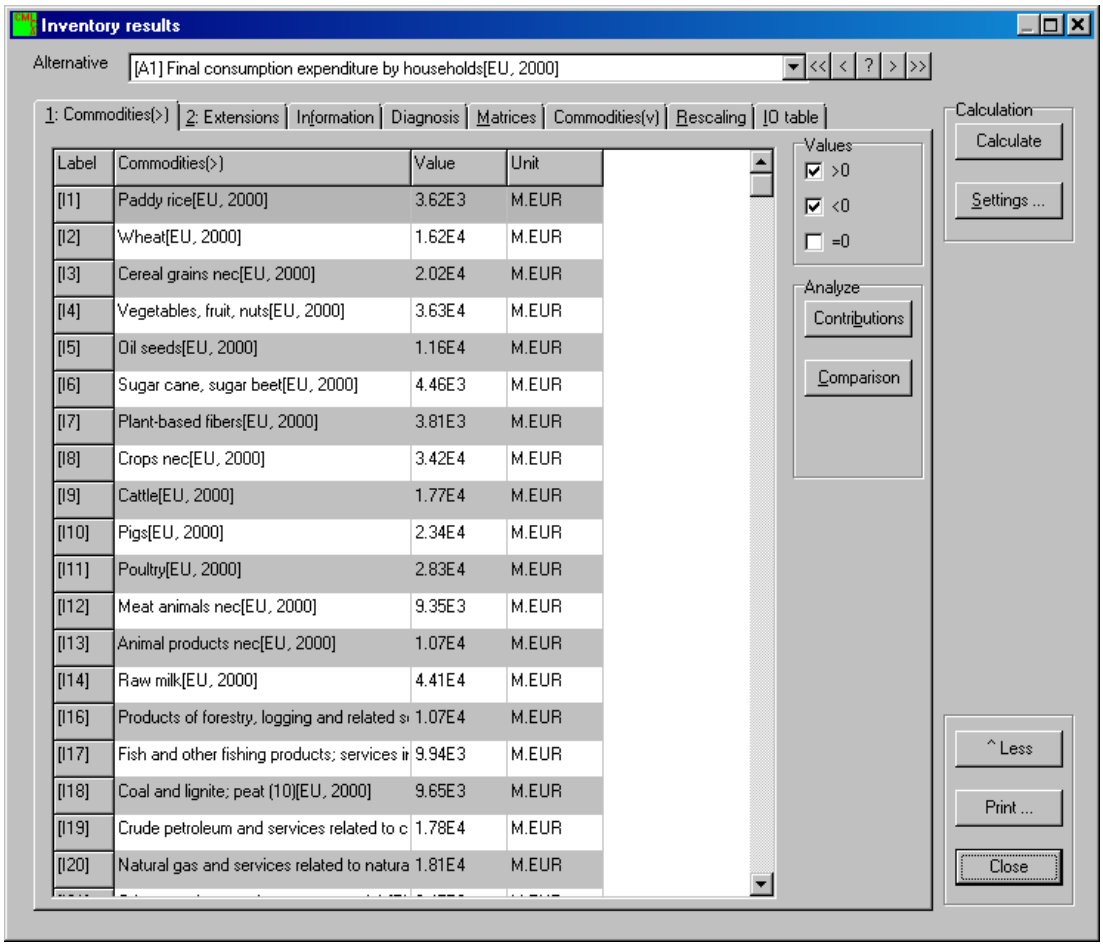


Figure 12: The results of the calculation of activity levels.

Question 12: What was the demand for paddy rice[EU] in this alternative, and what is the output of paddy rice[EU]? What about the difference?

For economic analysis, output levels are important, but for environmental analysis, the extensions are more interesting. These can be accessed by clicking from the main screen Basic results – Extensions, or by selecting from the previous screen the tabsheet for Extensions.

The formula is

$$\mathbf{g} = \mathbf{B}(\mathbf{I} - \mathbf{A})^{-1}\,\mathbf{y}$$

where B is the satellite matrix, and **g** is the vector extensions.

