

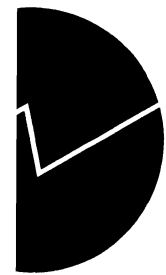
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Documents

**The OM95 - An Oil Model for the
Kingdom of Saudi Arabia**

Technical Documentation of Computer
Programs and Procedures



Robin Choudhury

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Abstract:

This document contains a detailed description of the computer programs and procedures developed to operate the OM95, a short to medium term oil model for the Kingdom of Saudi Arabia. The model was developed by the United Nations Department for Development Support and Management Service (UN/DDSMS) residents experts Dr. Khalil M. Zahr and Dr. Hashim A-Shami and programmed and implemented into the computer system by Statistics Norway, for the Ministry of Planning in Saudi Arabia. The assignment is part of the UN/DDSMS Project SAU/94/001/A/01/01 Support for Economic Planning, Modelling and Management Information Systems Development and an extension of the contract TCD CON 4/95 with Statistics Norway. The importance of acquiring appropriate tools for the study of world and domestic energy markets was early recognised in the Ministry of Planning, when it, in 1982, developed a long term energy model for domestic, regional and world markets, in the context of preparing long term energy plans for Saudi Arabia. While this model fulfilled the need for studying long term developments in the oil market, it did not provide the appropriate tools for studying short to medium term oil markets developments. This fact, together with the increased volatility in the market since the mid eighties, has motivated the development of a short to medium term oil model. Furthermore, an oil model was needed to support the economic planning process in Saudi Arabia which is based on five-year development plans. Portable TROLL, a PC-based modelling and simulation system developed by Intex Solutions, Inc., has been used for the development and operating of the model. This document describes the organization of directories and the file structure of the computer programs used to operate the model, including a complete presentation of the programs controlling input and output. A description of the routines to generate the data base as well as a detailed presentation of the models themselves is also included. Finally, the document presents the programs and procedures made to organize the simulations.

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1. Introduction¹

This document describes the model system and presents the computer programs produced to operate the Oil Model (OM95) developed by the UN/DDSMS Resident Experts Dr. Khalil M. Zahr and Dr. Hashim A-Shami. Its purpose is to serve as a detailed documentation of the system specific computer programs, and thereby as a reference work for those operating the models.

The Saudi Arabian economy is heavily dependent upon large, but yet depletable, petroleum resources. The main purpose of the Oil Model is to support the preparation of the Kingdoms five year plans, and to allow for analysis of short to medium term development in the oil market focusing on important figures as income from oil export and domestic sales, domestic consumption of refined products, demand and supply, etc.

The OM95 in fact consist of four different versions of the model to be used depending on whether or not Saudi Arabia adhere to its official OPEC quota, irrespective to OPECs overall adherence, or if it instead wishes to preserve its market share of the total OPEC production. In addition we have made one model version where the prices are treated as endogenous and one where the prices is treated as given or exogenous.

The model and the procedures used to simplify the handling of the model system are programmed in Portable TROLL modelling and programming language, and is run on a Personal Computer under a Windows environment. The TROLL system is particularly useful when it comes to simulation of simultaneous equations, but also provides useful routines for updating the data bases and the models and for estimation tasks. This document will focus in detail on the programs made specially for the Oil Model, including routines for controlling input to and output from the model as well as programs used when forecasting and simulating.

The document is organized as follows: Chapter 2 gives a description of the directories and file structure used in operating the model. Chapter 3 will present the files that organize the input to TROLL from external files (data, models, models, etc.), and the files that direct output to prespecified files or data bases (extrapolation and simulation results, etc.). In chapter 4 we describe how to generate the data to be used in the models into the TROLL data base. This chapter also present, in full details, the program files made for this purpose. Chapter 5 presents the equations in the different models. Chapter 6 presents the input file containing the coefficients in the model. In chapter 7 programs used when extrapolating and simulating are presented.

In general we have tried to give ample comments inside the programs. Because of this we have chosen to present almost all the program files, as they have been written for TROLL, in this document. A /* (slash followed by a multiplication operator) at the beginning of a line indicates that this line contains a comment, and will not be processed by TROLL. Note that some of the chapters headings in fact are file names.

¹We owe special thanks to Einar Bowitz, Statistics Norway, whose assistance in the development of the model system has been crucial. Many programs made for the Oil Model are modified versions of programs originally developed by him, Nils. Ø. Mæhle and Rune Johansen, also Statistics Norway, see Bowitz et al. (1995).

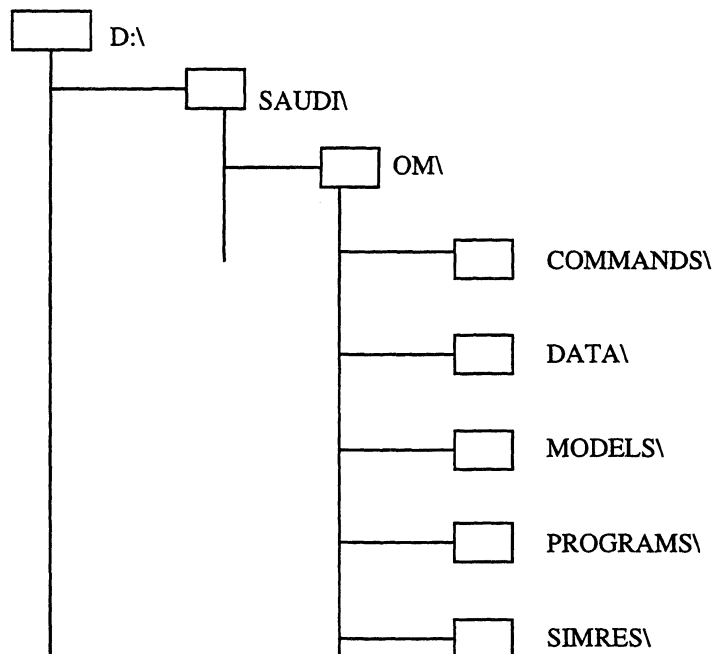
2. Directories and file structure

This chapter gives an overview over the files and directories created to operate the OM95 properly. TROLL is very flexible when it comes to decide where to get input and where to direct output, and the organization of the system around the models, data bases, programs etc., is only limited by the model user, not by technical restrictions. This chapter first describes the directories and their content, before the different files attached to the model are explained.

2.1 Directories

If nothing else has been specified, TROLL will read input to the model from the TROLL directory, and save output, for instance simulation results, to the same location. This directory already contains originally designed programs and macros. If we, in addition to them, shall store time series, models, simulation results, etc. at the same directory, it will be almost impossible to keep it organized. Due to this we have chosen to keep the model system separated from the TROLL directory.

Figure 1 Directory structure for the OM95.



The organization of directories is shown in Figure 1. As can be seen, the directories are separated from the TROLL directory (not shown here). The D:\TROLL directory contains the original TROLL software (commands, macros and program files) which we don't want to mix with our specially designed programs. This requires some kind of link between the directories made for the Century Model and the TROLL system files. This link is made by running the access and search files. All the programs developed by us, except the access and search files, are located in the sub-directories on D:\SAUDI\CM. The access and search files are located at the D:\TROLL directory².

Figure 1 shows the different directories created to organize the different dataobjects in connection with the model system. SAUDI is a main directory where the Oil Model, together with the other model systems developed (not shown here), are located. The OM directory itself consist of five sub-

² This name of the root directory (D) is, of course, special for our machines, but it should be noticed that some of the programs are dependent of this name. This means that if these programs are transferred to a machine with another name of the root directory, the programs must be changed.

directories. The first one, COMMANDS, consists of the text files used to generate the historical time series and the models. These text files contain commands which, when executed by TROLL, establishes the data base and the model in TROLL format, located at the DATA and MODELS directories respectively. The historical time series are saved in a formdata file while the model is saved as an ordinary disk file. It should be noticed that, in contrast to for instance the Implementation Model, there is no sub-directory for estimated coefficients. This is because the coefficients is not so numerous, so we have chosen to install them into the RAM memory instead on disk. The PROGRAMS directory contains the model specific programs and macros made to operate the Oil Model. Note that this directory contains both the compiled and uncompiled versions of the programs and macros. The SIMRES directory, is meant to be used for simulation output. The files on this directory will be of formdata type.

The extensions following the file names indicates what kind of «datatype» the data object is, and plays an important role in controlling input and output. For instance, we have two data objects which are classified as datatype «data» in two different sub-directories. These are the formdata files for the historical time series and for the simulation (and extrapolation) output. This means that we, in some way, have to distinguish between the output from the two tasks (we don't want to mix them together in the same file). We have solved this by using two different search files. One search file is used when updating or reinstalling the historical time series, to ensure that they are stored at the DATA directory, another search file is used when simulating the model to ensure that the simulation results are saved at the SIMRES directory.

In Table 2.1 we show the different sub-directories and what kind of filetypes they contain. As mentioned above there are two directories that consist of formdata files with datatype «data». The sub-directory DATA will consist of one formdata file containing historical time series. The SIMRES sub-directory can consist of many different formdata files for different simulations. For a brief explanation of the different filetypes see Table 3.1 (a more complete description is given in the TROLL Reference Manual, part 3.1.1).

Table 2.1 The directories

<i>Sub-directory</i>	<i>Type (extension)</i>	<i>Description</i>
COMMANDS	disk (INP)	input files.
DATA	formdata (DAT)	historical time series.
MODELS	disk (MOD)	models.
PROGRAMS	disk (SRC and PRG)	source files and programs.
SIMRES	formdata (DAT)	simulated and extrapolated time series.

2.2. Files developed for the OM95

This chapter presents the files in the different directories and gives a short explanation of their purpose. For more detailed information, specially of the programs, see inside the files and the uncompiled version of the programs (in general we have tried to give ample information inside the source files). The following five parts, 2.2.1-2.2.5, refers to the sub-directories briefly described in Table 2.1.

2.2.1. Commands³

This directory contains input files. An input file is a «collection» of TROLL commands passed over to, and executed by TROLL, from a file rather than from the keyboard. Generating TROLL commands from a file has the advantage that the commands can be given many times by calling the file, instead of retyping the commands themselves each time we want them executed. Another advantage is that they can easily be edited using a text editor.

Table 2.2. The directories

<i>Files</i>	<i>Description</i>
OM95PMMC.INP	generates the model with «Preserve market share policy» in the market clearing mode.
OM95AQMC.INP	generates the model with «Adhere to quota policy» in the market clearing mode.
OM95PMGA.INP	generates the model with «Preserve market share policy» in the gap mode.
OM95AQGA.INP	generates the model with «Adhere to quota policy» in the gap mode.
OM95DATA.INP	contains most of the historical time series.
TRANSDAT.INP	used for calculating some of the historical time series on behalf of time series already installed by the OM95DATA file. It also calculates the residuals.

