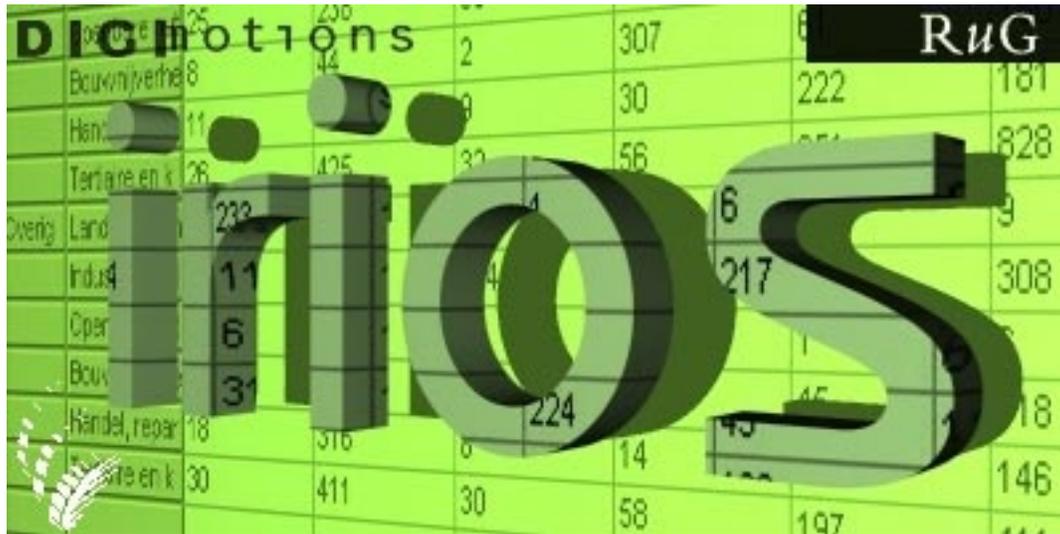


Interregional Input-Output Software



IRIOS 1.0 MANUAL

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1 Introduction

This manual assumes that the reader has some basic knowledge of input-output analysis. It is therefore not an introduction to the theory.* Where necessary, concepts used will be explained, but only briefly.

Note that IRIOS is a program for input-output *analysis*, not for the *construction* of an input-output *table*. Therefore, IRIOS only works with existing i-o tables, but it does offer the possibility of editing an input-output table by means of aggregation. Input-output analysis essentially means that you construct a *model* with the help of a *table*. This is why IRIOS works with two types of files:

- an IRIOS table file with the extension .TBL
- an IRIOS model file with the extension .MDL

The .TBL file only serves as an input medium. Once opened in IRIOS, a table can be saved as a .MDL file with all the additional information the user may have added to the table to make an input-output *analysis*, such as, for example, an exogenous demand impulse, emission coefficients, employment coefficients, a consumption function, an investment function, and so on.

IRIOS has been constructed as a fully-fledged Windows program. This means that you can exchange data with other programs, for example with a spreadsheet application, by means of the Windows Clipboard. You could, for example, create an exogenous demand impulse in Excel and then enter this data into IRIOS with Copy/Paste. Conversely, you can use this method to transfer (parts of) the table, the model, or the analysis results from IRIOS to other programs.

Chapter 2 explains how to create a .TBL file in other applications. The format of the .TBL file is such that it allows direct import and export of data from a spreadsheet created in Excel or another spreadsheet application. Furthermore, spreadsheet applications enable you to convert a table to all kinds of other file formats. IRIOS itself, therefore, does not have additional import or export formats: IRIOS can only open and save .TBL and .MDL files. The .TBL format is standard ASCII/Text, the .MDL format is IRIOS-specific and cannot be read by other applications.

The content of the rest of this manual is as follows. The remainder of chapter 2 and chapter 3 provide a description of the .TBL and .MDL file formats and explain how IRIOS interprets an i-o table. Chapters 4 to 9 contain a step-by-step description of the IRIOS menu structure.

* For that purpose the reader is referred to R.E. Miller & P.D. Blair, Input-Output Analysis: Foundations and Extensions, Prentice Hall, Englewood Cliffs, 1985.

2 Table files (.TBL)

2.1 Introduction

Usually, a national or regional input-output table has three dimensions:

- a number of sectors, i
- a number of primary cost categories, k
- a number of final demand columns, f

In such a table, the number of sectors per row i need not be the same as the number of sectors per column j , although this is usually the case. However, for an i-o model analysis, the **A** matrix of input coefficients should be square, which means that for an IRIOS table i should always equal j .

In IRIOS, the k dimension has been broadly defined as *all rows in the table that do not belong to the intermediate part*. From a strictly economic point of view, the “foreign import” row, for example, is not a primary cost category. Nevertheless, it does not belong to the intermediate part and it is therefore one of the k rows in IRIOS. A borderline case is the commonly used last sector: “other sectors not included elsewhere.” Since the NIE row usually does not concern the same activities as the NIE column, this “sector” is often removed from the intermediate part. If that is the case, the NIE row will be regarded as one of the k primary cost categories and the NIE column as one of the f final demand categories. However, such a change should be made “by hand” at an early stage, viz. during the creation of the .TBL file.

In IRIOS, all cells in a column should add up exactly to the column total and all cells in a row to the row total, which should be the same for each regional sector. This has certain consequences, for example for value added. Value added is often used as an endogenous variable in i-o analyses, but one is usually not allowed to include it as a separate k row in a .TBL file because value added is generally an *aggregate* of several specific primary cost categories k . Value added may only be included if its elements have been added up and are no longer present as separate rows. This limitation of the input is necessary so that IRIOS can check the accuracy of the i-o table to be read. *Therefore, it is not allowed to include subtotals in IRIOS tables.*

If it is necessary to work with subtotals, these should be defined as part of a *model* (with the **Model specification/Additional variables** menu command, see section 7.1).

Since IRIOS has been designed to carry out *inter*regional i-o analyses, the program has a fourth dimension:

- a number of regions, r

IRIOS can work with an i-o table without the regional dimension (for example, a national table) as a table with regional dimension $r = 1$. An $r = 1$ table may also be an *intra-regional* table in which the trade with other regions is only represented by a few columns (included among the f final demand categories) and a few rows (included among the k primary cost rows).

In a fully-fledged interregional i-o table a special distinction is created that does not exist in $r = 1$ tables, namely:

- the regional final demand categories, $f1$
- the other final demand categories, $f2$

Figure 1. Example of the layout of an IRIOS input-output table in spreadsheet format

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	2	4	2	3	5																
2	table name																				
3			region1	region1	region1	region1	region2	region2	region2	region2		region1	region1	region2	region2						Total
4			sec1	sec2	sec3	sec4	sec1	sec2	sec3	sec4		fin1	fin2	fin1	fin2		ofin1	ofin2	ofin3		
5	region1	sec1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
6	region1	sec2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
7	region1	sec3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
8	region1	sec4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
9	region2	sec1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
10	region2	sec2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
11	region2	sec3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
12	region2	sec4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
13																					
14	other	pc1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
15	other	pc2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
16	VA	pc3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
17	VA	pc4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
18	VA	pc5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
19																					
20		Total	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

- red = obligatory
- blue = optional for explanatory purposes
- other = optional (will be ignored by IRIOS for the sake of consistency. The display will show the corresponding red values)

The $f1$ categories are defined in terms of *regional destination*, such as, for example, regional private consumption and regional investment. The $f2$ categories (foreign exports, change in stocks, etc.) are categories that have not been defined in terms of regional destination.