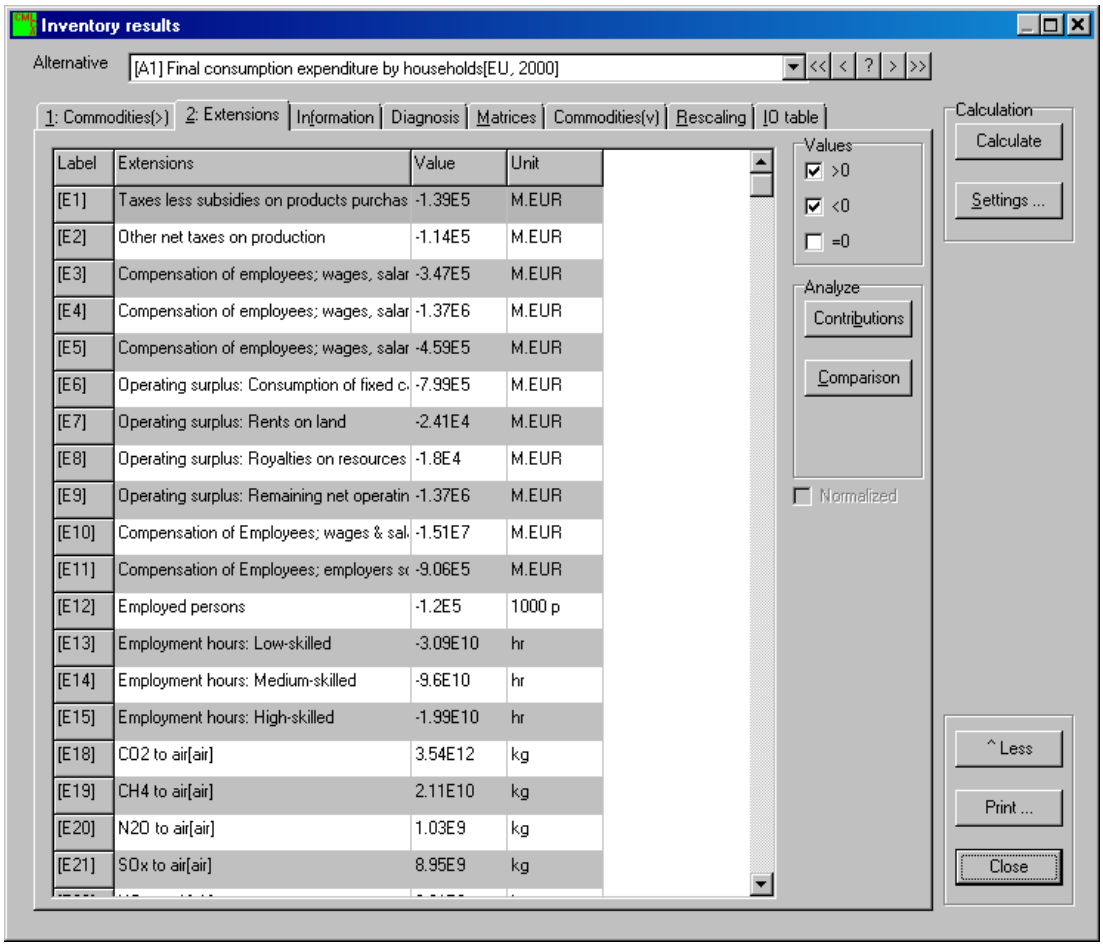


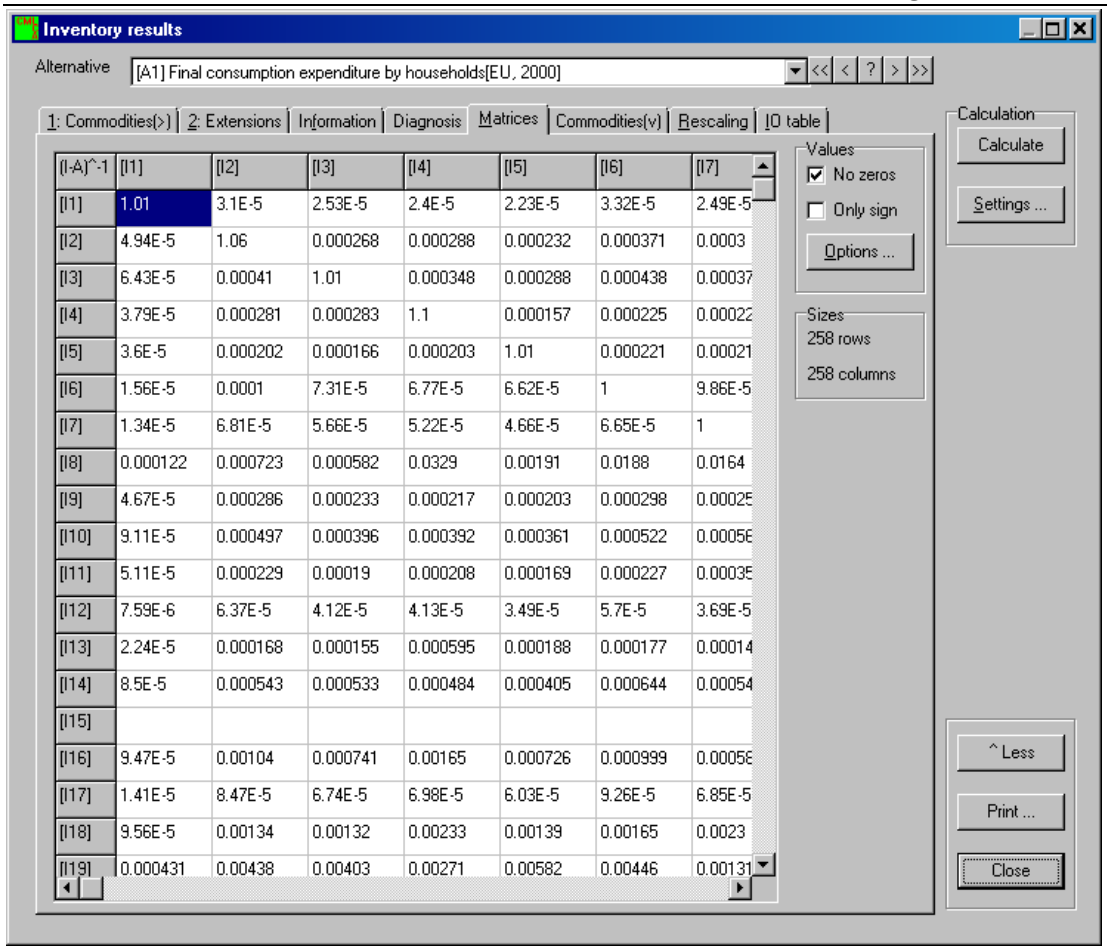
Figure 13: The results of the calculation of extensions.

As you can see, the table of extensions contains environmental extensions (CO_2, etc.) and economic extensions (surplus, etc.), and even social extensions (employment, etc.).

Question 13: Can you understand the + and – in this table?

3.2 Calculating structure

To well-trained IO-economists, the Leontief inverse is an important asset. One can access it by clicking Basic results – Leontief inverse.