2.2.2. Data

The historical time series are stored inside a formdata file. The file is generated from the two input files OM95DATA.INP and TRANSDAT.INP, and is, through the search and access rules, given the name OM95DATA.DAT. The first input file, OM95DATA, contains some of the time series data (base year including necessary lags) to create the TROLL data base, using the `dedit` command. The second input file, TRANSDAT, defines time series from those time series already installed by the OM95DATA input file. This is done by utilizing the `dofile` command, which assigns existing values to a variable. The `dofile` command instruct TROLL that the variables on the left hand side should be assigned to the values of the variables on the right hand side. The new variable will have the same shape as the expression on the right hand side. If the variables on the right hand side is some combinations of time series and scalars, the new variable will be a time serie, if it consist of scalars the new variable will also be a scalar.

Due to this «assignment procedure» the TRANSDAT file operates in a recursive way. All the variables on the right hand side must have been created earlier, either by the `dedit` command in the OM95DATA file, or on a previous line in the TRANSDAT file.

By running the input files to generate the formdata file containing the time series, the old version of the file is renamed. This is done because the old file must either be renamed or deleted before a new file with the same name can be installed.

Table 2.3

<i>Files</i>	<i>Description</i>
OM95DATA.DAT	formdata file containing the historical time series (base year including lags). This is generated from OM95DATA.INP and TRANSDAT.INP.

³ We have chosen the name «COMMANDS» on this directory because it contains input files (*.INP), which are files that give commands to TROLL through a text (ASCII) file. All commands in these files are possible to execute directly (online in interactive use of TROLL) but this is not recommendable, specially because it's easier to undertake corrections and updating inside the text file rather than from the console inside TROLL. There are strong similarities to «batch programming» in DOS.

2.2.3. Programs⁴

This directory contains programs developed by the staff at Statistics Norway to handle the model system efficiently. The programs are written as source files (SRC-files) and then compiled in TROLL and given the extension that shows that this is an executable program file (PRG-file).

It should be noticed that the generality of the programs varies a lot. This means that, for instance, while some programs may be used for all models, others may be specific to one model, or even one simulation. The main programs for organizing the simulations, REFSIM and ALTSIM, are examples of quite general programs, and may be used over and over again, for different simulations and for different models. The input to this programs, for instance EXTRAP and ALT1REF1, are simulation specific. EXTRAP is the name of a file with one specific set of assumptions about the growth rates for the exogenous variables, while ALT1REF1 is a name of a file where we give specific changes in one or more variables relative to the reference path. When another policy analysis is to be undertaken (other growth rates and/or shifting other variables), new names should be given to the files.

Due to the difference between the «gap mode» and the «market clearing mode» there has to be two such «basic» files, with and without the variable for the crude oil price respectively.

Table 2.4.

<i>Files</i>	<i>Description</i>
FOREECON.SRC	for extrapolation of time series, allows the user to set different levels of the variables in different sub-periods (this program is useful for extrapolation of the econometric residuals).
FORECAST.SRC	for extrapolation of time series, allows the user to set different growth rates in different sub-periods.
GORECAST.SRC	for extrapolation of time series, allows the user to set different growth rates in different sub-periods. This is a modified version of FORECAST. See the source file for more details (chapter 7.2.2).
REFGAP.SRC	this program contains a list of all the exogenous variables in the model with gap mode. It's purpose is to extrapolate these variables so that the endogenous variables can be simulated beyond the last year of historical data. Each variable can have different growth rates in different sub-periods. This file is called upon from the program REFSIM, where it is compiled and used for input in a simulation. After simulation the formdata file containing the simulation output is stored with the name REFGAP.DAT. Since this is done automatically, the different versions of REFGAP should have different names (changes in the file, with respect to extrapolation period, growth rates, etc. should be saved with another name). In this context, the file REFGAP.SRC is just <u>an example</u> of the program. This example will contain one special way of extrapolating the variables, while another way of extrapolating the variables should be given another filename.
REFMCL.SRC	same as REFGAP, except that this should be used in the market clearing mode.
REFSIM.SRC	program that organizes the reference path simulation. The program asks for the file where the exogenous variables are prepared for extrapolation, for instance EXTRAP.SRC, then it compiles it and simulates the model using these exogenous variables as input. The reference path is stored with the same name as the file that extrapolates the variables, but with extension DAT.
ALTSIM.SRC	a general program that organizes simulation scenarios, or scenarios where one or more exogenous variables are changed relative to the reference path. The

⁴ Programs are written as ASCII files, then «compiled into» TROLL format. This means that all programs have two formats, a source file (*.SRC) and a program file (*.PRG). We only show the source files here.

ALT1REF1.SRC	<p>exogenous variables are changed in a source file of the type ALT1REF1.SRC, which is called from this program.</p> <p>file for making changes in one, or some, of the exogenous variables relative to the reference path, to make alternative scenarios. It passes the variables that are going to be changed to the program DEVIAT.SRC. When different scenarios are of interest, they should be stored with different names, so that this file is just <u>an example</u> of the program. This program is called upon and compiled from ALTSIM. The alternative simulation are then performed and stored in the same formdata file as the reference simulation. The formdata base are stored with the name of this file but with extension DAT e.g. ALT1REF1.DAT.</p> <p>Inside this formdata file the variables from the two different simulations are stored with prefix depending on the names from the simulations. As an example: Assume that we already have performed a reference simulation, saved in the formdata file BASIC.DAT. We want to compare the simulation results with a simulation where we have changed some of the variables, e.g. in the file ALT1REF1.SRC. By using the program ALTSIM, both simulations are stored in a new file called ALT1REF1.DAT. Inside this file the values of the variables from the reference simulation (originally stored in BASIC.DAT) has got the name BASIC_varname, and the values from the alternative simulation will have the name ALT1REF1_varname, where varname is the variable name.</p>
DEVIAT.SRC	<p>the program makes per cent changes in exogenous variables over user specified sub-periods. It receives variables from programs of the type ALT1REF1.SRC. The program can also be called separately.</p>
CHANGEXA.SRC	<p>program that makes absolute changes in exogenous variables over user specified sub-periods. The changes are stored in the dosave datatable and will be deleted when leaving TROLL or when typing DELSAVE (varname). Multiple pairs of sub-periods and changes are possible.</p>
CHANGEXP.SRC	<p>program that makes per cent changes in exogenous variables over user specified sub-periods. The changes are stored in the dosave datatable and will be deleted when leaving TROLL or when typing DELSAVE (varname). Multiple pairs of sub-periods and changes are possible.</p>
DEVIA2.SRC	<p>the program makes absolute changes in exogenous variables over user specified sub-periods. It receives variables from programs of the type ALT1REF1.SRC. The program can also be called separately.</p>
PRTREF.SRC	<p>the program prints output from a model simulation. Assumes that the simulation output has been stored in accordance to the REFSIM program.</p>
EQEVAL.SRC	<p>evaluates an individual equation from a model. The program evaluates the left hand side, the right hand side or the residual.</p>
SIM	<p>simulation program that stores the extrapolation and simulation results in a user specified DAT-file.</p>
DB	<p>program to open an «unaccessed» and «unsearched» data base. Prompt the model user for filename and nickname.</p>

2.2.4. Models

The model files (Table 2.5) is generated from the input files for the respective models. They contains commands to the model editor, the equations in the model and a symbol table. If the purpose is to change one the models and then reinstall it, the procedure is to first delete the old version of the model, then perform the changes in the input file for the model, before installing it by typing INPUT *MODELNAME*.

The model files is not, in contrast to data files, readable in a text editor. They can, however, be read inside TROLL, in the MOEDIT mode (see the TROLL Reference Manual, parts 4.11-4.12).

Table 2.5.

<i>Files</i>	<i>Description</i>
OM95AQGA.MOD	The model in TROLL code, generated from the input file OM95AQGA.INP. Model with adhere to quota (AQ) in gap mode (GA).
OM95PMGA.MOD	The model in TROLL code, generated from the input file OM95PMGA.INP. Model with preserve market share policy (PM) in gap mode (GA).
OM95AQMC.MOD	The model in TROLL code, generated from the input file OM95AQMC.INP. Model with adhere to quota policy (AQ) in market clearing mode (MC).
OM95PMMC.MOD	The model in TROLL code, generated from the input file OM95PMMC.INP. Model with preserve market share policy (PM) in market clearing mode (MC).

2.2.5. *Simres*

This directory is aimed at storing the simulation results. Through the access and search rules, we have ensured that one formdata file is always created if the directory is empty. This file, SIMOUT.DAT, will be the target for output when using the FILESIM command when the model is simulated «manually» (Table 2.6). The variables will be saved inside this file with a user supplied prefix. If the file already exist, new variables will add to it.

However, when utilizing the simulation program REFSIM, the output will be saved in a file whose name is the same as the file used to extrapolate the exogenous variables. For example, we have a file called TESTFILE.SRC, consisting of all the exogenous variables to be extrapolated. We use the program REFSIM and, when prompted for «name of the file with the exogenous input to the reference scenario» we type the name TESTFILE. The resulting simulated reference scenario will automatically be saved as TESTFILE.DAT.

A new formdata file will add to this directory if a new reference scenario is simulated. This directory thus, in contrast to the directory for the historical time series, may consist of many formdata files.

Table 2.6.

<i>Files</i>	<i>Description</i>
SIMOUT.DAT	Here simulation output are stored when the model are simulated «manually». This means that we call and execute the program that extrapolates the exogenous variables, and then simulates interactively (from the keyboard). Note that an empty version of this file will be created along with the simulation output from the ALTSIM command.

3. Organization of input and output

3.1. Introduction

The filesystem commands control access to information stored outside TROLL. The information is classified by the following filetypes:

Table 3.1.

<i>Filetype</i>	<i>Description (extension)</i>
DATA	data objects, for instance time series and simulation results (DAT).
INPUT	text files containing TROLL commands (INP).
MODEL	model created by the model editor.
SOURCE	source code for TROLL macros and functions written in text format (SRC).
PROGRAM	compiled code of the source file (PRG).