The $f1$ regional final demand categories, therefore, are present in all regions, the $f2$ other final demand categories only once. *Therefore, the total number of final demand columns f in an interregional table equals $(r \times f1) + f2$.*

The example table inspreadsheet format presented in Figure 1 illustrates that an interregional table thus consists of four quadrants with four different types of purchases:

- I purchases that are **regional in terms of both origin and destination**: the intermediate purchases (Ia) and the *regional* final demand categories (Ib)
- II purchases that are **only regional in terms of origin**: the *other* final demand categories.
- III purchases that are **only regional in terms of destination**: the primary costs belonging to quadrant Ia and Ib.
- IV purchases that are **exclusively national**: the primary costs belonging to quadrant II.

2.2 Creating i-o tables in a spreadsheet application

Figure 1 shows the layout of an **IRIOS table in spreadsheet format** for two regions ($r = 2$), four sectors ($i = 4$), two regional final demand categories ($f1 = 2$), three other final demand categories ($f2 = 3$), and five primary cost categories ($k = 5$).

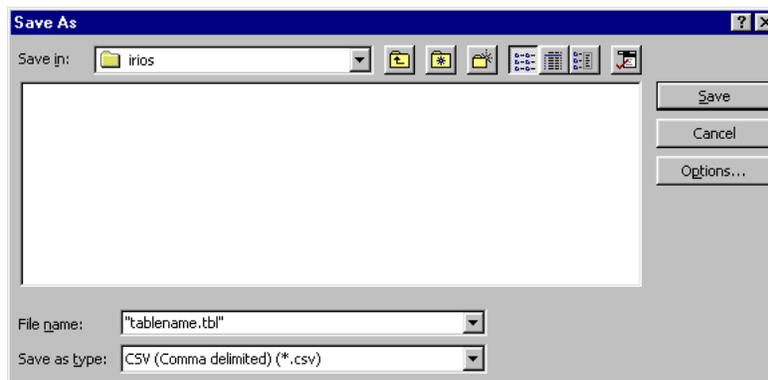
To distinguish the intermediate purchases and the regional final demand, both the intermediate columns and the regional final demand columns have been placed in separate groups. Viewed from left to right, you will first encounter all intermediate purchases (**Ia**) and then all regional final demand categories (**Ib**). The same is true for **IIIa** and **IIIb**.

As you can see from Figure 1, the format of an **IRIOS** table created in a spreadsheet application should conform to the following rules:

- Cells A1 to E1 should contain the 5 input-output table parameters:
 - A1: r = number of regions
 - B1: i = number of sectors
 - C1: $f1$ = number of regional final demand categories
 - D1: $f2$ = number of other final demand categories
 - E1: k = number of primary cost categories
- Cell A2 should contain the title of the table.
- From column C onwards, rows 3 and 4 should contain the names of the regions (region1, etc.), sectors (sec1, etc.), and final demand categories (fin1, etc.). Each row should first contain the intermediate sales to region 1 and region 2, then an *empty* column, then the regional final sales to region 1 and region 2, then an *empty* column again, than the other final sales, again an *empty* column, and finally the total gross production.
- Only the texts printed in **red** are obligatory and will be read by IRIOS. All texts printed in black may be omitted. They only have an auxiliary function. This has been done to avoid mistakes and inconsistencies, since “region1” in C3 should be the same as “region1” in L3. The same applies to “sec1,” “sec2,” ... and “fin1,” “fin2,”.... The text “Total” in B20 and U3 may be omitted because IRIOS will generate it automatically, independent of what the .TBL file contains.

- In the same way, the A and B columns from row 5 onwards should contain the names of the regions of origin, the sectors, and the primary cost categories. Only the names of the primary cost categories (pc1, etc.) printed in **red** in column B are obligatory. You may omit the other region and sector names in the rows, since these will be derived from the names printed in red in the columns. Additional texts (printed in blue) may be added in column A to the primary cost block. The example given in Figure 2 uses these texts as reminders to indicate that the last three primary cost categories constitute the value added.
- The numerical values in the table (indicated with red dots in Figure 2) should be entered in the C5-U20 block. IRIOS does not make a distinction between the zero value and a non-defined (empty) cell. *Non-defined cells must contain a zero. IRIOS does not accept empty cells.* The last row and the last column should contain the totals. If these totals do not correspond with the sums of the values in the columns and rows respectively, IRIOS will display an error message.
- The **empty** columns K, P, and T and the **empty** rows 13 and 19 must be added to the table (they will obviously be in a different location when the table parameters are different). All of them must be added even when $r=1$ (as For the sake of clarity, the various blocks of the i-o table displayed in the IRIOS table window are separated by means of an empty column or row, and you should follow this practice when creating an IRIOS table).

Once you have finished creating your table with the required layout in your spreadsheet application, you should export the data in “CSV format” to a file with the extension .TBL. Excel can do this, but most other spreadsheet applications also have this export format. In Excel, you should enter the following data in the Save As dialog box:



The example illustrates that you should place quotation marks around the table name (including the .TBL extension). If you fail to do this, you will encounter the strange Excel practice of saving the file as “tablename.tbl.csv”. If you omit the quotation marks and the.tbl extension, the table will be saved with the name “tablename.csv,” which is not convenient either, since you will then have to change the extension to .tbl in the Windows Explorer or IRIOS will refuse to open the file.

Note: correct export of the table from Excel requires that in Windows/Settings/Control Panel/Regional Settings the **List Separator** is set to **comma “,”**.

2.3 Creating i-o tables in other applications

CSV (“Comma Separated Value”) is a standard ASCII/Text format that has been around for a long time. Nearly all applications can read this format, and many are able to export data with this format. The values in the cells are delimited by a comma. If a text cell contains commas, the entire text will be placed in quotation marks, for example “Transport, trade and communication”. There is no need to pay specific attention to commas when working in Excel, since the CSV export routine will deal with them automatically.

IRIOS does not have built-in direct Excel, Quattro, or Lotus import routines, because such routines will in all probability become obsolete when new versions of these applications are introduced. Moreover, if more than two regions are involved, the size of the table will quickly exceed the spreadsheet maximum of 256 columns (column IV) that exists even today. Scientific applications such as, for example, Gauss, Gams, Matlab, etc. can easily save large tables in CSV format. IRIOS does not have a maximum table size. The maximum number of dimensions is limited by the hardware, not by the application.

The IRIOS/CSV format to be generated by other applications for the data of the example table in Figure 1 should look like this (the line numbers should *not* be included in the file):

```
[1] 2,4,2,3,5
[2] table name
[3] ,,region1,region1,region1,region1,region2,region2,region2,region2,,region1,region1,region2,region2,,,,,total
[4] ,,sec1,sec2,sec3,sec4,sec1,sec2,sec3,sec4,,fin1,fin2,fin1,fin2,,ofin1,ofin2,ofin3,,
[5] region1,sec1,<value>,<value>,...
[6] region1,sec2,<value>,<value>,...
[7] region1,sec3,<value>,<value>,...
[8] region1,sec4,<value>,<value>,...
[9] region2,sec1,<value>,<value>,...
[10] region2,sec2,<value>,<value>,...
[11] region2,sec3,<value>,<value>,...
[12] region2,sec4,<value>,<value>,...
[13]
[14] other,pc1,<value>,<value>,...
[15] other,pc2,<value>,<value>,...
[16] VA,pc3,<value>,<value>,...
[17] VA,pc4,<value>,<value>,...
[18] VA,pc5,<value>,<value>,...
[19]
[20] ,total,<value>,<value>,...
```

As you can see, empty rows are literally empty lines. Note that each empty column requires an extra comma! From line 3 onwards, each line should contain the required number of columns (in this case columns A to U, i.e. 21). If all optional text were to be omitted from Figure 1, the resulting CSV file would look like this:

```

[1] 2,4,2,3,5
[2] table name
[3] ,,region1,,,region2,,,,,,,,,,,,,
[4] ,,sec1,sec2,sec3,sec4,,,,,fin1,fin2,,,,ofin1,ofin2,ofin3,,
[5] ,,<value>,<value>,....
[6] ,,<value>,<value>,....
[7] ,,<value>,<value>,....
[8] ,,<value>,<value>,....
[9] ,,<value>,<value>,....
[10] ,,<value>,<value>,....
[11] ,,<value>,<value>,....
[12] ,,<value>,<value>,....
[13]
[14] ,pc1,<value>,<value>,....
[15] ,pc2,<value>,<value>,....
[16] ,pc3,<value>,<value>,....
[17] ,pc4,<value>,<value>,....
[18] ,pc5,<value>,<value>,....
[19]
[20] ,,<value>,<value>,....