(I-A)^-1	[I1]	[I2]	[I3]	[I4]	[I5]	[I6]	[I7]
[I1]	1.01	3.1E-5	2.53E-5	2.4E-5	2.23E-5	3.32E-5	2.49E-5
[I2]	4.94E-5	1.06	0.000268	0.000288	0.000232	0.000371	0.0003
[I3]	6.43E-5	0.00041	1.01	0.000348	0.000288	0.000438	0.00037
[I4]	3.79E-5	0.000281	0.000283	1.1	0.000157	0.000225	0.00022
[I5]	3.6E-5	0.000202	0.000166	0.000203	1.01	0.000221	0.00021
[I6]	1.56E-5	0.0001	7.31E-5	6.77E-5	6.62E-5	1	9.86E-5
[I7]	1.34E-5	6.81E-5	5.66E-5	5.22E-5	4.66E-5	6.65E-5	1
[I8]	0.000122	0.000723	0.000582	0.0329	0.00191	0.0188	0.0164
[I9]	4.67E-5	0.000286	0.000233	0.000217	0.000203	0.000298	0.0002
[I10]	9.11E-5	0.000497	0.000396	0.000392	0.000361	0.000522	0.0005
[I11]	5.11E-5	0.000229	0.00019	0.000208	0.000169	0.000227	0.0003
[I12]	7.59E-6	6.37E-5	4.12E-5	4.13E-5	3.49E-5	5.7E-5	3.69E-5
[I13]	2.24E-5	0.000168	0.000155	0.000595	0.000188	0.000177	0.00014
[I14]	8.5E-5	0.000543	0.000533	0.000484	0.000405	0.000644	0.00054
[I15]							
[I16]	9.47E-5	0.00104	0.000741	0.00165	0.000726	0.000999	0.0005
[I17]	1.41E-5	8.47E-5	6.74E-5	6.98E-5	6.03E-5	9.26E-5	6.85E-5
[I18]	9.56E-5	0.00134	0.00132	0.00233	0.00139	0.00165	0.0023
[I19]	0.000431	0.00438	0.00403	0.00271	0.00582	0.00446	0.00131

Figure 14: The Leontief inverse for the IO-system.

The Leontief inverse is often needed for all sorts of further study. CMLCA can do some of these, but one can also export the Leontief inverse to another program. Almost every screen contains a button "Print". Clicking this will send the information to the printer, to a file, or to the clipboard. The button "Options" will further offer a number of formats, e.g. Matlab.

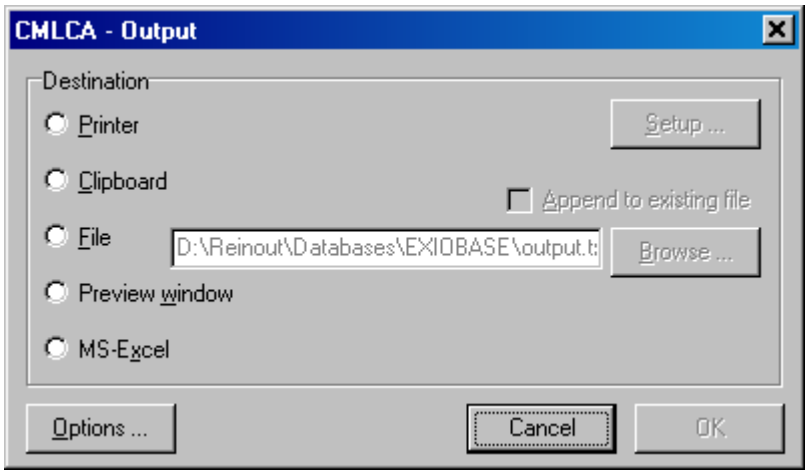


Figure 15: The screen for sending data and results to the printer, a file, or the clipboard.

The present system is quite small, "just" 258 rows and columns. For Excel, this is already rather big, in fact Excel 2003 has a limit of 255 columns. But the newer Excel, Matlab, and several other programs can work with a matrix of this size. Notice, however, that the full-fledged EXIOBASE data has a Leontief matrix with 5676 rows and columns.

3.3 Break-down of results

The results discussed are aggregated results for the final demand of several purchase categories and the emissions of several activities. For many policy studies, it is important to study the contributions from individual purchase categories or activities.

With Analysis – Contribution analysis, one can study this. Let's take CO_2.