3.2. Access and search

TROLL can store and retrieve files through the host operating system on the computer. To organize where to get, and where to store the different data objects, some kind of link between the TROLL software and the model system must be established. This is the purpose of the access and search files. The access commands opens data bases and disk directories, while the search commands specifies where TROLL should look for files, and if there is readable or writeable search to them. We have chosen to use only one access file that opens all the relevant data bases, then we have made two different search files, which usage depends on where to store the datatype «data» (DAT-files). As mentioned earlier, both the historical and the simulated time series are defined as datatype «data» by TROLL, and given extension DAT. To be organized we want to store this two different «objects» in different directories. We use the search file that gives writeable search to the directory where we want to store our output. For instance, when we want to install or update the historical time series we must have writeable search to the directory (and formdata file) for the historical time series. We then use the search file SRCHTIOM, which has writeable search to this location.

Note that, since the access and search files instructs where to look for other files, no commands are given to tell where to look for these files themselves. That is why they are stored on the TROLL directory, which has default access and search. This chapter will show the files in their full details. We have tried to give comment inside the files to provide ample information to the model user⁵.

3.2.1. Access

The following file opens all necessary directories and data bases (formdata files) needed to use the Oil Model.

3.2.1.1. Accessom.inp

option screen off;

/* Input file: ACCESSOM.INP.

/* Input file for the OM95. Opens databases and disk directories and adds them
/* to the list of accessed data bases.

/* To ensure that the correct access rules are given the next command deletes all (eventually)
/* earlier accessed data bases.

⁵ Comments inside a TROLL program must be indicated by a /* (slash followed by a multiplication operator) at the beginning of the line.

```
delaccess all;
```

```
/* Opens the database, or formdata file, for the timeseries data.  
access omdata type formdata id d:\saudi\om\data\om95data.dat mode w;
```

```
/* Opens the database, or disk files, for the different models.  
access ommod type disk id d:\saudi\om\models mode w;
```

```
/* Opens the database, or disk files, for the programs.  
access ompro type disk id d:\saudi\om\programs mode w;
```

```
/* Opens the database, or the disk files, for the input files.  
access omcom type disk id d:\saudi\om\commands mode w;
```

```
/* Opens the database, or formdata file, for the simulation output.  
access omsim type formdata id d:\saudi\om\simres\simout.dat mode w;
```

3.2.2. Search

In this part we presents the two search files. They are distinguished only in where to write dataobjects of type «data» (DAT-files). The first one has writeable search to the historical time series data base, while the second writes to the data base for simulation output.

3.2.2.1. Srchtiom

```
option screen off;
```

```
/* Input file SRCHTIOM.INP.
```

```
/* Input file for the OM95. Add entries to the searchlist, which specifies where to look for files.  
/* This search file has writeable search to the data base for the historical timeseries, and should  
/* be used when it is to be installed.
```

```
/* To ensure that the correct search rules are given, the next commands deletes all (eventually)  
/* earlier searches. We also deletes the dosave datatable before the regression coefficients are  
/* temporarily installed into the RAM memory.
```

```
delsearch all;  
do; delsave all;
```

```
/* Writeable search for the time series data.  
search data omdata w;
```

```
/* Readable search for the simulation output.  
search data omsim;
```

```
/* Writeable search for the models.  
search model ommod w;
```

```
/* Writeable search for the input files (eksklusive access and search files).  
search input omcom;
```

```
/* Writeable search for the compiled version of the programs (program files).  
search program ompro w;
```

```
/* Writeable search for the uncompiled version of the programs (source files).  
search source ompro w;
```

/* Lists the coefficients into the dosave datatable.
input omcoef

/* To go from DO command mode to TROLL command mode.
quit;

3.2.2.2. Srchsiom

option screen off;

/* Input file SRCHSIOM.INP.

/* Input file for the OM95. Add entries to the searchlist, which specifies where to look for files.
/* This search file has writeable search to the data base for the simulation output, and should
/* be used when storing simulation result from a "manual" simulation. When the programs made
/* specially to organize the simulation output are used, the correct search are automatically given.

/* To ensure that the correct search rules are given, the next commands deletes all (eventually)
/* earlier searches. We also deletes the dosave datatable before the regression coefficients are
/* temporarily installed into the RAM memory.

delsearch all;
do; delsave all;

/* Readable search for the time series data.
search data omdata;

/* Writeable search for the models.
search model ommod w;

/* Writeable search for the simulation output.
search data omsim w;

/* Writeable search for the input files (eksklusive access and search files).
search input omcom;

/* Writeable search for the compiled version of the programs (program files).
search program ompro w;

/* Writeable search for the uncompiled version of the programs (source files).
search source ompro w;

/* Lists the coefficients into the dosave datatable.
input omcoef

/* To go from DO command mode to TROLL command mode.
quit;

4. Historical data

The historical data base for the variables in the Oil Models is located at the \SAUDI\NOM\DATA sub-directory. It consist of annual observations, from different sources, such as the National Account, Saudi Arabian Monetary Agency (SAMA), OPECs Annual Statistical Bulletin etc. This chapter presents the two input files that together generates the historical data base.

The input file OM95DATA contains basic data for variables in the baseyear, including the necessary lags. All this variables are generated with the `dedit` command. The other input file, TRANSDAT, utilizes already defined variables to generate data. This file also generates the residuals in such a way that they will always balance the respective equations.

We first present, in Table 4.1, the data used for the endogenous and exogenous variables. We then presents the files in their original shape.

4.1. Overview of the data

Table 4.1.

<i>ENDOGENOUS :</i>	<i>1990</i>	<i>1991</i>	<i>1992</i>	<i>1993</i>	<i>1994</i>
CUOPEC		0.86	0.87	0.82	0.80
DAA	14.02	14.55	15.46	16.21	17.17
DAF	1.95	1.98	1.99	2.02	2.05
DCI		414221.71	428224.35	488930.64	509227.56
DCR		907151.29	957742.55	1122124.24	1240849.25
DCS		157.4	166.17	194.36	215.64
DES		1330.38	1436.16	1527.1	1610.2
DGI		1813489.40	2136301.49	2239207.11	2388249.75
DGR		1813489.40	2136301.49	2239207.11	2388249.75
DGS		457.50	538.93	564.9	602.5
DLA	5.17	5.33	5.49	5.67	5.87
DME	3.27	3.37	3.6	3.86	3.96
DNA	18.94	18.6	18.95	19.2	19.7
DNE	10.08	9.66	8.46	7.05	6.15
DOE	12.99	13.38	13.58	13.58	13.65
DOPEC		25.06	27.08	27.10	27.89
DOS	871.8	872.88	897.67	962.2	1007.7
DPI			3117035.79	3252926.05	3103180.31
DPR			6948442.58	7356940.43	7531230.37
DPS	718	715.88	731.99	767.5	792.4
DW	66.42	66.87	67.54	67.59	68.55
IOECD	3633	3555	3570	3551	3714
IW	4562	4443	4499.2	4501	4679.64
NGLOPEC	2.03	2	2.1	2.3	2.31
NGLS	533.2	670	690	690	690
PCX	21.5	16.44	16.89	14.51	14.25
PMCX			17.29	14.05	14.98
PNBX	17.24	17.24	17.84	16.2	15.18
PPX	17.33	15.30	14.27	13.57	12.86
PR			26.02	26.26	26.03
PS	32.20	33.17	34.32	34.74	35.21
PXAH	16.64	13.96	15.2	13.03	13.67

<i>ENDOGENOUS :</i>	<i>1990</i>	<i>1991</i>	<i>1992</i>	<i>1993</i>	<i>1994</i>
PXAL	20.7	17.38	17.93	15.67	15.39
PXAM	19.38	15.71	16.4	14.19	14.43
PXAS	22.7	19.35	19.03	16.8	15.9
RPS	1537.6	1417.14	1483.64	1503.6	1511.3
SCX	4.45	6.38	6.42	6.25	6.18
SCXI	31634.02	33702.64	34976.71	27863.84	26767.96
SCXR	35313.75	39159.91	40577.04	33328.67	32424.59
SMCXI			35940.09	29108.78	28447.21
SMCXR			41540.41	34573.61	34103.84
SN	41.86	41.48	41.61	40.49	41.14
SNPXI			8163.60	7194.10	6527.88
SNPXR			9390.65	8432.52	7806.29
SOPEC	23.02	23	24.1	24.7	25
SOX	5.80	7.75	7.86	7.67	7.59
SPX	1.35	1.37	1.44	1.42	1.40
SPXI			5496.52	5027.30	4510.92
SPXR	8557.06	7662.35	7513.50	7063.54	6613.23
SS	6.41	8.12	8.35	8.05	8.05
TDEI			5681.56	5981.06	6000.65
TDER			10042.48	10718.27	11160.32
TSOPEC	25.05	25	26.2	27	27.31

<i>EXOGENOUS :</i>	<i>1990</i>	<i>1991</i>	<i>1992</i>	<i>1993</i>	<i>1994</i>
CAPOPEC	28.1	26	26.86	29.32	30.3
D8285	1	1	1	1	1
DNGL6981	1	1	1	1	1
EXCH	3.74	3.74	3.74	3.74	3.74
FAA	1	1	1	1	1
FAF	1	1	1	1	1
FLA	1	1	1	1	1
FME	1	1	1	1	1
FNA	1	1	1	1	1
FNE	1	1	1	1	1
FOE	1	1	1	1	1
P (gap mode)	22.7	19.35	19.03	16.8	15.9
PCS	7.84	7.84	7.84	7.84	7.84
PDASPH			24.86	24.86	24.86
PDDF			19.08	19.08	19.08
PDFO			24.86	24.86	24.86
PDGA			55.65	55.65	55.65
PDJF			47.7	47.7	47.7
PDLO			425	425	425
PDLP			28.61	28.61	28.61
PGS	10.86	10.86	10.86	10.86	10.86
PHASPH			9.39	9.39	9.39
PHDF			5.56	5.56	5.56
PHFO			9.39	9.39	9.39
PHGA			16.22	16.22	16.22
PHJF			18.97	18.97	18.97
PHKE			12.64	12.64	12.64
PHLO			123.91	123.91	123.91
PHLP			8.34	8.34	8.34
PHOT			6.32	6.32	6.32
QTAOPEC	22.25	22.48	23.6	24.15	24.52
QTAS			8.07	8.11	8
RCAPS	1750	1750	1750	1750	1750
SHAH			0.15	0.15	0.15
SHAL			0.7	0.7	0.7
SHAM			0.15	0.15	0.15
SHAS			0	0	0
SHASPH			0.022	0.023	0.021
SHDF			0.488	0.488	0.472
SHFO			0.123	0.109	0.116
SHGA			0.248	0.26	0.266
SHJF			0.057	0.059	0.067
SHKE			0.007	0.007	0.007
SHLO			0.008	0.008	0.008
SHLP			0.039	0.039	0.039
SHOT			0.009	0.008	0.004
SPC	8.39	8.58	8.73	8.91	9.31
SPG	0	0	0	0	0
SRC			5.62	5.74	6
TXASPH			14.61	14.61	14.61

<i>EXOGENOUS :</i>	<i>1990</i>	<i>1991</i>	<i>1992</i>		
TXCR	7.95	7.95	7.95	7.95	7.95
TXDF			7.95	7.95	7.95
TXFO			14.61	14.61	14.61
TXGA			23.18	23.18	23.18
TXJF			27.1	27.1	27.1
TXKE			18.06	18.06	18.06
TXLO			177.01	177.01	177.01
TXLP			11.92	11.92	11.92
TXNG	0	0	0	0	0
TXOT			9.03	9.03	9.03
YAA	4401748	4589980	4743116	4871180.1	5027057.9
YAF	260488	262644	262727	264566.1	271709.4
YLA	802045	829268	852524	879804.8	920275.8
YME	510264	526993	549631	560623	572957.3
YNA	5500068	5421622	5584410	5751942.3	5930252.5
YNE	1022528	908608	809212	734764	665696.6
YNS	241211	246037	246876	249345	249400
YOE	5009298	4956652	5085500	5065158	5206982

4.2. Om95data.inp

Option screen off;

/* Input file OM95DATA.INP.