```

The line format is not obligatory. If you like you can also start each cell of the table on a separate line:

```

[1] 2,
[2] 4,
[3] 2,
[4] 3,
[5] 5,
[6] table name,
[7] ,
[8] region1,

```

etc.

Of course, you can also use a text editor to edit the .TBL file directly (for example to edit or delete texts) instead of using a spreadsheet or any other application. However, this is not recommended, since it is easy to make mistakes in this way: one comma too many or too few may result in all numbers on the line moving to the right or left. This would result in an IRIOS error message when the program reads the file.

3 Model files (.MDL)

Each modification of an IRIOS table is stored as a file with the .MDL extension. These files have a binary format that can only be read by IRIOS. *Besides the table itself*, a model file contains all data the user has added to the table for the purpose of computing a model. This may be:

- an aggregation of the table
- “distributed trade and transport margins”
- additional variables, e.g. employment coefficients
- additional relations, e.g. a consumption function
- additional exogenous final demand impulses

An .MDL file thus contains an input-output table plus all model specifications.

In chapters 5 to 9, the menu commands will be discussed that can be used to include these model specifications in the model files.

Any **model results** to be kept for later use should either be printed or saved separately to a new file via the Clipboard before the end of the IRIOS session.

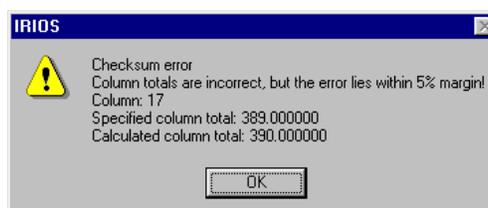
4 The File menu

4.1 The New model Command

When you open IRIOS, the program displays the Model, View, and Help menus. Use the New model command of the Model menu to create a new model. By default, the new model will be given the name IRIOS1.MDL, IRIOS2.MDL, and so on. A dialog box will be displayed in which you can select the i-o table to be used:



When reading the selected .TBL file, IRIOS will check if the row and column totals equal the totals entered in the last row and column of the .TBL file. Any deviations will be reported and tolerated as long as they do not exceed 5 per cent:



Larger deviations will also be reported, but then IRIOS will stop reading and display an error message. When the table has been read the table window appears. Below is an example of a biregional table with 6 sectors for the Dutch province Groningen and the rest of the country.

Biregional input-output table Groningen 1997		Groningen intermediate purchases	Groningen intermediate purchases	Groningen intermediate purchases	Groningen intermediate purchases
		Agriculture and fisheries	Manufacturing	Public utility	Construction
Groningen	Agriculture and fisheries	424	2725	14	5
Groningen	Manufacturing	1242	1743	31	554
Groningen	Public utility	167	484	280	19
Groningen	Construction	44	195	5	1252
Groningen	Transport, trade & communication	80	280	28	94
Groningen	Services	158	1286	56	258
Rest of the country	Agriculture and fisheries	308	2595	2	1
Rest of the country	Manufacturing	812	4403	783	902
Rest of the country	Public utility	18	13	72	0
Rest of the country	Construction	26	73	4	847
Rest of the country	Transport, trade & communication	71	323	28	70
Rest of the country	Services	156	890	97	198
	Foreign imports	390	8504	478	1158
	Trade- and transport margins	235	2194	38	517
	Direct and indirect taxes	114	78	110	35
VA	Wages	356	6029	348	2038
VA	Social insurance	83	1815	28	513
VA	Other income	1915	3667	1278	713
Total		8058	37394	2687	9182

If necessary, use the mouse pointer to change the column width or row height, for example if some texts are not displayed in their entirety. To have long texts displayed in full, you can either increase the column width or increase the row height. The latter has been done in the above example for the second row.

Note that in the second row the text “intermediate purchases” has been added after the name of the region in columns 3 and beyond. Further to the right, the texts “regional final demand” and “other final demand” have been added above the appropriate columns, so that you will always know which part of the table you are looking at, even if the table is too big for the table window.

Because the first few rows and columns that contain texts have been “locked,” they will always remain visible, even when you use the scroll bars, for example, to look at the rest of the table. You can select part of the table with the mouse pointer or Shift-arrow keys and subsequently copy it to another file by means of the Clipboard. As we have explained in the Introduction, the table itself cannot be edited in IRIOS.

4.2 The Open model Command

Use this command to open an existing model:



Only one model can be open at any time.

4.3 The Close, Save, Save As..., and Exit Commands

The functions of these commands are self-evident and do not require further explanation.

4.4 The Page Settings, Print Preview, and Print Commands

These commands offer the user options for printing the entire table or parts of it, changing the page settings, and previewing the print. The layout is standard, although changed column widths and row heights will be preserved during printing. If you want to use special layout elements, such as borders, specific fonts, etc. you should copy the data to be printed to a spreadsheet application, which has far more layout and formatting options than IRIOS.

Print commands can also be given while working in IRIOS results' windows.

5 The Edit menu

5.1 The Cut, Copy, and Paste Commands

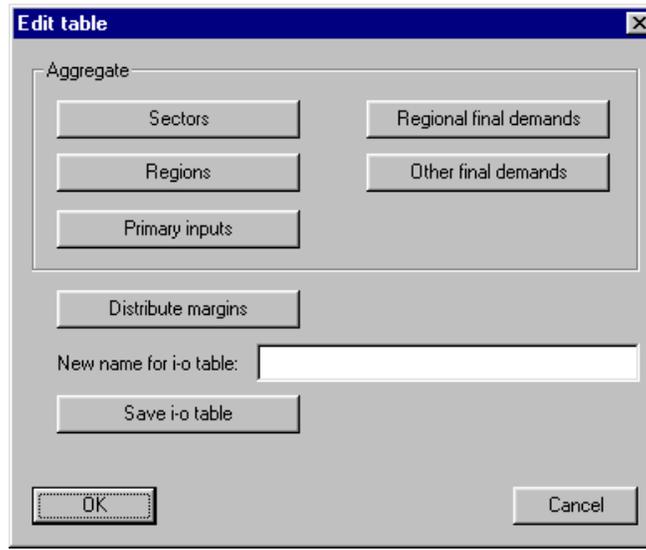
Naturally, the Edit menu contains the default Windows commands **Cut**, **Copy**, and **Paste**. Any window (or parts of it) displayed by IRIOS as a result of one of the commands to be discussed in the next chapters can be selected there and copied to a different location by means of these commands. Conversely, data can be imported by cutting and pasting from other applications (usually spreadsheet programs).

If a row or column of n values should be pasted at a particular location in an IRIOS window, and a spreadsheet row or column consisting of $m > n$ numbers has been placed on the Clipboard, the numbers $(n + 1) - m$ will be ignored. If $m < n$, the numbers $(m + 1) - n$ in IRIOS will not be changed. If you try to paste a selected *column* in a *row* (or vice versa), only the first number in the selected row or column will be pasted.