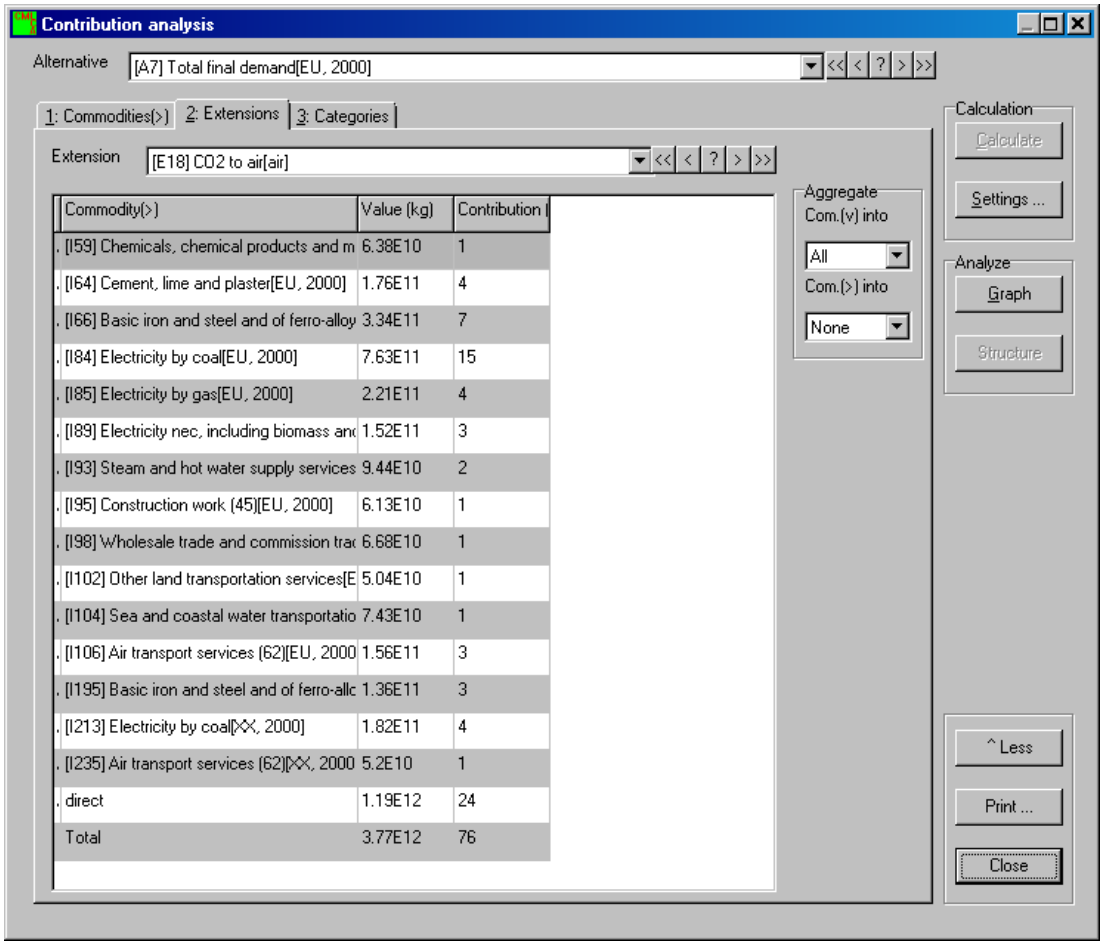


Figure 16: The contribution analysis for CO_2 of the total final demand of the EU.

This shows the contributions by activity. We see that 24% of the CO_2 that is attributed to the EU's total final demand is emitted directly, so not by industry but by the consumer, and that another 15% is emitted by coal-fired power plants in the EU.

We can also ask which purchase categories are decisive. To that end, we change the aggregation of commodities row-wise (v) into None, and the aggregation of

commodities column-wise (>) into All. After all, rows represent purchases, so rows should not be aggregated now. Columns represent industrial activities, and we want to aggregate these.

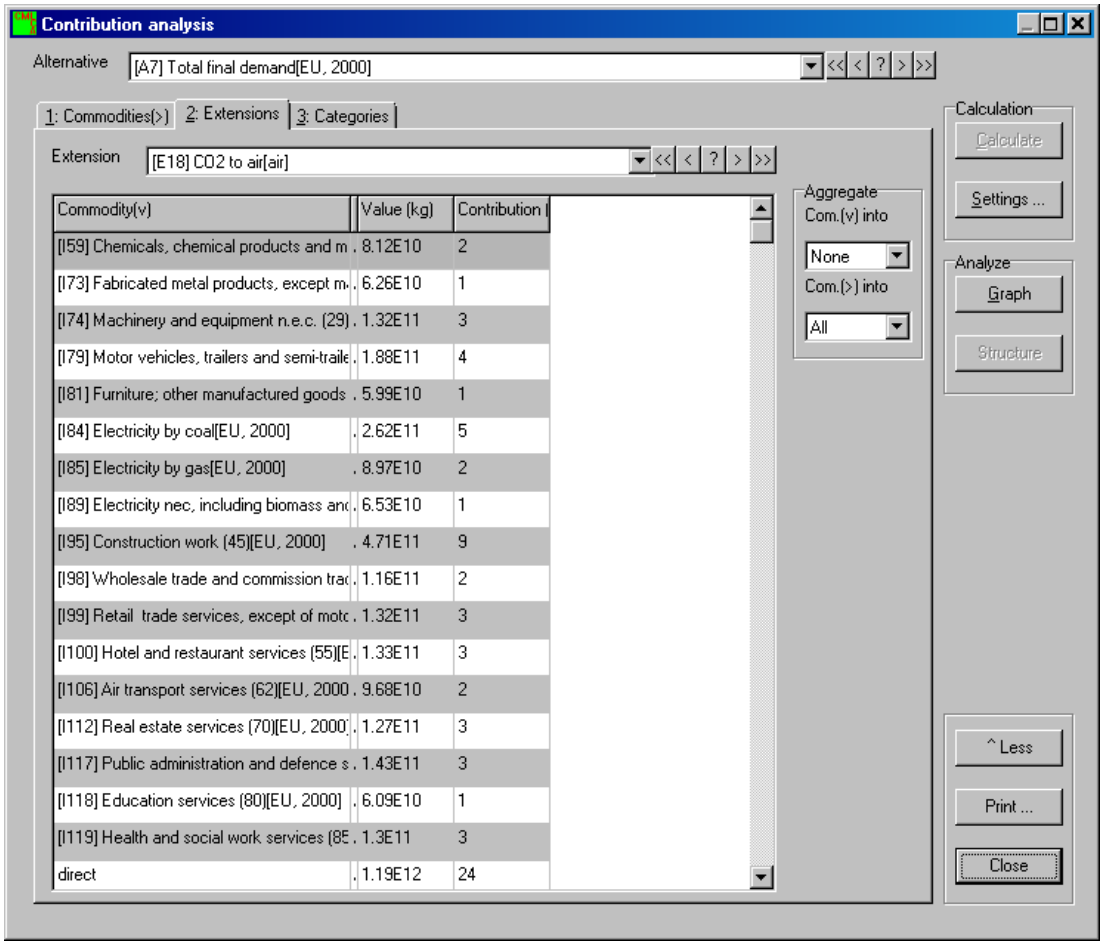


Figure 17: Another contribution analysis for CO_2 of the total final demand of the EU.

The direct term is obviously still 24%. Now, we see an important contribution from construction work.

Question 14: What do the numbers 1% (first screen) and 9% (second screen) mean?

Electricity by coal has dropped considerably.

Question 15: Can you understand this?

3.4 Multipliers

Multipliers are an important aspect of IOA. A multiplier shows how a result (activity level, emission, etc.) changes if the demand for a purchase category schanges by one unit.

Use Analysis – Multiplier analysis to study multipliers. Choose CO_2.