/* Input file for the OM95. Generates the historical data. Note that this file alone don't establishes
 /* all the time series necessary to run the OM95. To generate all the time series, or baseyear data,
 /* the input file TRANSDAT.INP also had to be executed. This file generates additional variables
 /* and the residuals.

/* host "command.com /c if exist c:\\saudi\\om\\data\\om95data.dat del c:\\saudi\\om\\data\\om95data.dat";

/* host "command.com /c copy c:\\saudi\\om\\data\\om95data.dat c:\\saudi\\om\\data\\om95gml.dat";

&DEDIT DNA 1990A; DATA 18.94 18.6 18.95 19.2 19.7; FILE;

&DEDIT DLA 1990A; DATA 5.17 5.33 5.49 5.67 5.87; FILE;

&DEDIT DOE 1990A; DATA 12.99 13.38 13.59 13.58 13.65; FILE;

&DEDIT DNE 1990A; DATA 10.08 9.66 8.46 7.05 6.15; FILE;

&DEDIT DME 1990A; DATA 3.27 3.37 3.6 3.86 3.96; FILE;

&DEDIT DAF 1990A; DATA 1.95 1.98 1.99 2.02 2.05; FILE;

&DEDIT DAA 1990A; DATA 14.02 14.55 15.46 16.21 17.17; FILE;

&DEDIT P 1990A; DATA 22.7 19.35 19.03 16.8 15.9; FILE;

&DEDIT PS 1990A; DATA 32.208 33.1787 34.32145 34.745538 35.21635 ; FILE;

&DEDIT YNA 1990A; DATA 5500068 5421622 5584410 5751942.3 5930252.5; FILE;

&DEDIT YLA 1990A; DATA 802045 829268 852524 879804.8 920275.8;FILE;
&DEDIT YOE 1990A; DATA 5009298 4956652 5085500 5065158 5206982;FILE;
&DEDIT YNE 1990A; DATA 1022528 908608 809212 734764 665696.6;FILE;
&DEDIT YME 1990A; DATA 510264 526993 549631 560623 572957.3;FILE;
&DEDIT YAF 1990A; DATA 260488 262644 262727 264566.1 271709.4;FILE;
&DEDIT YAA 1990A; DATA 4401748 4589980 4743116 4871180.1 5027057.9;FILE;
&DEDIT YW 1990A; DATA 17506439 17495767 17887120 18128039.4 18594932;FILE;
&DEDIT SS 1990A; DATA 6.41 8.12 8.35 8.05 8.05; FILE;
&DEDIT SN 1990A; DATA 41.86 41.48 40.61 40.49 41.14; FILE;
&DEDIT SOX 1990A; DATA 5.806 7.752 7.8696 7.6787 7.594;FILE;
&DEDIT IW 1990A; DATA 4562 4443 4499.2 4501 4679.64;FILE;
&DEDIT IOECD 1990A; DATA 3633 3555 3570 3551 3714;FILE;
&DEDIT SOPEC 1990A; DATA 23.02 23 24.1 24.7 25.0;FILE;
&DEDIT QTAOPEC 1990A; DATA 22.25 22.48 23.6 24.15 24.52;FILE;
&DEDIT CAPOPEC 1990A; DATA 28.1 26 26.86 29.32 30.3;FILE;
&DEDIT NGLOPEC 1990A; DATA 2.03 2 2.1 2.3 2.31 ;FILE;
&DEDIT D8285 1990A; DATA 1 1 1 1 1;FILE;
&DEDIT QTAS 1992A; DATA 8.0705 8.11 8.0;FILE;
&DEDIT NGLS 1990A; DATA 533.2 670 690 690 690;FILE;
&DEDIT GPSCS 1990A; DATA 800 800 800 800 800;FILE;
&DEDIT RPS 1990A; DATA 1537.6 1417.14 1483.641 1503.6 1511.3;FILE;
&DEDIT RCAPS 1990A; DATA 1750 1750 1750 1750 1750;FILE;
&DEDIT DNGL6981 1990A; DATA 1 1 1 1 1;FILE;
&DEDIT DES 1990A; DATA 1317.5 1330.389 1436.616 1527.1 1610.2;FILE;
&DEDIT DOS 1990A; DATA 871.8 872.8877 897.6767 962.2 1007.7;FILE;
&DEDIT DCS 1990A; DATA 153.8 157.4 166.1781 194.7 215.3;FILE;
&DEDIT YNS 1990A; DATA 241211 246037 246876 249345 249400 ;FILE;
&DEDIT DEF 1990A; DATA 90 89.81881 90.17747 90 90 ;FILE;
&DEDIT SCX 1990A; DATA 4.5 6.526 6.582 6.293 6.234;FILE;

&DEDIT PXAS 1990A; DATA 22.7 19.35 19.03 16.8 15.9;FILE;
&DEDIT PXAL 1990A; DATA 20.7 17.38 17.93 15.67 15.39;FILE;
&DEDIT PXAM 1990A; DATA 19.38 15.71 16.4 14.19 14.43;FILE;
&DEDIT PXAH 1990A; DATA 18.64 13.96 15.2 13.03 13.67 ;FILE;
&DEDIT PCX 1990A; DATA 21.5 16.44 16.89 14.51 14.25;FILE;
&DEDIT PPX 1990A; DATA 17.33 15.30472 14.27386 13.57 12.86;FILE;
&DEDIT SPC 1990A; DATA 8.39 8.58 8.73 8.91 9.31;FILE;
&DEDIT EXCH 1990A; DATA 3.745 3.745 3.745 3.745 3.745 ;FILE;
&DEDIT PCS 1990A; DATA 7.84 7.84 7.84 7.84 7.84;FILE;
&DEDIT PGS 1990A; DATA 10.86 10.86 10.86 10.86 10.86 ;FILE;
&DEDIT TXCR 1990A; DATA 7.95 7.95 7.95 7.95 7.95 ;FILE;
&DEDIT TXNG 1990A; DATA 0 0 0 0 0;FILE;
&DEDIT SPG 1990A; DATA 0 0 0 0 0;FILE;
&DEDIT SRC 1992A; DATA 5.62 5.74 6.0; FILE;
&DEDIT PNBX 1992A; DATA 17.84 16.20 15.18; FILE;
&DEDIT FNA 1990A; DATA 1 1 1 1 1; FILE;
&DEDIT FLA 1990A; DATA 1 1 1 1.02775 1; FILE;
&DEDIT FOE 1990A; DATA 1 1 1 0.99305 1; FILE;
&DEDIT FNE 1990A; DATA 1 1 1 0.99701 1; FILE;
&DEDIT FME 1990A; DATA 1 1 1 0.97656 1; FILE;
&DEDIT FAF 1990A; DATA 1 1 1 0.93197 1; FILE;
&DEDIT FAA 1990A; DATA 1 1 1 0.99502 1; FILE;
&DEDIT PDLP 1992A; DATA 28.6125 28.6125 28.6125; FILE ;
&DEDIT PDJF 1992A; DATA 47.7 47.7 47.7; FILE;
&DEDIT PDKE 1992A; DATA 31.8 31.8 31.8; FILE;
&DEDIT PDGA 1992A; DATA 55.65 55.65 55.65; FILE;
&DEDIT PDDF 1992A; DATA 19.0875 19.0875 19.0875; FILE;
&DEDIT PDFO 1992A; DATA 24.8625 24.8625 24.8625; FILE;
&DEDIT PDASPH 1992A; DATA 24.8625 24.8625 24.8625; FILE;

&DEDIT PDLO 1992A; DATA 425 425 425; FILE;
&DEDIT PDOT 1992A; DATA 15.9 15.9 15.9; FILE;
&DEDIT SHLP 1992A; DATA 0.039 0.039 0.039; FILE;
&DEDIT SHJF 1992A; DATA 0.057 0.059 0.067; FILE;
&DEDIT SHKE 1992A; DATA 0.007 0.007 0.007; FILE;
&DEDIT SHGA 1992A; DATA 0.248 0.260 0.266; FILE;
&DEDIT SHDF 1992A; DATA 0.488 0.488 0.472; FILE;
&DEDIT SHFO 1992A; DATA 0.123 0.109 0.116; FILE;
&DEDIT SHASPH 1992A; DATA 0.022 0.023 0.021; FILE;
&DEDIT SHLO 1992A; DATA 0.008 0.008 0.008; FILE;
&DEDIT SHOT 1992A; DATA 0.009 0.008 0.004; FILE;
&DEDIT TXLP 1992A; DATA 11.92 11.92 11.92; FILE;
&DEDIT TXJF 1992A; DATA 27.1 27.1 17.1; FILE;
&DEDIT TXKE 1992A; DATA 18.06 18.06 18.06; FILE;
&DEDIT TXGA 1992A; DATA 23.18 23.18 23.18; FILE;
&DEDIT TXDF 1992A; DATA 7.95 7.95 7.95; FILE;
&DEDIT TXFO 1992A; DATA 14.6125 14.6125 14.6125; FILE;
&DEDIT TXASPH 1992A; DATA 14.6125 14.6125 14.6125; FILE;
&DEDIT TXLO 1992A; DATA 177.01 177.01 177.01; FILE;
&DEDIT TXOT 1992A; DATA 9.03 9.03 9.03; FILE;
&DEDIT PHLP 1992A; DATA 8.34 8.34 8.34; FILE;
&DEDIT PHJF 1992A; DATA 18.97 18.97 18.97; FILE;
&DEDIT PHKE 1992A; DATA 12.64 12.64 12.64; FILE;
&DEDIT PHGA 1992A; DATA 16.22 16.22 16.22; FILE;
&DEDIT PHDF 1992A; DATA 5.565 5.565 5.565; FILE;
&DEDIT PHFO 1992A; DATA 9.3969 9.3969 9.3969; FILE;
&DEDIT PHASPH 1992A; DATA 9.3969 9.3969 9.3969; FILE;
&DEDIT PHLO 1992A; DATA 123.91 123.91 123.91; FILE;
&DEDIT PHOT 1992A; DATA 6.32 6.32 6.32; FILE;

&DEDIT SHCO 1990A; DATA 0.176 0.180 0.185 0.202 0.214; FILE;

&DEDIT SHAS 1992A; DATA 0.0 0.0 0.0; FILE;

&DEDIT SHAL 1992A; DATA 0.7 0.7 0.7; FILE;

&DEDIT SHAM 1992A; DATA 0.15 0.15 0.15; FILE;

&DEDIT SHAH 1992A; DATA 0.15 0.15 0.15; FILE;

4.3. Transdat.inp

Option screen off;

/* Input file TRANSDAT.INP.