Note: the Copy command from Excel takes numbers to IRIOS only with the number of decimals shown on your Excel screen, regardless of their internal accuracy. In addition, in **Windows/Settings/Control Panel/Regional Settings the decimal symbol should be set to the decimal point “.”**

5.2 The Edit table Command

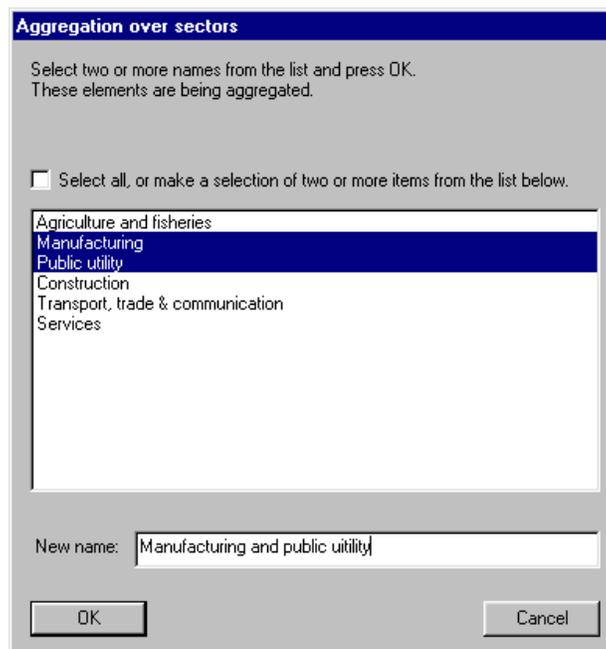
Another Edit menu command is **Edit table**, which will display the following dialog box:



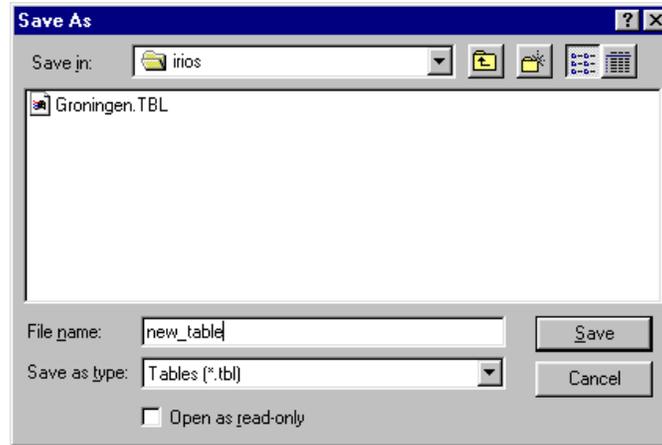
The top box of the **Edit table** dialog box lists the five familiar dimensions of the IRIOS table over which you can **aggregate** the table:

- sectors (*i*)
- regions (*r*)
- primary inputs (*k*)
- regional final demand (*f1*)
- other final demand (*f2*)

After you have selected one of these five dimensions by clicking its button, IRIOS will present a dialog box in which you can click the names of the categories to be aggregated and enter a new name for the resulting aggregation. In the case of sectors, for example, you may aggregate “Manufacturing” and “Public utilities” to produce “Manufacturing and public utilities”:

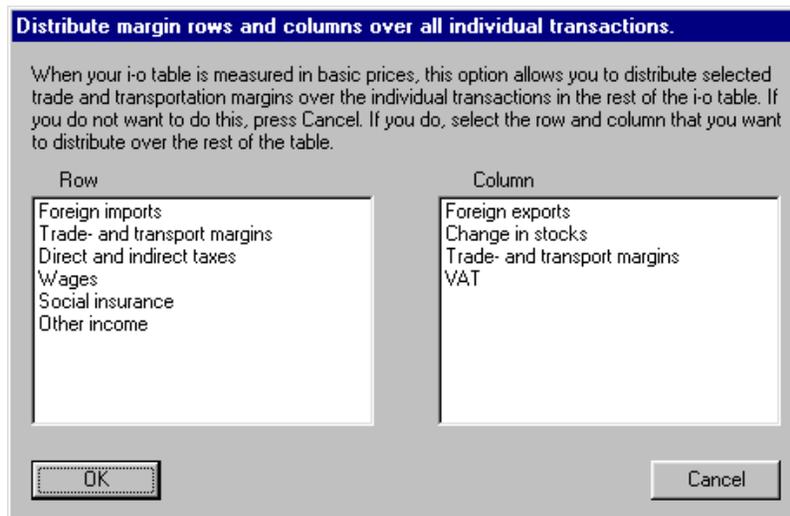


IRIOS will carry out the aggregation and immediately display the result in the table window. If you wish, use the same procedure for another aggregation. The aggregated table can be saved as a.TBL file with the **Save i-o table** option, but you will have to enter a new name for that table. This is the title of the i-o table displayed at the top left of the i-o table window. IRIOS will select this title as the name for the file to be saved, but you are free to enter a different name.



NB: *It is not possible to undo an aggregation!* If you wish to return to the original data, you will have to open the unaggregated file again.

The **Distribute margins** option displays a dialog box specifically intended for i-o tables measured in basic prices in which you can indicate which row in block III and which column in block II (see Figure 1) contain the trade and transport margins that you wish to distribute to produce a table expressed in manufacturers' prices (including trade and transport margins):



To carry out the distribution, a RAS procedure is followed. This procedure requires additional explanation that falls outside the scope of this manual. In brief, the procedure distributes the values in the selected row and column proportionally over the rows and columns of blocks I and II. The user can “modify” the “structure of the matrix” according to which these rows and columns are distributed over the table. You can also select other rows and columns than the ones containing the trade margins, for example the “foreign imports” row and the “VAT” column. IRIOS will then display an error message, since the totals in this row and column are not the same. Furthermore, the algorithm is generalized in such a way that you can

distribute several rows and columns simultaneously, as long as the sum totals of all rows and of all columns involved are the same.

NB: You can only select **Edit table** if you have not yet added model information, such as, for example, an exogenous impulse or employment coefficients. This safeguard has been included because not all model information can be aggregated routinely.

6 The Descriptive Statistics menu

This menu allows the user to extract some frequently used economic structure data from the table without specifying a model (with the **Model specification** menu, see Chapter 7).

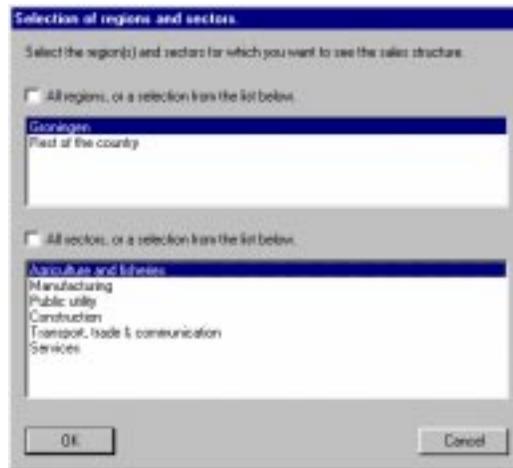
6.1 The Analysis of i-o table Command

Use this command to compute economic structure data from the table. The submenu of this command offers three options:

- **Sector structure:** computes the sector structure for all categories in blocks II and III and total gross production, i.e. the distribution per region across the i sectors expressed as running-total permillages adding up to 1000. To compute the sector structure of the total production of Groningen, for example, select the following items:



- **Sales structure:** computes the sales structure for all sectors in each region, i.e. the “horizontal” distribution of the total row concerned expressed as running-total permillages adding up to 1000. There are additional options for aggregating over the row with respect to region (r), sector (i), regional final demand ($f1$), and other final demand ($f2$), in all cases with respect to destination. If no aggregation is chosen, all sales coefficients for all the selected row(s) will be presented. To compute the sales structure of the agricultural and fisheries sector in Groningen, for example, select the following items:



You can then aggregate over regions of destination:



Then aggregate over sectors of destination:



Then aggregate over regional final demand of destination:



Finally, you can aggregate over the other final demand of destination:



- **Cost structure:** the cost structure can be computed for any column in the table, i.e. the “vertical” distribution of the column in question expressed as running-total permillages adding up to 1000. There are additional options for aggregating over the column with respect to region of origin (r), sector of origin (i), and primary cost category (k). If no aggregation is selected, the whole of the selected column will be presented in the form of column coefficients.