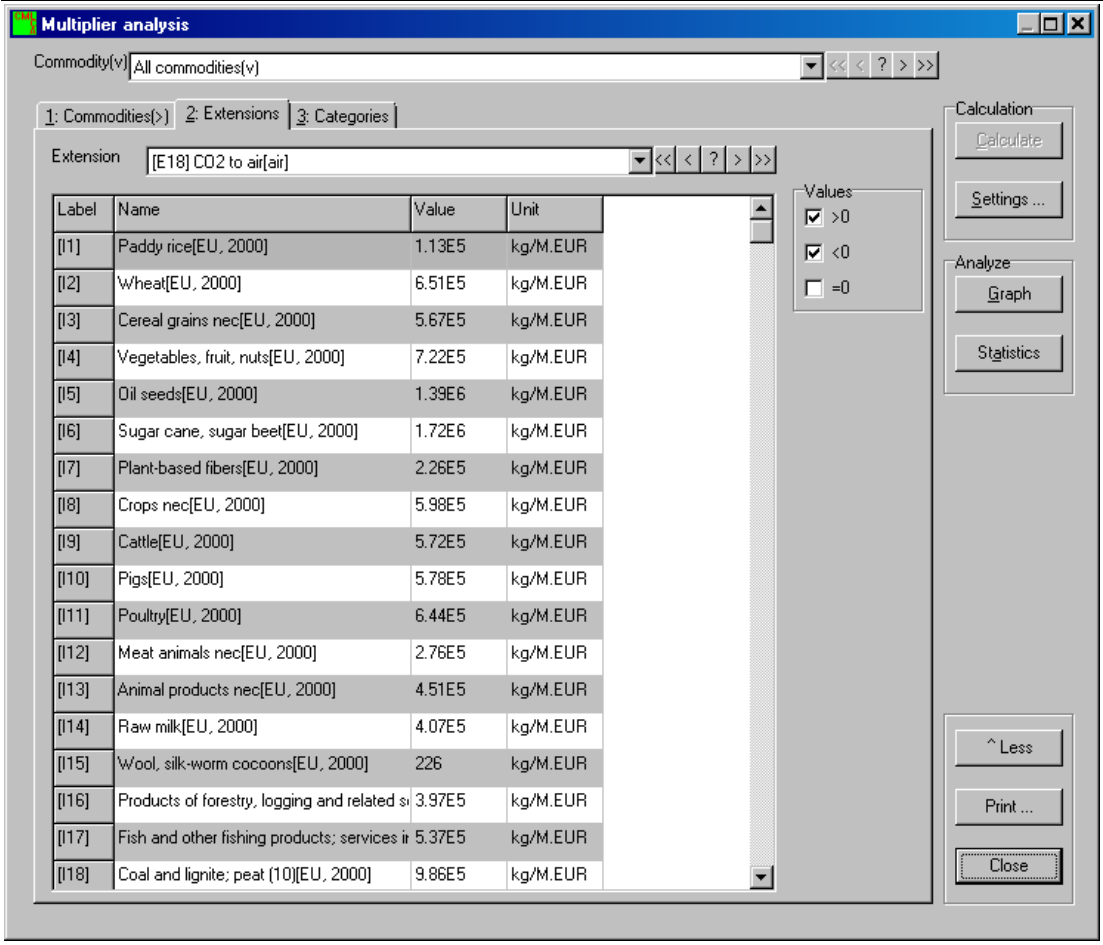


Figure 18: Multipliers for CO_2.

Question 16: Which products has the largest and which has the smallest multiplier for CO_2?

3.5 Impacts

Finally, we will address the impacts. As stated before, these are not the external costs, but the NAMEA categories GWP, ACID and TOFP. Use Impacts – Characterisation to see these.