/* Input file for the OM95, to be used as part of generating the data base for the OM95. The most basic
/* historical data to be used in installing the data base for the OM95, are installed with the input file
/* OM95DATA.INP, while this file generates definitions containing variables already installed. It also
/* generates the residuals.

/* The advantage by using the dofile command to generate data using an expression, instead of using
/* the dedit command, is that when the right hand side in the expression is updated, the left hand side
/* is automatically updated when the data base is installed. For instance, if we want to implement more
/* recent observations, we don't have to type in the observations in the dedit command for the variables
/* on the left hand side. Instead we first install the input file OM95DATA, and then the input file
/* TRANSDAT.

/* This way of defining the residuals ensures that the left and right hand sides of the equations balances,
/* since the value for the residuals by definition is installed (filed) as the difference between the left and
/* the right hand of the equations.

/* Note that this file operates in a recursive way, meaning that a variable that is assigned to a right hand
/* side expression, in a following line can operate on the right hand side to be assigned to a new variable.
/* As a consequence of this, only the minimum number of observations of the variables should be
/* generated into TROLL language from the dedit command.

/* A later dofile command will overwrite an already existing one.

/* Definition of the world oil demand.

DOFILE DW = DNA+DLA+DOE+DNE+DME+DAF+DAA;

/* Demand from OPEC is defined as residual demand.

DOFILE DOPEC = DW - SN + (IW-IW(-1)) / 365;

/* OPECs capacity utilization.

DOFILE CUOPEC = QTAOPEC/CAPOPEC;

/* Total supply from OPEC.

DOFILE TSOPEC = SOPEC+NGLOPEC;

/* Total supply world.

DOFILE SW = TSOPEC + SN;

/* Gas consumption in Saudi Arabia.

DOFILE DGS = DES - DOS;

/* Crude oil domestic use for direct combustion.
DOFILE DCS = SHCO * DOS;

/* Petroleum product consumption in Saudi Arabia.
DOFILE DPS = DOS - DCS;

DOFILE PSR = DEF * PS;

/* Petroleum products exports.
DOFILE SPX = (RPS+NGLS-DPS) / 1000;

/* Crude oil exports.
DOFILE SCX = SOX - SPX;

/* Weighted average price of crude oil, USD per barrel.
DOFILE PMCX =
(PXAS * SHAS + PXAL * SHAL + PXAM * SHAM + PXAH * SHAH) / (SHAS + SHAL + SHAM+ SHAH);

/* Crude oil export revenue based on official export statistics.
DOFILE SCXR = SCX * PCX * 365;

/* Crude oil export income based on official export statistics.
DOFILE SCXI = SCX * (PCX - (SPC / EXCH))* 365;

/* Oil products export revenue, based on official export statistic.
DOFILE SPXR = SPX * PPX *365;

/* Oil products export income, based on official export statistic
DOFILE SPXI = SPX * (PPX - (SPC + SRC) / EXCH)*365;

/* Crude oil export revenue, based on official export statistic.
DOFILE SMCXR = SCX * PMCX * 365;

/* Crude oil export revenue, based on official export statistic.
DOFILE SMCXI = SCX * (PMCX - SPC/EXCH) * 365;

/* Oil products export revenue, based on official export statistic
DOFILE SNPXR = SPX * PNBX * 365;

/* Oil products export income, based on official export statistic.
DOFILE SNPXI = SPX * (PNBX - (SPC / EXCH)) * 365;

/* Domestic weighted average wholesale price, plus taxes, for refined products.
DOFILE PR =
((PHLP+TXLP)*SHLP + (PHJF+TXJF)*SHJF + (PHASPH+TXASPH)*SHASPH+(PHGA+TXGA)*SHGA +
(PHKE+TXKE)*SHKE + (PHDF+TXDF)*SHDF +(PHLO+TXLO)*SHLO+ (PHFO+TXFO)*SHFO +
(PHOT+TXOT)*SHOT) ;

/* Domestic revenue from petroleum products.
DOFILE DPR = DPS * PR * 365;

/* Domestic income from petroleum products.
DOFILE DPI = DPS * (PR - SPC - SRC) * 365;

/* Crude oil from for direct combustion, revenue.
DOFILE DCR = DCS * (PCS + TXCR) *365;

/* Crude oil from for direct combustion, income.

DOFILE DCI = DCR - DCS * SPC * 365;

/* Natural gas revenue, in thousand SR
DOFILE DGR = DGS * (PGS + TXNG) * 365;

/* Natural gas income, in thousand SR
DOFILE DGI = DGR - DGS * SPG * 365;

/* Total domestic energy revenue.
DOFILE TDER = (DPR + DCR + DGR) / 1000;

/* Total domestic energy income.
DOFILE TDEI = (DPI + DCI + DGI) / 1000;

/* Generation of the residuals

DOFILE RESDNA = LOG(DNA) -
(DNA.1 * LOG(DNA(-1)) + DNA.2 * LOG(YNA) - DNA.1 * DNA.2 * LOG(YNA(-1)) + (DNA.3 +
DNA.2 * DNA.4) * LOG(P * FNA) - DNA.1 * DNA.4 * DNA.2 * LOG(P(-1) * FNA(-1)));

DOFILE RESDLA = LOG(DLA) -
(DLA.1 * LOG(DLA(-1)) + DLA.2 * LOG(YLA) - DLA.1 * DLA.2 * LOG(YLA(-1)) + (DLA.3 +
DLA.2 * DLA.4) * LOG(P * FLA) - DLA.1 * DLA.4 * DLA.2 * LOG(P(-1) * FLA(-1)));

DOFILE RESDOE = LOG(DOE) -
(DOE.1 * LOG(DOE(-1)) + DOE.2 * LOG(YOE) - DOE.1 * DOE.2 * LOG(YOE(-1)) + (DOE.3 +
DOE.2 * DOE.4) * LOG(P * FOE) - DOE.1 * DOE.4 * DOE.2 * LOG(P(-1) * FOE(-1)));

DOFILE RESDNE = LOG(DNE) -
(DNE.1 * LOG(DNE(-1)) + DNE.2 * LOG(YNE) - DNE.1 * DNE.2 * LOG(YNE(-1)) + (DNE.3 +
DNE.2 * DNE.4) * LOG(P * FNE) - DNE.1 * DNE.4 * DNE.2 * LOG(P(-1) * FNE(-1)));

DOFILE RESDME = LOG(DME) -
(DME.1 * LOG(DME(-1)) + DME.2 * LOG(YME) - DME.1 * DME.2 * LOG(YME(-1)) + (DME.3 +
DME.2 * DME.4) * LOG(P * FME) - DME.1 * DME.4 * DME.2 * LOG(P(-1) * FME(-1)));

DOFILE RESDAF = LOG(DAF) -
(DAF.1 * LOG(DAF(-1)) + DAF.2 * LOG(YAF) - DAF.1 * DAF.2 * LOG(YAF(-1)) + (DAF.3 +
DAF.2 * DAF.4) * LOG(P * FAF) - DAF.1 * DAF.4 * DAF.2 * LOG(P(-1) * FAF(-1)));

DOFILE RESDAA = LOG(DAA) -
(DAA.1 * LOG(DAA(-1)) + DAA.2 * LOG(YAA) - DAA.1 * DAA.2 * LOG(YAA(-1)) + (DAA.3 +
DAA.2 * DAA.4) * LOG(P * FAA) - DAA.1 * DAA.4 * DAA.2 * LOG(P(-1) * FAA(-1)));

DOFILE RESSW = SW - DW ;

DOFILE RESSN = LOG(SN) - (SN.1 * LOG(SN(-1)) + SN.2 * LOG(P)) ;

DOFILE RESIOECD = IOECD - (IOECD.1 * DW(-1)) ;

DOFILE RESIW = IW - IW.1 * IOECD;

DOFILE RESSOPEC =
SOPEC - (SOPEC.1 + SOPEC.2 * CUOPEC + SOPEC.3 * D8285 + SOPEC.4 * QTAOPEC);

DOFILE RESNGLOPEC =
NGLOPEC - (NGLOPEC.1 + NGLOPEC.2 * CAPOPEC + NGLOPEC.3 * (SOPEC/CAPOPEC));

DOFILE RESNGLS = NGLS - (NGLS.1 + NGLS.2 * SS + NGLS.3 * DNGL6981);
 DOFILE RESRPS = RPS - RPS.1 * RCAPS ;
 DOFILE RESDCS = DCS - (SHCO*DOS);
 DOFILE RESDES = LOG(DES) - (DES.1 * LOG(DES(-1)) + DES.3 * LOG(YNS) +DES.2 * LOG(PSR));
 DOFILE RESDOS = LOG(DOS) - (DOS.1 * LOG(DOS(-1)) + DOS.3 * LOG(YNS) + DOS.2 * LOG(PSR));
 DOFILE RESSOX = SOX - (SS + (NGLS- DOS - DCS.1 * RPS + RPS) / 1000);
 DOFILE RESPXAS = PXAS - PXAS.1 * P ;
 DOFILE RESPXAL = PXAL - PXAL.1 * P ;
 DOFILE RESPXAM = PXAM - PXAM.1 * P ;
 DOFILE RESPXAH = PXAH - PXAH.1 * P ;
 DOFILE RESPCX = PCX - PCX.1 * PXAL ;
 DOFILE RESPPX = PPX - PPX.1 * P ;
 DOFILE RESPNBX = PNBX - PNBX.1 * P ;
 quit;

5. The models

5.1. Introduction

As mentioned earlier, the OM95 consist of four various models, different with respect to weather or not the oil price is endogenous, and weather or not Saudi Arabia adhere to its official OPEC quota, irrespective of OPECs overall adherence, or if Saudi Arabia choose to preserve its market share of total OPEC production. The models with endogenous oil price is referred to as the «market clearing mode» while the situation with exogenous oil price is referred to as the «gap mode».