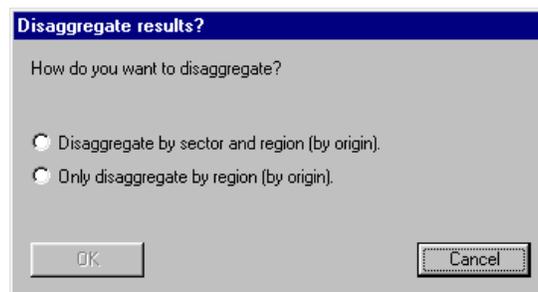
The aggregations specified with this menu command only have an effect on the **presentation** of the sales and cost structures in the results’ window and do not influence the aggregation level of the table itself.

6.2 The Analysis of i-o linkages Command

1. For descriptive purposes, linkages have been defined in two ways:
 - **backwards:** the total of the direct and indirect *purchasing* of inputs per sector (i.e. the ordinary production multipliers of the Leontief inverse $(\mathbf{I} - \mathbf{A})^{-1}$ minus the direct effect).
 - **forwards:** the total of the direct and indirect *processing* of outputs per sector (i.e. the production multipliers of the Ghosh inverse $(\mathbf{I} - \mathbf{B})^{-1}$ minus the direct effect).

Both options in the command’s submenu allow you to select the sectors i in region r for which the linkages should be displayed (as we have seen above).

You can then also have the linkages desaggregated for each region and each sector by means of the “Disaggregate results?” dialog box.



If you select the “Disaggregate by sector and region” option, the entire column of the Leontief or the entire row of the Ghosh inverse minus the unity matrix will be displayed. If you had selected all sectors and all regions in the previous dialog box, the entire Leontief or Ghosh inverse matrix (minus \mathbf{I}) will be displayed.

7 The Model specification menu

By default, IRIOS works with the standard demand-driven Leontief model¹, which is referred to as the “basic model” in various IRIOS windows:

$$\mathbf{V} = \mathbf{E} \mathbf{x} = \mathbf{E} (\mathbf{I} - \mathbf{A})^{-1} \mathbf{F}.$$

This basic model contains gross production \mathbf{x} and all primary cost categories \mathbf{V} related to gross production through the primary cost coefficients \mathbf{E} that are included in the table by default (these are always referred to as “variables” in the IRIOS menus). It is therefore possible to carry out the various multiplier and impact analyses described in Chapters 8 and 9 without providing any further model specification.

The **Model specification** menu allows the user to extend the basic model step by step to:

$$\mathbf{V}^* = (\mathbf{E}^* + \mathbf{Qe}) \mathbf{x} = (\mathbf{E}^* + \mathbf{Qe}) (\mathbf{I} - \mathbf{A} - \mathbf{Q})^{-1} \mathbf{F}^{\text{ex}}$$

by adding additional data to the basic model. This may be done in two ways:

- by adding additional rows of coefficients to the default \mathbf{E} matrix to produce the larger \mathbf{E}^* matrix with the additional variables in the larger \mathbf{V}^* matrix (*without* feedbacks to production);
- by adding additional relations to the basic model, with feedbacks to gross production by way of $\mathbf{Q} \mathbf{x}$ and with feedbacks to the (additional) variables by way of $\mathbf{Qe} \mathbf{x}$. This can be achieved by adding several \mathbf{Q} matrices and their accompanying \mathbf{Qe} matrices.

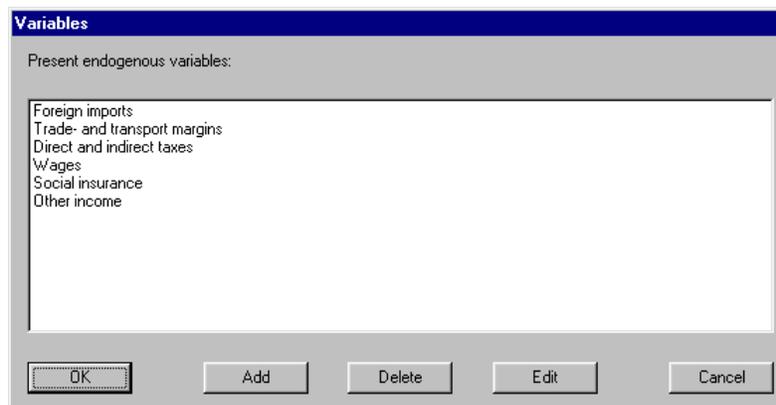
The final model will thus have the following general form:

$$\mathbf{V}^* = (\mathbf{E}^* + \mathbf{Qe}_1 + \mathbf{Qe}_2 + \mathbf{Qe}_3 \dots + \mathbf{Qe}_n) (\mathbf{I} - \mathbf{A} - \mathbf{Q}_1 - \mathbf{Q}_2 - \mathbf{Q}_3 \dots - \mathbf{Q}_n)^{-1} \mathbf{F}^{\text{ex}}.$$

In order to compute impacts and/or projections with the basic model or the extended model, various exogenous impulses for the \mathbf{F}^{ex} matrix may be specified with the **Impacts/projections** menu (see Chapter 9).

7.1 The Additional variables Command

The variables that you can add to the model as default options are all primary cost categories k from block III. These variables are pre listed in the “Variables” dialog box:



¹ See J. Oosterhaven in: Leontief versus Ghoshian Price and Quantity Model. *Southern Economic Journal* 62/3 (1996), pp. 750-59, for the alternative supply-driven model, the standard cost-push price model and the alternative demand-pull price model.

You can **Add** additional variables, for example employment or CO₂ emissions. Adding variables may be done by adding the specification of additional vectors **e** with ... *coefficients per unit x* to be added to the default **E** matrix. After entering (for example) “employment” as the name of the new variable, the following entry window will be displayed:

	Groningen	Groningen	Groningen	Groningen
	Agriculture and fisheries	Manufacturing	Public utility	Constructio
Foreign imports	0.058567352	0.254158421	0.129102251	0.122610415
Trade- and transport margins	0.035290584	0.058672514	0.009764036	0.056800703
Direct and indirect taxes	0.017119688	0.002085896	0.029834554	0.003845309
VA Wages	0.053461481	0.161229074	0.094385679	0.223577236
VA Social insurance	0.009460880	0.027143392	0.007594250	0.056361239
VA Other income	0.287580718	0.095389635	0.346080825	0.078334432
employment	0.000000000	0.000000000	0.000000000	0.000000000

For the sake of completeness, all existing variables in block III will also be displayed, but these cannot be edited, since these coefficients have been taken from the i-o table itself. Only the variables you have added yourself can be deleted again (by clicking the **Delete** button). The default variables of the basic model cannot be deleted. If you wish to use other coefficients for wages than the default coefficients from the table, you will have to **Add** these yourself as a new variable.