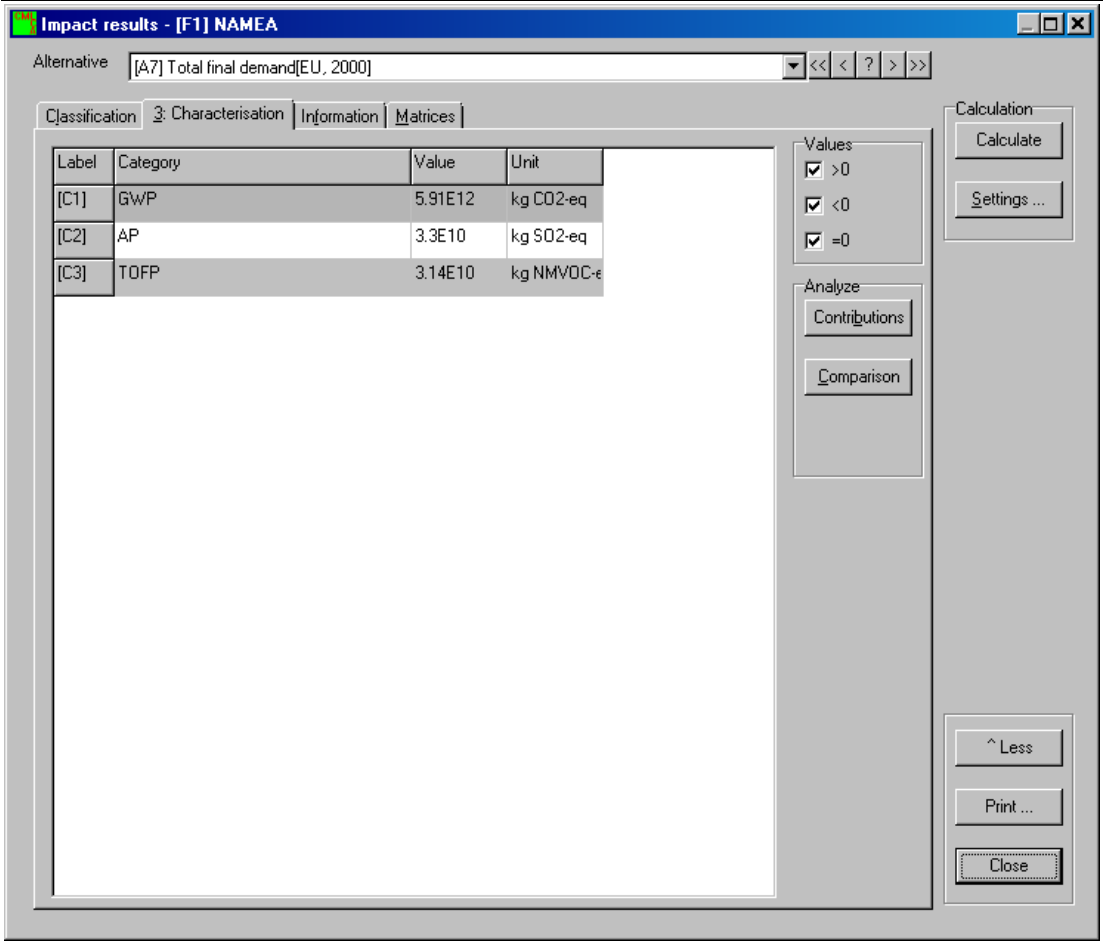


Figure 19: Climate change impacts for the EU's total final.

We can directly move on to the contribution analysis by clicking Contributions.

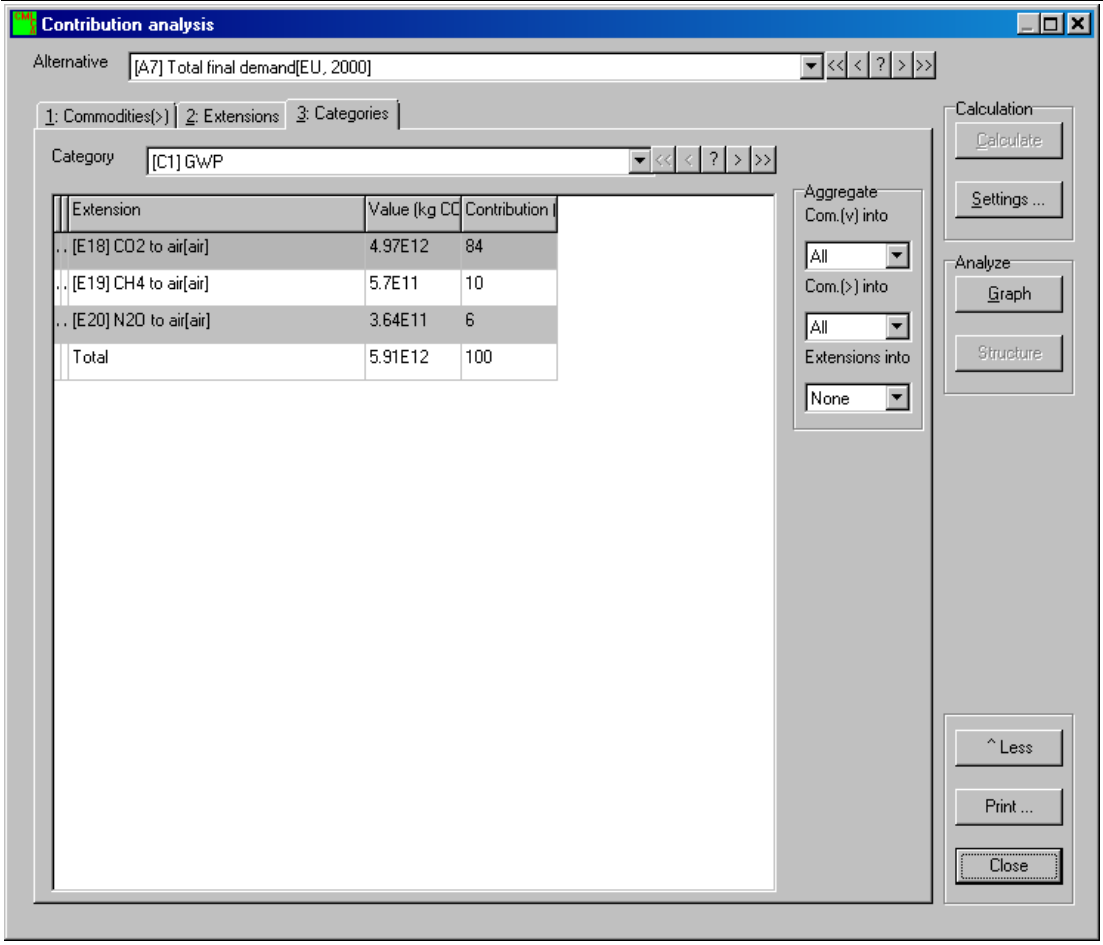


Figure 20: The contribution analysis for climate change of the total final demand of the EU.

Now, we have even three directions for break-down: by purchase category (v), by activity (>), and by extension.

Question 17: Which one do we see now?

3.6 Multi-region IO

In contribution analysis, there are more possibilities than just fully aggregating or fully disaggregating. Rather, we can also aggregate by region. Try to obtain the picture below.