The difference between the gap mode and the market clearing mode is that in the latter one the price is made endogenous to clear the market. The additional equation needed to ensure consistency simply states that total world demand is equal to the sum of total supply from OPEC and total supply from non-OPEC. In the market clearing mode the model has a simultaneous block, in contrast to the gap mode, where it is completely recursive.

The four models can be identified as follows:

OM95AQGA Adhere to quota (AQ), gap mode (GA)
OM95AQMC Adhere to quota (AQ), market clearing mode (MC)
OM95PMGA Preserve market share (PM), gap mode (GA)
OM95PMMC Preserve market share (PM), market clearing mode (MC)

5.1.1. Om95aqga.inp

option screen off;

/* Input file OM95AQGA.INP.

/* Input file for OM95 with adhere to quota policy and exogenous prices (gap mode). This input file
/* is for generating the OM95 into TROLL code.

/* Since the equations are "installed" with the addeq top command, the old version of the model
/* should be deleted before a new version is installed.

usemod om95aqga;
modedit;
addeq top,

/* World oil demand by region.

/* Demand North America

LOG(DNA) =
DNA.1 * LOG(DNA(-1)) + DNA.2 * LOG(YNA) - DNA.1 * DNA.2 * LOG(YNA(-1)) + (DNA.3 +
DNA.2 * DNA.4) * LOG(P * FNA) - DNA.1 * DNA.4 * DNA.2 * LOG(P(-1) * FNA(-1)) + RESDNA,

/* Demand Latin America.

LOG(DLA) =
DLA.1 * LOG(DLA(-1)) + DLA.2 * LOG(YLA) - DLA.1 * DLA.2 * LOG(YLA(-1)) + (DLA.3 +
DLA.2 * DLA.4) * LOG(P * FLA) - DLA.1 * DLA.4 * DLA.2 * LOG(P(-1) * FLA(-1)) + RESDLA ,

/* Demand OECD-Europe.

LOG(DOE) =

DOE.1 * LOG(DOE(-1)) + DOE.2 * LOG(YOE) - DOE.1 * DOE.2 * LOG(YOE(-1)) + (DOE.3 + DOE.2*DOE.4) * LOG(P*FOE) - DOE.1 * DOE.4 * DOE.2 * LOG(P(-1)*FOE(-1)) + RESDOE,

/* Demand non OECD-Europe.

LOG(DNE) =

DNE.1 * LOG(DNE(-1)) + DNE.2 * LOG(YNE) - DNE.1 * DNE.2 * LOG(YNE(-1)) + (DNE.3 + DNE.2*DNE.4) * LOG(P*FNE) - DNE.1 * DNE.4 * DNE.2 * LOG(P(-1)*FNE(-1)) + RESDNE,

/* Demand Middle East.

LOG(DME) =

DME.1 * LOG(DME(-1)) + DME.2 * LOG(YME) - DME.1 * DME.2 * LOG(YME(-1)) + (DME.3 + DME.2*DME.4) * LOG(P*FME) - DME.1 * DME.4 * DME.2 * LOG(P(-1)*FME(-1)) + RESDME,

/* Demand Africa.

LOG(DAF) =

DAF.1 * LOG(DAF(-1)) + DAF.2 * LOG(YAF) - DAF.1 * DAF.2 * LOG(YAF(-1)) + (DAF.3 + DAF.2*DAF.4) * LOG(P*FAF) - DAF.1 * DAF.4 * DAF.2 * LOG(P(-1)*FAF(-1)) + RESDAF,

/* Demand Asia and Australia.

LOG(DAA) =

DAA.1 * LOG(DAA(-1)) + DAA.2 * LOG(YAA) - DAA.1 * DAA.2 * LOG(YAA(-1)) + (DAA.3 + DAA.2*DAA.4) * LOG(P*FAA) - DAA.1 * DAA.4 * DAA.2 * LOG(P(-1)*FAA(-1)) + RESDAA,

/* World demand.

DW = DNA+DLA+DOE+DNE+DME+DAF+DAA ,

/* Non - OPEC supply.

LOG(SN) = SN.1 * LOG(SN(-1)) + SN.2 * LOG(P) + RESSN,

/* World oil stocks.

IOECD = IOECD.1 * DW(-1) + RESIOECD,

IW = IW.1 * IOECD + RESIW,

/* Call on opec supply.

DOPEC = DW - SN + (IW-IW(-1)) / 365,

/* OPEC supply.

CUOPEC = QTAOPEC/CAPOPEC ,

SOPEC = SOPEC.1 + SOPEC.2 * CUOPEC + SOPEC.3 * D8285+ SOPEC.4 * QTAOPEC + RESSOPEC,

NGLOPEC = NGLOPEC.1 + NGLOPEC.2 * CAPOPEC + NGLOPEC.3 * (SOPEC/CAPOPEC) + RESNGLOPEC,

/* Total OPEC supply.

TSOPEC = SOPEC+NGLOPEC ,

/* Total World Supply.

SW= SN + TSOPEC,

/* Saudi arabia's oil production under adhere to quota policy.

SS = QTAS,

/* In this equation we state a logical expression to make sure that Saudi Arabias production of
/* NGL don't exceeds the capacity of the 'gas gathering and processing system', GPSCS.

NGLS =

IF ((NGLS.1 + NGLS.2 * SS + NGLS.3 * DNGL6981 + RESNGLS) <= GPSCS)
THEN NGLS.1 + NGLS.2 * SS + NGLS.3 * DNGL6981 + RESNGLS ELSE GPSCS ,

/* Refined products.

RPS = RPS.1 * RCAPS + RESRPS,

/* Saudi domestic energy consumption.

/* Primary energy consumption.

LOG(DES) =

DES.1 * LOG(DES(-1))+ DES.2 * LOG(PSR) + DES.3 * LOG(YNS)+ RESEDES ,

/* Oil consumption.

LOG(DOS) =

DOS.1 * LOG(DOS(-1)) +DOS.2 * LOG(PSR) +DOS.3 * LOG(YNS) + RESDOS,

PSR = DEF*PS,

/* Natural gas consumption.

DGS = DES - DOS ,

/* Average domestic price of refined products.

PS =

PDLP * SHLP + PDJF * SHJF + PDKE * SHKE + PDGA * SHGA + PDDF * SHDF + PDFO * SHFO +
PDASPH * SHASPH + PDLO * SHLO + PDOT * SHOT,

/* Crude oil for direct consumption.

DCS = SHCO * DOS + RESDCS,

/* Petroleum product consumption.

DPS = DOS - DCS ,

/* Total oil exports of Saudi Arabia.

SOX = SS + (NGLS - DOS - DCS.1*RPS + RPS) / 1000 + RESSOX,

/* Crude oil exports.

$$SCX = SOX - SPX ,$$

/* Petroleum products exports.

$$SPX = (RPS + NGLS - DPS) / 1000 ,$$

/* Saudi arabias oil export prices.

$$PXAS = PXAS.1 * P + RESPXAS,$$

$$PXAL = PXAL.1 * P + RESPXAL,$$

$$PXAM = PXAM.1 * P + RESPXAM,$$

$$PXAH = PXAH.1 * P + RESPXAH,$$

$$PCX = PCX.1 * PXAL + RESPCX ,$$

/* Average export price of Saudi crude oils based on spot market prices.

$$PMCX = \\ (PXAS * SHAS + PXAL * SHAL + PXAM * SHAM + PXAH * SHAH) / \\ (SHAS + SHAL + SHAM + SHAH) ,$$

/* Petroleum products.

$$PPX = PPX.1 * P + RESPPX,$$

$$PNBX = PNBX.1 * P + RESPNBX,$$

/* Saudi arabia's oil export revenues based on SAMA Statistics.

/* Crude oil.

$$SCXR = SCX * PCX * 365 ,$$

$$SCXI = SCX * (PCX - (SPC / EXCH)) * 365 ,$$

/* Oil products.

$$SPXR = SPX * PPX * 365 ,$$

$$SPXI = SPX * (PPX - (SPC + SRC) / EXCH) * 365 ,$$

/* Valuation based on spot market prices for crude oil and Arab Light netback valuation for products.

/* Crude oil.

$$SMCXR = SCX * PMCX * 365 ,$$

$$SMCXI = SCX * (PMCX - SPC/EXCH) * 365 ,$$

/* Oil products.

SNPXR = SPX * PNBX * 365 ,

SNPXI = SPX * (PNBX - (SPC / EXCH)) * 365 ,

/* Average government revenue (wholesale price+ taxes) per barrel of domestic refined products.

PR =

((PHLP+TXLP)*SHLP + (PHJF+TXJF)*SHJF + (PHASPH+TXASPH)*SHASPH
+(PHGA+TXGA)*SHGA + (PHKE+TXKE)*SHKE + (PHDF+TXDF)*SHDF +
(PHLO+TXLO)*SHLO+ (PHFO+TXFO)*SHFO + (PHOT+TXOT)*SHOT) /
(SHLP+ SHJF+SHASPH+SHGA+SHKE+SHDF+SHLO+SHFO+SHOT) ,

/* Domestic energy revenues and income.