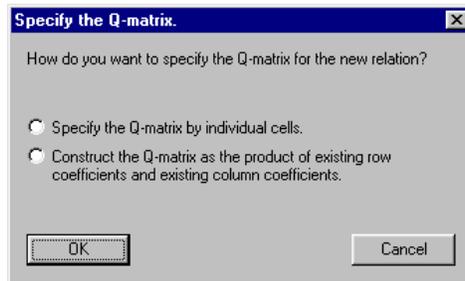
When you scroll through the table to the right, you will see that each variable has the same number of columns as the **A** matrix, i.e. $r \times i$. By default, IRIOS will enter a zero value for each new variable. In most cases, the user will not enter the coefficients by hand but compute them (for example in Excel) and then import them via the Clipboard.

The **Edit** button will display the window shown above again. This option, too, only works for the variables added by the user. The default variables cannot be edited.

7.2 The Additional relations Command

Adding relations actually implies the definition of a **Q** matrix that establishes an additional relation between the sales of sector **a** and a spending category **b**. The q_{ab} coefficient in a **Q(a,b)** matrix represents the additional sales of sector **a** per unit of gross production in sector **b**. In the most commonly used example of a consumption function, **a** relates to the sales of consumer goods by sector **a** to the households in sector **b** per unit of production unit in sector **b**. In the latter case, the causality of the additional relation could, for example, be as follows: increased production in sector **b** → increased earned income in sector **b** → increased total household consumption in sector **b** → increased consumer spending on goods supplied by sector **a** to these households.

The first selection window allows you to edit previously defined relations and **Add** new relations. When you have entered the name of the relation, the following dialog box will be displayed:



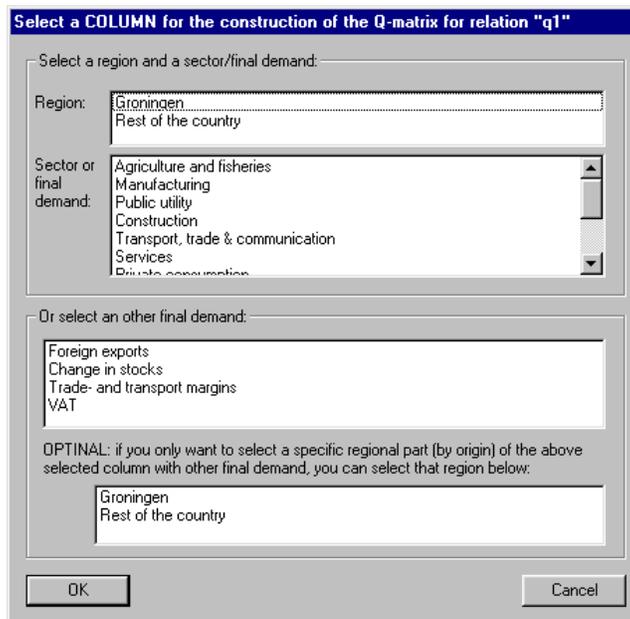
If you select the first option, "Specify the Q matrix by individual cells," the following entry window will be presented (in this example, the name "q1" was given to the relation):

A window titled "Specify Q-matrix for relation 'q1'" showing a grid of coefficients. The columns are labeled "Groningen" and "Rest of the country", and the rows are labeled "Agriculture and fisheries", "Manufacturing", "Public utility", "Construction", "Transport, trade & communication", and "Services". All cells in the grid contain the value 0.00000000.

		Groningen	Rest of the country	Groningen	Rest of the country
		Agriculture and fisheries	Manufacturing	Public utility	Construction
Groningen	Agriculture and fisheries	0.00000000	0.00000000	0.00000000	0.00000000
Groningen	Manufacturing	0.00000000	0.00000000	0.00000000	0.00000000
Groningen	Public utility	0.00000000	0.00000000	0.00000000	0.00000000
Groningen	Construction	0.00000000	0.00000000	0.00000000	0.00000000
Groningen	Transport, trade & communication	0.00000000	0.00000000	0.00000000	0.00000000
Groningen	Services	0.00000000	0.00000000	0.00000000	0.00000000
Rest of the country	Agriculture and fisheries	0.00000000	0.00000000	0.00000000	0.00000000
Rest of the country	Manufacturing	0.00000000	0.00000000	0.00000000	0.00000000
Rest of the country	Public utility	0.00000000	0.00000000	0.00000000	0.00000000
Rest of the country	Construction	0.00000000	0.00000000	0.00000000	0.00000000
Rest of the country	Transport, trade & communication	0.00000000	0.00000000	0.00000000	0.00000000
Rest of the country	Services	0.00000000	0.00000000	0.00000000	0.00000000

Apart from entering coefficients by hand, you can also use the Clipboard to past a matrix created in a spreadsheet application. The dimensions of **Q** are the same as the dimensions of the **A** matrix: $(r\ i) \times (r\ i)$.

The second option is convenient if the **a** and **b** elements of relation **Q** are already present in the model. When you select this option, IRIOS will first display a window to select the column:



As you can see, any column from block I (the upper two panes must be used to select region r and sector i or regional final demand $f1$ respectively) or any column from block II (other final demand $f2$) may be selected. In the case of other final demand, the regional component may also be selected. This is convenient, for example, if a relation should be established between a particular row and the foreign exports of Groningen only.

After selecting a column IRIOS will display the selection window to select a row:

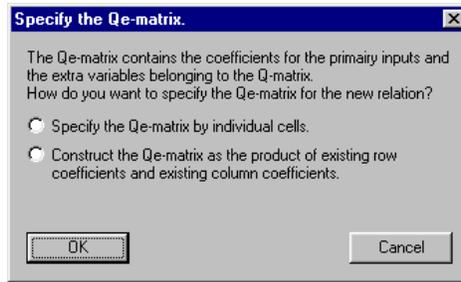
As with the column, any row from the *table* may be chosen: a sector i in region r , or one of the primary cost categories k , or one of the user-defined new variables. Again, of the primary cost and additional variables only the regional part may be selected.

Finally, this menu command allows you to edit a previously defined relation. If you click the **Edit** button of the “Variables” dialog box, the “Specify the Q matrix by individual cells” window will be displayed again.

7.3 The link between a Relation and a Variable: the Q_e matrix

Since a variable is defined as a row with coefficients per unit of gross production \mathbf{e} , variable \mathbf{v} in the basic model may be computed as $\mathbf{v} = \mathbf{e} (\mathbf{I} - \mathbf{A})^{-1} \mathbf{f}$. However, in a model extended with a relation \mathbf{Q} , the link between a variable \mathbf{v} and a relation $\mathbf{Q}(\mathbf{a}, \mathbf{b})$ should be specified. This link is referred to as the Q_e matrix and consists of k rows (for each variable k) and $i \times r$ columns. In the same example of a \mathbf{Q} matrix representing the endogenous consumption, the cell $Q_{e_{ki}}$ represents, for example, the foreign imports of consumer goods (variable k) by households per earned income unit in sector i per gross production unit in sector i .

To specify the **Q_e** matrix, you should follow a similar procedure as the one for the definition of the **Q** matrix described in the previous section:



If you select the first option, the following entry window will be displayed:

		Groningen Agriculture and fisheries	Groningen Manufacturing	Groningen Public utility	Groningen Construction
	Foreign imports	0.000000000	0.000000000	0.000000000	0.000000000
	Trade- and transport margins	0.000000000	0.000000000	0.000000000	0.000000000
	Direct and indirect taxes	0.000000000	0.000000000	0.000000000	0.000000000
VA	Wages	0.000000000	0.000000000	0.000000000	0.000000000
VA	Social insurance	0.000000000	0.000000000	0.000000000	0.000000000
VA	Other income	0.000000000	0.000000000	0.000000000	0.000000000
	employment	0.000000000	0.000000000	0.000000000	0.000000000

To create the “foreign imports” variable, for example, the import coefficients of the “consumption function” relation are required. In this case, this concerns the direct foreign imports by households, again as in the **Q** matrix per earned income unit in sector *j* per gross production unit in sector *j*. This row can be simply computed by multiplying the household import coefficient (= only one value, see the “foreign imports” row in the “household consumption” column of the i-o table) with the row of coefficients on which the **Q** matrix is based.