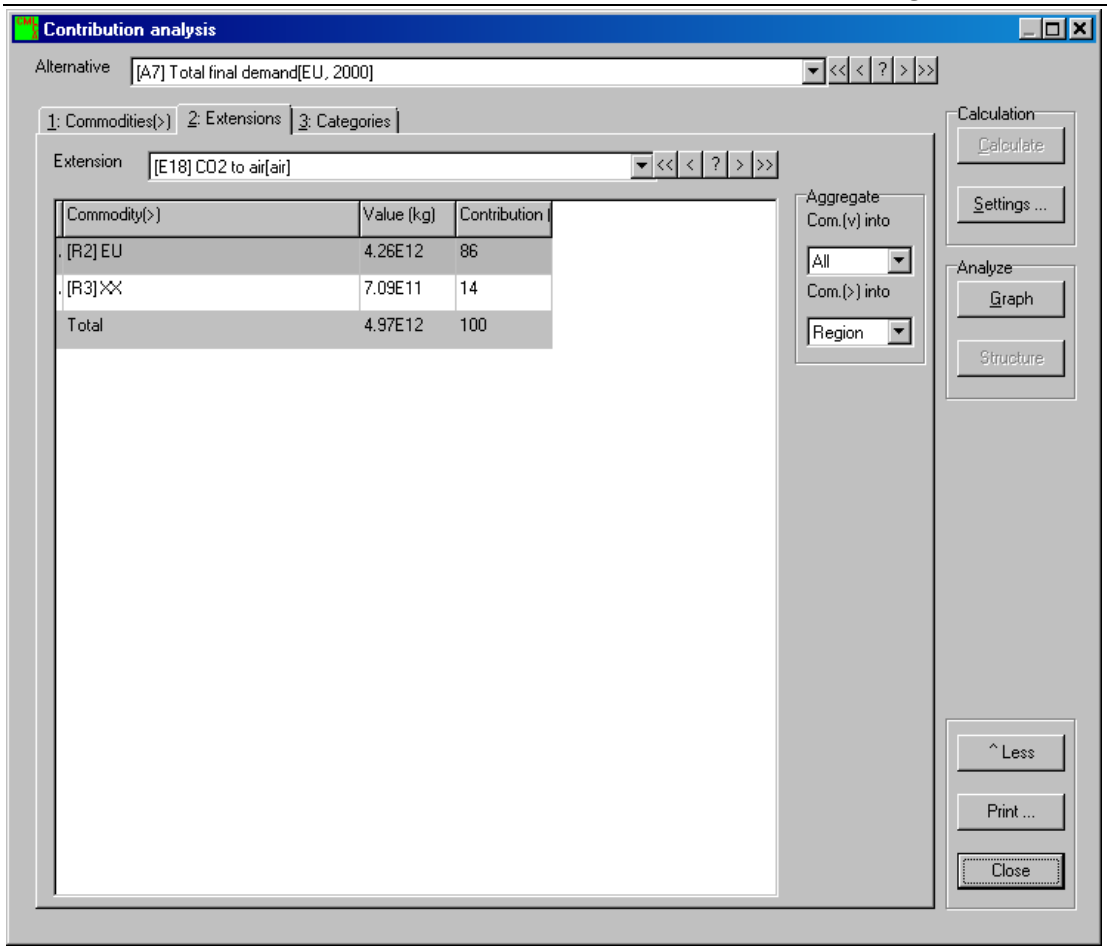


Figure 21: Yet another contribution analysis for CO_2 of the total final demand of the EU.

Question 18: What do these numbers mean?

4 Outlook

4.1 The external costs revisited

In the zipped datafile, there is another *.lca file. It contains the EXIOBASE IO-data for 18 regions: the aggregated EU, AU, BR, CA, CH, CN, ID, IN, JP, MX, NO, RU, TR, TW, US, ZA, and WW (aggregated rest of the world). The technology matrix has 2322 rows and columns, so calculating results takes much longer than with the two-country file studied until now. With a 4-year old dual-core laptop running Vista the Leontief inverse still completes in 10 minutes, and once it is there, most other calculations go quite fast.

This second datafile has also many more extensions: 6443. All air emissions have been split out in three ways:

- by country (the 18 countries listed above);
- by population density (urban and rural);
- by source type (low stack, medium stack, high stack, and mobile).

So, we see extensions such as "NMVOC to air rural Low stack[air, BR]".

This has been done to enable a connection with the external cost factors. For some of the air pollutants, country, population density, and source type differ, so the IO-data had to match this refinement. Extra bridge matrices have been introduced into EXIOBASE to allow for the air emissions to be split out by population density and source type.

In terms of impact categories, 122 lists of factors have been included. These have been grouped into 7 families:

- external cost, from the EXIOPOL project;
- footprints, for land, energy, water and energy;
- economics, value added and employment;
- air emissions, all pollutants aggregated per substance;
- NAMEA, the three impact categories from EUROSTAT;
- nutrients, loads of N and P;
- CML, 1999, the baseline LCA impact categories.