DPR = DPS * PR * 365 ,

DPI = DPS * (PR - SPC - SRC) * 365 ,

DCR = DCS * (PCS + TXCR) * 365 ,

DCI = DCR - DCS * SPC * 365 ,

DGR = DGS * (PGS + TXNG) * 365 ,

DGI = DGR - DGS * SPG * 365 ,

TDER = (DPR + DCR + DGR) / 1000 ,

TDEI = (DPI + DCI + DGI) / 1000 ;

CHANGESYM ENDOGENOUS

CUOPEC DAA DOS DPS DPI DPR DAF DGI DGR DGS DLA DCI DCR DES DME DNA DNE DOE
DOPEC DW SW IOECD IW NGLOPEC NGLS PXAS PXAL PXAM PXAH PMCX PNBX PR PS PCX
PSR PPX RPS SMCXI SNPXR SN SOPEC SOX SCX SPX SPXI SPXR SMCXR SNPXI SCXI SCXR
SS TSOPEC TDEI TDER DCS ;

CHANGESYM COEFFICIENT

DAA.1 DAA.2 DAA.3 DAA.4 DAA.1 DAA.2 DAA.3 DAA.4 DAA.1 DAA.2 DAA.3 DAA.4 DAA.1
DAA.2 DAA.3 DAA.4 DAA.1 DAA.2 DAA.3 DAA.4 DAA.1 DAA.2 DAA.3 DAA.4 DAA.1 DAA.2
DAA.3 DAA.4 DES.1 DES.2 DES.3 DOS.1 DOS.2 DOS.3 IOECD.1 IW.1 NGLOPEC.1 NGLOPEC.2
NGLOPEC.3 NGLS.1 PNBX.1 PPX.1 RPS.1 SN.1 SN.2 SOPEC.1 SOPEC.2 SOPEC.3 SOPEC.4 PCX.1
DAF.1 DAF.2 DAF.3 DAF.4 DCS.1 DLA.1 DLA.2 DLA.3 DLA.4 DME.1 DME.2 DME.3 DME.4
DNA.1 DNA.2 DNA.3 DNA.4 DNE.1 DNE.2 DNE.3 DNE.4 DOE.1 DOE.2 DOE.3 DOE.4 NGLS.2
NGLS.3 PXAH.1 PXAL.1 PXAM.1 PXAS.1;

FILEMOD;

5.1.2. Om95aqmc.inp

option screen off;

/* Input file OM95AQMC.INP.

/* Input file for OM95 with adhere to quota policy and endogenous oil price (market clearing mode). This

/* input file is for generating the OM95 into TROLL code.

/* Since the equations are "installed" with the addeq top command, the old version of the model
/* should be deleted before a new version is installed.

usemod om95aqmc;
modedit;
addeq top,

/* World oil demand by region.

/* Demand North America

LOG(DNA) =
DNA.1 * LOG(DNA(-1)) + DNA.2 * LOG(YNA) - DNA.1 * DNA.2 * LOG(YNA(-1)) + (DNA.3 +
DNA.2 * DNA.4) * LOG(P * FNA) - DNA.1 * DNA.4 * DNA.2 * LOG(P(-1) * FNA(-1)) + RESDNA,

/* Demand Latin America.

LOG(DLA) =
DLA.1 * LOG(DLA(-1)) + DLA.2 * LOG(YLA) - DLA.1 * DLA.2 * LOG(YLA(-1)) + (DLA.3 +
DLA.2 * DLA.4) * LOG(P * FLA) - DLA.1 * DLA.4 * DLA.2 * LOG(P(-1) * FLA(-1)) + RESDLA ,

/* Demand OECD-Europe.

LOG(DOE) =
DOE.1 * LOG(DOE(-1)) + DOE.2 * LOG(YOE) - DOE.1 * DOE.2 * LOG(YOE(-1)) + (DOE.3 +
DOE.2 * DOE.4) * LOG(P * FOE) - DOE.1 * DOE.4 * DOE.2 * LOG(P(-1) * FOE(-1)) + RESDOE,

/* Demand non OECD-Europe.

LOG(DNE) =
DNE.1 * LOG(DNE(-1)) + DNE.2 * LOG(YNE) - DNE.1 * DNE.2 * LOG(YNE(-1)) + (DNE.3 +
DNE.2 * DNE.4) * LOG(P * FNE) - DNE.1 * DNE.4 * DNE.2 * LOG(P(-1) * FNE(-1)) + RESDNE,

/* Demand Middle East

LOG(DME) =
DME.1 * LOG(DME(-1)) + DME.2 * LOG(YME) - DME.1 * DME.2 * LOG(YME(-1)) + (DME.3 +
DME.2 * DME.4) * LOG(P * FME) - DME.1 * DME.4 * DME.2 * LOG(P(-1) * FME(-1)) + RESDME,

/* Demand Africa.

LOG(DAF) =
DAF.1 * LOG(DAF(-1)) + DAF.2 * LOG(YAF) - DAF.1 * DAF.2 * LOG(YAF(-1)) + (DAF.3 + DAF.2 * DAF.4)
* LOG(P * FAF) - DAF.1 * DAF.4 * DAF.2 * LOG(P(-1) * FAF(-1)) + RESDAF,

/* Demand Asia and Australia.

LOG(DAA) =
DAA.1 * LOG(DAA(-1)) + DAA.2 * LOG(YAA) - DAA.1 * DAA.2 * LOG(YAA(-1)) + (DAA.3 +
DAA.2 * DAA.4) * LOG(P * FAA) - DAA.1 * DAA.4 * DAA.2 * LOG(P(-1) * FAA(-1)) + RESDAA,

/* World demand.

DW = DNA + DLA + DOE + DNE + DME + DAF + DAA ,

/* Non - OPEC supply.

LOG(SN) = SN.1 * LOG(SN(-1)) + SN.2 * LOG(P) + RESSN,

/* World oil stocks.

IOECD = IOECD.1 * DW(-1) + RESIOECD,

$$IW = IW.1 * IOECD + RESIW,$$

/* Call on opec supply.

$$DOPEC = DW - SN + (IW - IW(-1)) / 365,$$

$$CUOPEC = QTAOPEC / CAPOPEC,$$

/* OPEC supply.

$$SOPEC = SOPEC.1 + SOPEC.2 * CUOPEC + SOPEC.3 * D8285 + SOPEC.4 * QTAOPEC + RESSOPEC,$$

$$NGLOPEC = NGLOPEC.1 + NGLOPEC.2 * CAPOPEC + NGLOPEC.3 * (SOPEC / CAPOPEC) + RESNGLOPEC,$$

/* Total OPEC supply.

$$TSOPEC = SOPEC + NGLOPEC,$$

/* Total supply world.

$$SW = TSOPEC + SN,$$

/* Market clearing equation.

$$SW = DW + RESSW,$$

/* Saudi arabia's oil production under adhere to quota policy.

$$SS = QTAS,$$

/* In this equation we state a logical expression to make sure that Saudi Arabias production of
/* NGL don't exceeds the capacity of the 'gas gathering and processing system', GPSCS.

$$NGLS =$$

$$IF((NGLS.1 + NGLS.2 * SS + NGLS.3 * DNGL6981 + RESNGLS) <= GPSCS)$$

$$THEN (NGLS.1 + NGLS.2 * SS + NGLS.3 * DNGL6981 + RESNGLS)$$

$$ELSE GPSCS,$$

/* Refined products.

$$RPS = RPS.1 * RCAPS + RESRPS,$$

/* Saudi domestic energy consumption.

/* Primary energy consumption.

$$LOG(DES) =$$

$$DES.1 * LOG(DES(-1)) + DES.2 * LOG(PSR) + DES.3 * LOG(YNS) + RESDES,$$

/* Oil consumption.

$$LOG(DOS) =$$

$$DOS.1 * LOG(DOS(-1)) + DOS.2 * LOG(PSR) + DOS.3 * LOG(YNS) + RESDOS,$$

$$PSR = DEF * PS,$$

/* Natural gas consumption.

$$DGS = DES - DOS ,$$

/* Average domestic price of refined products.

PS =

$$PDLP * SHLP + PDJF * SHJF + PDKE * SHKE + PDGA * SHGA + PDDF * SHDF + PDFO * SHFO + PDASPH * SHASPH + PDLO * SHLO + PDOT * SHOT,$$

/* Crude oil for direct consumption.

$$DCS = SHCO * DOS ,$$

/* Petroleum product consumption.

$$DPS = DOS - DCS ,$$

/* Total oil exports of Saudi Arabia.

$$SOX = SS + (NGLS - DOS - DCS.1 * RPS + RPS) / 1000 + RESSOX,$$

/* Crude oil exports.

$$SCX = SOX - SPX ,$$

/* Petroleum products exports.

$$SPX = (RPS + NGLS - DPS) / 1000 ,$$

/* Saudi arabias oil export prices.

$$PXAS = PXAS.1 * P + RESPXAS,$$

$$PXAL = PXAL.1 * P + RESPXAL,$$

$$PXAM = PXAM.1 * P + RESPXAM,$$

$$PXAH = PXAH.1 * P + RESPXAH,$$

$$PCX = PCX.1 * PXAL + RESPCX ,$$

/* Average export price of Saudi crude oils based on spot market prices.

PMCX =

$$(PXAS * SHAS + PXAL * SHAL + PXAM * SHAM + PXAH * SHAH) / (SHAS + SHAL + SHAM + SHAH) ,$$

/* Petroleum products.

$$PPX = PPX.1 * P + RESPPX,$$

$$\text{PNBX} = \text{PNBX.1} * \text{P} + \text{RESPNBX},$$

/* Saudi arabia's oil export revenues based on SAMA Statistics.

/* Crude oil.

$$\text{SCXR} = \text{SCX} * \text{PCX} * 365 ,$$

$$\text{SCXI} = \text{SCX} * (\text{PCX} - (\text{SPC} / \text{EXCH})) * 365 ,$$

/* Oil products.

$$\text{SPXR} = \text{SPX} * \text{PPX} * 365 ,$$

$$\text{SPXI} = \text{SPX} * (\text{PPX} - (\text{SPC} + \text{SRC}) / \text{EXCH}) * 365 ,$$

/* Valuation based on spot market prices for crude oil and Arab Light netback valuation for products.

/* Crude oil.

$$\text{SMCXR} = \text{SCX} * \text{PMCX} * 365 ,$$

$$\text{SMCXI} = \text{SCX} * (\text{PMCX} - \text{SPC} / \text{EXCH}) * 365 ,$$

/* Oil products.

$$\text{SNPXR} = \text{SPX} * \text{PNBX} * 365 ,$$

$$\text{SNPXI} = \text{SPX} * (\text{PNBX} - (\text{SPC} / \text{EXCH})) * 365 ,$$

/* Average government revenue (wholesale price+ taxes) per barrel of domestic refined products.