If you have constructed the **Q** matrix as the product of an existing row and column of the table, you can use the second option (“Construct the Q_e matrix as the product ...”) to compute the **Q_e** matrix. **NB:** in that case you should of course select the row and column that you previously selected to create the **Q** matrix.

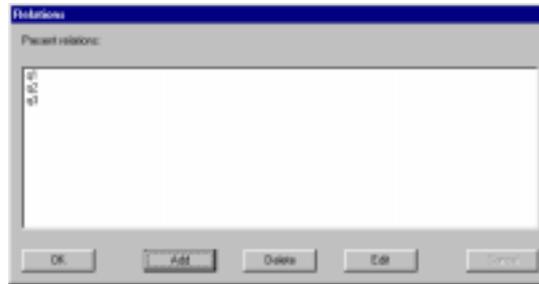
IRIOS will keep a record of all links defined between all variables and relations.

The **Q_e** matrix represents a relation that you may not wish to add in some cases. If this is so, select the “Specify the Q_e matrix by individual cells” option and simply leave all coefficients zero.

8 The Multiplier analysis menu

8.1 The Select additional relation(s) Command

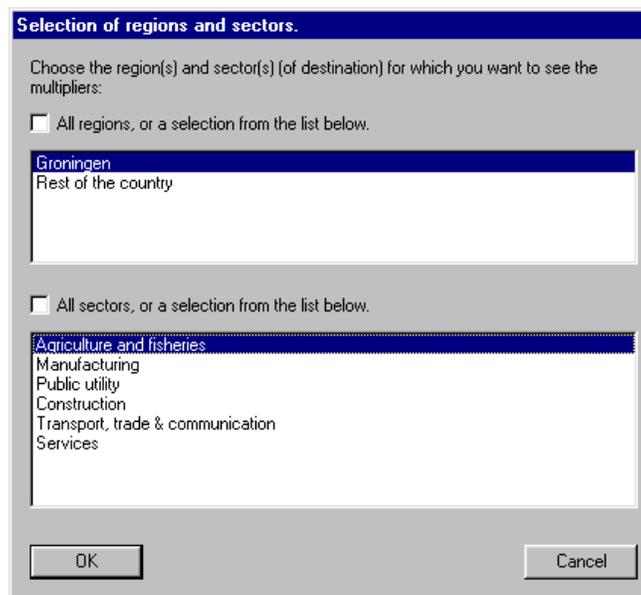
No final impulse is required for a multiplier analysis, but the user should specify the additional relations to be used, in other words which matrix $(I - A - Q_1 - Q_2 - Q_3 - \dots - Q_n)^{-1}$ should be used for the computation. If you do not select any relation, the basic model $(I - A)^{-1}$ will be used. If you want to use additional relations, use the **Select additional relations** command, which displays the following window:



NB: this window requires you to **deselect** all the relations displayed with Ctrl-left mouse button in case you do not want to use *any* of the previously selected relations.

8.2 The Production multipliers Command

Use this command to have IRIOS compute production multipliers for all regions and sectors or a selection of regions and sectors:



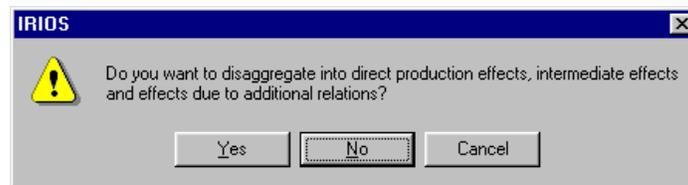
In simple terms, this window allows you to select the columns of the Leontief inverse. In the window shown, agriculture and fisheries in Groningen has been selected. The next step is to have the desired production multipliers displayed as totals per region or disaggregated by sector, by means of the “Disaggregate results?” dialog box described in section 6.2:

The option selected in this example, "Only disaggregate by region (by origin)," will lead to all sectors (of origin) being added up for each region. The results window will then look like this:

Aggregated production multipliers; model: "base"		
Groningen		
Agriculture and fisheries		
Groningen	total	1.406135788
Rest of the country	total	0.443570543
TOTAL		1.849706331

The total production multiplier of the agriculture and fisheries sector in Groningen is 1.85: 1.41 for Groningen itself (i.e. including the direct effect of 1.00 of Groningen agriculture itself) and 0.44 for the rest of the country.

If you have selected one or more additional relations, IRIOS will first display an additional message box that will give you the opportunity to have the production multipliers displayed separately for the Leontief inverse itself and for the additional relations:



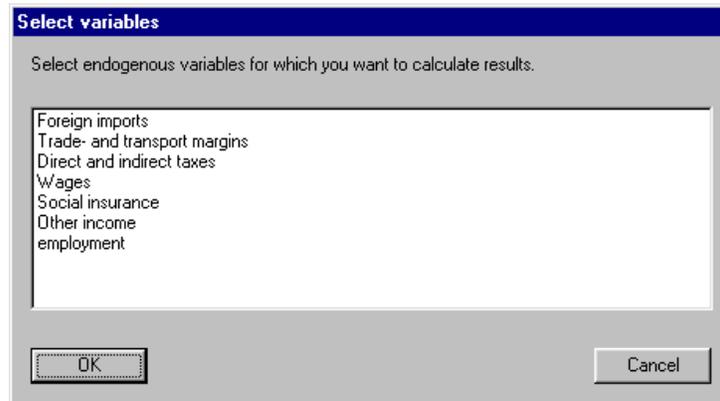
If you click "Yes," the results window for an additional relation **q1** will look like this:

Disaggregated production multipliers; model: "base" + "q1"		
Groningen		
Agriculture and fisheries		
Disaggregated production multipliers with regard to direct effects and intermediate purchases		
Groningen	total	1.417095790
Rest of the country	total	0.465769924
TOTAL		1.882865714
Disaggregated production multipliers with regard to "q1"		
Groningen	total	0.065097015
Rest of the country	total	0.023843189
TOTAL		0.088940204

Note that the total production multiplier has become slightly larger as a result of the additional relation **q1** (1.88 instead of 1.85). The last value displayed in the window is the **q1** multiplier, which is approx. 0.09. If **q1** is a consumption function, it indicates that for the total Dutch economy 0.09 units of consumer spending are generated per unit exogenous final output of agriculture and fisheries in Groningen.

8.3 The Multipliers for variables Command

The first step when using this menu command is selecting the variable(s) for which you want the multipliers computed:



You will then be presented with the same windows as described in Chapter 6, "Descriptive Statistics," to select the degree of disaggregation of the multiplier across the rows (all sectors or only totals per region). If, in the above example, the variable selected is wages and you select **Ordinary multipliers** from the **Multipliers for variables** submenu, the result (without an additional relation Q) will be as follows:

Standard multipliers; model: "base"		
		Groningen
		Agriculture and fisheries
		Standard multipliers: Wages
Groningen	total	0.117177223
Rest of the country	total	0.080671412
TOTAL		0.197848635

The ordinary multiplier represents the number of units of the variable generated in the entire economy per unit exogenous final sales of the selected sector. Standardized multipliers will be computed if you select the **Standardized multipliers** command from the **Multipliers for variables** submenu. In the example above, this would produce the following results:

Normalized multipliers; model: "base"		
		Groningen
		Agriculture and fisheries
		Normalized multipliers: Wages
Groningen	total	2.191806536
Rest of the country	total	1.508963289
TOTAL		3.700769825

This multiplier is the number of wage income units generated in the entire economy *per exogenous wage income unit* in agriculture in Groningen.