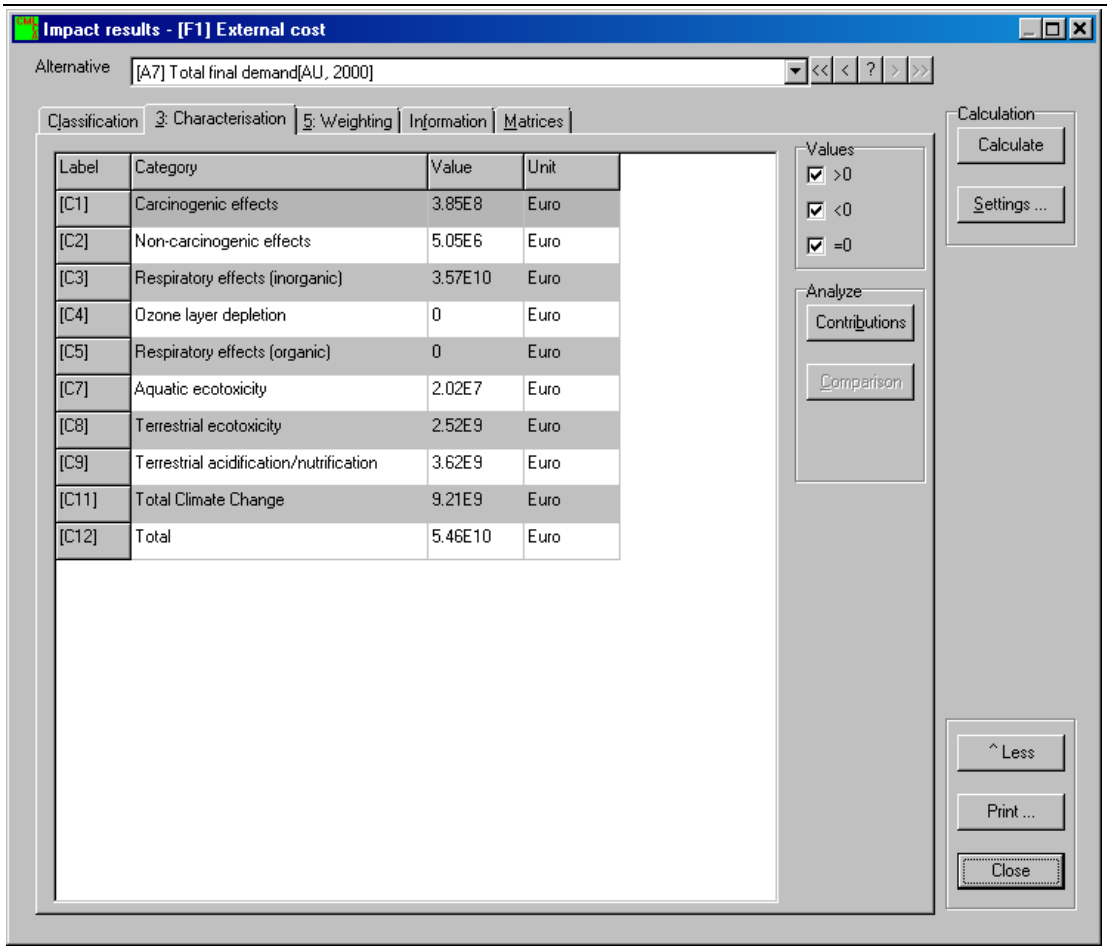


Figure 22: External costs of total final demand in Australia, by impact.

4.2 The complete EXIOBASE

So far, we have seen aggregations into 2 or 18 countries. EXIOBASE can easily provide other aggregations, for instance into EU, OECD except EU, and non-OECD. But one can also aggregate industries, for instance into 60*60 format.

The complete unaggregated EXIOBASE contain 5676 industries or commodities, and more than 10,000 extensions. Calculating the Leontief inverse with CMLCA can take an hour.

4.3 The complete CMLCA

The version of CMLCA that you downloaded is a full version. However, it has many more possibilities than the ones that are in this tutorial. To mention a few: structural path analysis, decomposition analysis, and Monte Carlo analysis can be done with CMLCA. The program contains these advanced options, and help is available. More options and more documentation will follow.

4.4 Continuation of EXIOBASE

The website http://www.exiobase.eu/ is being set-up to disseminate the EXIOBASE datafiles under precise licensing conditions. This includes a fee to enable maintenance and updates.

Further and more profound developments take place in the CREEA project; see http://www.creea.eu/.

4.5 Continuation of CMLCA

CMLCA has been around for more than 10 years, with distribution as freeware for more than 5 years. The website http://www.cmlca.eu/ provides access to downloads, updates, and other issues.

List of references

EUROSTAT. Manual for Air Emissions Accounts. 2009. http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-RA-09-004/EN/KS-RA-09-004-EN.PDF

Annex I: Answers to the questions

Question 1: It is a commodity-by-commodity table in coefficient form.

Question 2: It is the input in M.EUR of wheat needed for producing one M.EUR of cattle.

Question 3: You can see this in two ways. First, at the tabsheet for commidities out there is just 1 M.EUR. And in the other tabsheets all numbers are expressed in M.EUR/M.EUR.

Question 4: There are two blocks of commodities of length 129.

Question 5: Use the drop-down list to go to commodity 9, and look at the entry for commodity 2 in the tabsheet for commodities in.

Question 6: Below the input of commodity 129 (still from the EU), there are inputs of more commodities (from XX).

Question 7: These are Final consumption expenditure by households, Final consumption expenditure by non-profit organisations serving households (NPISH), Final consumption expenditure by government, Gross fixed capital formation, Changes in inventories, Changes in valuables, and Total final demand

Question 8: They spend most on real estate services in the EU, and least on metal secondary raw materials in XX.

Question 9: The direct emissions from final demand are not specified by purchase. It is as if you just see smoke the household's chimney: you cannot tell which of their consumables is causing the smoke.

Question 10: The characterisation factors for climate change (GWP) are 1 for CO_2, 21 for CH_4, and 310 for N_2O.

Question 11: These are CH_4 and NO_x.

Question 12: The household demand was 1640 M.EUR, and the production 3620 M.EUR. The difference between what is produced and what goes to consumers goes to industrial activity, such as food processing and restaurants.

Question 13: The + refers to things going out, such as emissions, and the – to things going in, such as labor.

Question 14: The 1% refers to the CO_2 from all construction works activities, the 9% to the CO_2 from the construction works plus its supply chain minus the construction works for industrial customers.

Question 15: Quite some electricity is used by industry, not by final consumers.

Question 16: Wool, silk-worm cocoons has the lowest, electricity by coal the highest.

Question 17: This screen in a break-down by substance.

Question 18: This means that 86% of the CO_2 that is world-wide emitted for the total final demand in the EU occurs in the EU and 16% outside the EU.

Annex II: Contributors to the report

This report has been written by Reinout Heijungs, CML, Leiden University, but it obviously builds on the work of and discussions between all partners in the EXIOPOL consortium. I mention specifically:

- All partners in Cluster III did an awesome lot of work to create a truly global harmonized EEIO-system;
- Wolf Müller from Cluster II managed to deliver the external cost estimates in a Cluster III-compatible form;
- Maaike Bouwmeester helped to carry her trade-routine from Matlab into EXIOBASE;
- Arjan de Koning was invaluable in developing the EXIOBASE system and fine-tuning it to match the CMLCA structure;
- Arnold Tukker managed to manage all these diverse inputs into an output at the end.