9 The Impacts/projections menu

If you want IRIOS to compute impact analyses or projections, you should not only specify the model itself (which additional relations and/or additional variables you wish to use), but you should also define one or more exogenous impulses f^{ex} , whose effects you want to be computed.

9.1 The Select additional relations Command

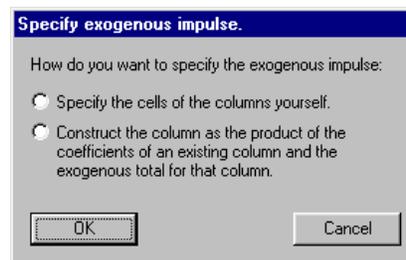
This command works in the same way as the command with the same name in the **Multiplier analysis** menu (see section 8.1).

9.2 The Specify exogenous impulses Command

This command allows the user to define one or more exogenous final demand impulses:



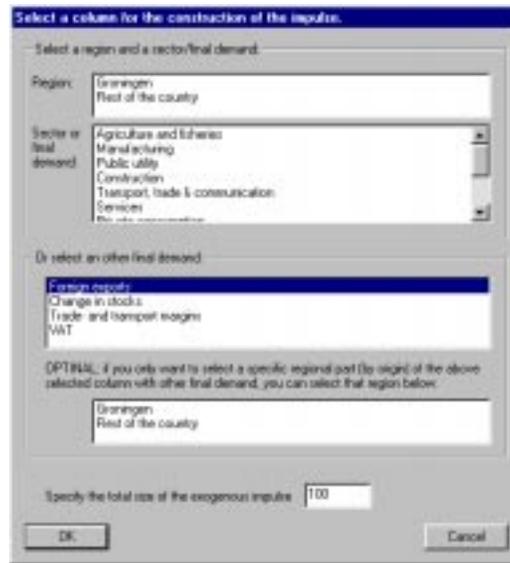
If no impulse has been defined yet, click **Add**. A new impulse may be added in two ways:



If you choose “Specify the cells of the columns yourself,” the following entry window will be displayed:

		euro2000
Groningen	Agriculture and fisheries	0.000000000
Groningen	Manufacturing	0.000000000
Groningen	Public utility	0.000000000
Groningen	Construction	0.000000000
Groningen	Transport, trade & communication	0.000000000
Groningen	Services	0.000000000
Rest of the country	Agriculture and fisheries	0.000000000
Rest of the country	Manufacturing	0.000000000
Rest of the country	Public utility	0.000000000
Rest of the country	Construction	0.000000000
Rest of the country	Transport, trade & communication	0.000000000
Rest of the country	Services	0.000000000

Enter absolute numbers for the impulse, either by hand or by pasting from the Clipboard (filled with spreadsheet data). The example text “euro2000” is the name of the impulse. The same window will be displayed if you click the **Edit** button in the Impulses window. If you select the second option, “Construct the column ...,” you only need to specify the total impulse. IRIOS will then distribute it in accordance with an existing column of the i-o table:



When you select a column, the specified “total impulse” will be distributed across the entire column, so including the primary cost categories. An export impulse of 100, as in the example above, also implies direct foreign imports (in fact, this is a transit, in block IV of the i-o table), which means that the total foreign sales of companies in Groningen and the rest of the country due to the impulse will not add up to 100 but to a lower value.

However, if you choose to use the regional part of one of the other final demand columns only (this is OPTIONAL), the rest of the cells in the column will be set to zero and the regional part will add up exactly to the specified total (e.g. an increase of 100 in foreign sales of companies in Groningen only). The impulse created in this way can be edited by clicking the **Edit** button in the Impulses window.

9.3 The Select exogenous impulses Command

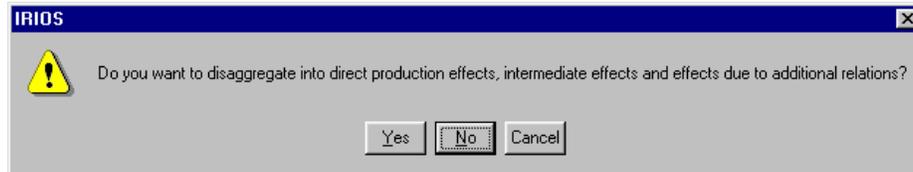
Previously defined impulses can be selected for computing impacts/projections by clicking them in the “Impulses” window:



If several impulses are computed in a model computation simultaneously, the effects of each separate impulse and the sum total of all effects will be computed and displayed.

9.4 The Production effects Command

The Production effects command offers a special option besides the ordinary disaggregation of effects. This option allows the user to make a distinction between the direct effect (f^{ex} itself), the intermediate effects ($A x$), and the production effects of the additional relations ($Q_i x$). To enable you to choose this option, IRIOS will present the following message box first:



If you click “No” (i.e. you do not wish to make use of the special option), the previously described “Disaggregate results?” dialog box to select either disaggregation of the effects for each intermediate sector or display of regional totals only will be displayed. In the example below, an arbitrary impulse of 100 by Groningen manufacturing has been defined (and given the name “impulse”) with an additional relation q_1 . Only if you request IRIOS to compute the total production effects per region will the following results window be displayed:

Endogenous production effects; model: "base" + "q1"		
impulse		
Groningen	total	143.006419631
Rest of the country	total	50.712076181
TOTAL		193.718495812

In this case, the total production effects, including the impulse itself, are approx. 193.7. If you select disaggregation of the effects, the following window will be displayed instead:

Endogenous production effects; model: "base" + "q1"		
impulse		
Disaggregated direct production effects		
Groningen	total	100.000000000
Rest of the country	total	0.000000000
TOTAL		100.000000000
Disaggregated endogenous production effects with regard to intermediate purchases		
Groningen	total	26.520021249
Rest of the country	total	44.673576325
TOTAL		71.193597573
Disaggregated endogenous production effects with regard to "q1"		
Groningen	total	16.486398383
Rest of the country	total	6.038499856
TOTAL		22.524898239

The exogenous final demand impulse (100 for Groningen only in this case), the endogenous intermediate purchases, and the endogenous production effects for relation q_1 have been disaggregated in this window.

9.5 The Effects on endogenous variables Command

When you use this command, you should first select the variables for which you want IRIOS to compute the effects. This is done in the same way as with the **Variables multipliers** command; see section 8.3). Then select either disaggregation by sector or total per region in the way as described above. If you select the latter option, the results window may look like this:

Endogenous effects; model: "base" + "q1"		
		impulse
		Endogenous effects: Direct and indirect taxes
Groningen	total	1.178435104
Rest of the country	total	0.727333948
TOTAL		1.905769052

As you can see, in this case the effect of the selected endogenous effect (product-based taxes and subsidies) is small in comparison to the total impulse of 100.

10 To conclude

The other menus, **View** and **Window**, offer various standard commands for changing the display of windows, the status bar, and so on. The **Help** menu has not been implemented in the current version.

The results windows will *not* be saved when one of the **Close**, **Save**, or **Save As...** commands are selected. If you want to keep these, you will have to save them separately by means of the Clipboard or print them before the end of the IRIOS session.

We hope that you will enjoy working with **IRIOS** as much as we enjoyed developing the program and cooperating with Digimotions, the company that wrote the software for us and with us. Do not hesitate to contact us if you have suggestions for improvement or criticisms. You can reach us by e-mail (stelder@eco.rug.nl or oosterhaven@eco.rug.nl), fax (+31 50 363 7337), or letter (Sectie Ruimtelijke Economie, Rijksuniversiteit Groningen, Postbus 800, 9700 AV Groningen, Netherlands).