PR =

$$\begin{aligned} & ((\text{PHLP} + \text{TXLP}) * \text{SHLP} + (\text{PHJF} + \text{TXJF}) * \text{SHJF} + (\text{PHASPH} + \text{TXASPH}) * \text{SHASPH} \\ & + (\text{PHGA} + \text{TXGA}) * \text{SHGA} + (\text{PHKE} + \text{TXKE}) * \text{SHKE} + (\text{PHDF} + \text{TXDF}) * \text{SHDF} + \\ & (\text{PHLO} + \text{TXLO}) * \text{SHLO} + (\text{PHFO} + \text{TXFO}) * \text{SHFO} + (\text{PHOT} + \text{TXOT}) * \text{SHOT}) / \\ & (\text{SHLP} + \text{SHJF} + \text{SHASPH} + \text{SHGA} + \text{SHKE} + \text{SHDF} + \text{SHLO} + \text{SHFO} + \text{SHOT}) , \end{aligned}$$

/* Domestic energy revenues and income.

$$\text{DPR} = \text{DPS} * \text{PR} * 365 ,$$

$$\text{DPI} = \text{DPS} * (\text{PR} - \text{SPC} - \text{SRC}) * 365 ,$$

$$\text{DCR} = \text{DCS} * (\text{PCS} + \text{TXCR}) * 365 ,$$

$$\text{DCI} = \text{DCR} - \text{DCS} * \text{SPC} * 365 ,$$

$$\text{DGR} = \text{DGS} * (\text{PGS} + \text{TXNG}) * 365 ,$$

$$\text{DGI} = \text{DGR} - \text{DGS} * \text{SPG} * 365 ,$$

$$\text{TDER} = (\text{DPR} + \text{DCR} + \text{DGR}) / 1000 ,$$

$$\text{TDEI} = (\text{DPI} + \text{DCI} + \text{DGI}) / 1000 ;$$

CHANGESYM ENDOGENOUS

CUOPEC DAA DOS DPS DPI DPR DAF DGI DGR DGS DLA DCI DCR DES DME DNA DNE DOE
DOPEC DW IOECD IW NGLOPEC NGLS P PXAS PXAL PXAM PXAH PMCX PNBX PR PS PCX PPX
PSR RPS SMCXI SNPXR SN SOPEC SOX SCX SPX SPXI SPXR SMCXR SNPXI SCXI SCXR SS
SW TSOPEC TDEI TDER DCS ;

CHANGESYM COEFFICIENT

DAA.1 DAA.2 DAA.3 DAA.4 DAA.1 DAA.2 DAA.3 DAA.4 DAA.1 DAA.2 DAA.3 DAA.4 DAA.1
DAA.2 DAA.3 DAA.4 DAA.1 DAA.2 DAA.3 DAA.4 DAA.1 DAA.2 DAA.3 DAA.4 DAA.1 DAA.2
DAA.3 DAA.4 DES.1 DES.2 DES.3 DOS.1 DOS.2 DOS.3 IOECD.1 IW.1 NGLOPEC.1 NGLOPEC.2
NGLOPEC.3 NGLS.1 PNBX.1 PPX.1 RPS.1 SN.1 SN.2 SOPEC.1 SOPEC.2 SOPEC.3 SOPEC.4 PCX.1
DAF.1 DAF.2 DAF.3 DAF.4 DCS.1 DLA.1 DLA.2 DLA.3 DLA.4 DME.1 DME.2 DME.3 DME.4
DNA.1 DNA.2 DNA.3 DNA.4 DNE.1 DNE.2 DNE.3 DNE.4 DOE.1 DOE.2 DOE.3 DOE.4 NGLS.2
NGLS.3 PXAH.1 PXAL.1 PXAM.1 PXAS.1;

FILEMOD;

5.1.3. Om95pmga.inp

option screen off;

/* Input file OM95PMGA.INP.

/* Input file for OM95 with Preserve Market Share policy and exogenous prices (gap mode). This input file
/* is for generating the OM95 into TROLL code.

/* Since the equations are "installed" with the addeq top command, the old version of the model
/* should be deleted before a new version is installed.

usemod om95pmga;
modedit;
addeq top,

/* World oil demand by region.

/* Demand North America

LOG(DNA) =
DNA.1 * LOG(DNA(-1)) + DNA.2 * LOG(YNA) - DNA.1 * DNA.2 * LOG(YNA(-1)) + (DNA.3 +
DNA.2 * DNA.4) * LOG(P * FNA) - DNA.1 * DNA.4 * DNA.2 * LOG(P(-1) * FNA(-1)) + RESDNA,

/* Demand Latin America.

LOG(DLA) =
DLA.1 * LOG(DLA(-1)) + DLA.2 * LOG(YLA) - DLA.1 * DLA.2 * LOG(YLA(-1)) + (DLA.3 +
DLA.2 * DLA.4) * LOG(P * FLA) - DLA.1 * DLA.4 * DLA.2 * LOG(P(-1) * FLA(-1)) + RESDLA ,

/* Demand OECD-Europe.

LOG(DOE) =
DOE.1 * LOG(DOE(-1)) + DOE.2 * LOG(YOE) - DOE.1 * DOE.2 * LOG(YOE(-1)) + (DOE.3 +
DOE.2 * DOE.4) * LOG(P * FOE) - DOE.1 * DOE.4 * DOE.2 * LOG(P(-1) * FOE(-1)) + RESDOE,

/* Demand non OECD-Europe.

LOG(DNE) =
DNE.1 * LOG(DNE(-1)) + DNE.2 * LOG(YNE) - DNE.1 * DNE.2 * LOG(YNE(-1)) + (DNE.3 +
DNE.2 * DNE.4) * LOG(P * FNE) - DNE.1 * DNE.4 * DNE.2 * LOG(P(-1) * FNE(-1)) + RESDNE,

/* Demand Middle East.

LOG(DME) =

$$DME.1 * LOG(DME(-1)) + DME.2 * LOG(YME) - DME.1 * DME.2 * LOG(YME(-1)) + (DME.3 + DME.2 * DME.4) * LOG(P * FME) - DME.1 * DME.4 * DME.2 * LOG(P(-1) * FME(-1)) + RESDME,$$

/* Demand Africa.

$$LOG(DAF) =$$

$$DAF.1 * LOG(DAF(-1)) + DAF.2 * LOG(YAF) - DAF.1 * DAF.2 * LOG(YAF(-1)) + (DAF.3 + DAF.2 * DAF.4) * LOG(P * FAF) - DAF.1 * DAF.4 * DAF.2 * LOG(P(-1) * FAF(-1)) + RESDAF,$$

/* Demand Asia and Australia.

$$LOG(DAA) =$$

$$DAA.1 * LOG(DAA(-1)) + DAA.2 * LOG(YAA) - DAA.1 * DAA.2 * LOG(YAA(-1)) + (DAA.3 + DAA.2 * DAA.4) * LOG(P * FAA) - DAA.1 * DAA.4 * DAA.2 * LOG(P(-1) * FAA(-1)) + RESDAA,$$

/* World demand.

$$DW = DNA + DLA + DOE + DNE + DME + DAF + DAA ,$$

/* Non - OPEC supply.

$$LOG(SN) = SN.1 * LOG(SN(-1)) + SN.2 * LOG(P) + RESSN,$$

/* World oil stocks.

$$IOECD = IOECD.1 * DW(-1) + RESIOECD,$$

$$IW = IW.1 * IOECD + RESIW,$$

/* Call on opec supply.

$$DOPEC = DW - SN + (IW - IW(-1)) / 365,$$

/* OPEC supply.

$$CUOPEC = QTAOPEC / CAPOPEC ,$$

$$SOPEC = SOPEC.1 + SOPEC.2 * CUOPEC + SOPEC.3 * D8285 + SOPEC.4 * QTAOPEC + RESSOPEC,$$

$$NGLOPEC = NGLOPEC.1 + NGLOPEC.2 * CAPOPEC + NGLOPEC.3 * (SOPEC / CAPOPEC) + RESNGLOPEC,$$

/* Total OPEC supply.

$$TSOPEC = SOPEC + NGLOPEC ,$$

/* Total World Supply.

$$SW = SN + TSOPEC,$$

/* Saudi arabia's oil production under preserve market share policy.

$$SS = QTAS / QTAOPEC * SOPEC,$$

/* In this equation we state a logical expression to make sure that Saudi Arabias production of
/* NGL don't exceeds the capacity of the 'gas gathering and processing system', GPSCS.

NGLS =
IF((NGLS.1 + NGLS.2 * SS + NGLS.3 * DNGL6981 + RESNGLS) <= GPSCS)
THEN (NGLS.1 + NGLS.2 * SS + NGLS.3 * DNGL6981 + RESNGLS)
ELSE GPSCS ,

/* Refined products.

RPS = RPS.1 * RCAPS + RESRPS,

/* Saudi domestic energy consumption.

/* Primary energy consumption.

LOG(DES) =
DES.1 * LOG(DES(-1)) + DES.2 * LOG(PSR) + DES.3 * LOG(YNS) + RESEDES ,

/* Oil consumption.

LOG(DOS) =
DOS.1 * LOG(DOS(-1)) + DOS.2 * LOG(PSR) + DOS.3 * LOG(YNS) + RESDOS,

PSR = DEF*PS,

/* Natural gas consumption.

DGS = DES - DOS ,

/* Average domestic price of refined products.

PS =
PDLP * SHLP + PDJF * SHJF + PDKE * SHKE + PDGA * SHGA + PDDF * SHDF + PDFO * SHFO +
PDASPH * SHASPH + PDLO * SHLO + PDOT * SHOT,

/* Crude oil for direct consumption.

DCS = SHCO * DOS + RESDCS,

/* Petroleum product consumption.

DPS = DOS - DCS,

/* Total oil exports of Saudi Arabia.

SOX = SS + (NGLS - DOS - DCS.1 * RPS + RPS) / 1000 + RESSOX,

/* Crude oil exports.

SCX = SOX - SPX ,

/* Petroleum products exports.

SPX = (RPS + NGLS - DPS) / 1000 ,

/* Saudi arabias oil export prices.

$$PXAS = PXAS.1 * P + RESPXAS,$$

$$PXAL = PXAL.1 * P + RESPXAL,$$

$$PXAM = PXAM.1 * P + RESPXAM,$$

$$PXAH = PXAH.1 * P + RESPXAH,$$

$$PCX = PCX.1 * PXAL + RESPCX ,$$

/* Average export price of Saudi crude oils based on spot market prices.

PMCX =

$$(PXAS * SHAS + PXAL * SHAL + PXAM * SHAM + PXAH * SHAH) / (SHAS + SHAL + SHAM + SHAH) ,$$

/* Petroleum products.

$$PPX = PPX.1 * P + RESPPX,$$

$$PNBX = PNBX.1 * P + RESPNBX,$$

/* Saudi arabia's oil export revenues based on SAMA Statistics.

/* Crude oil.

$$SCXR = SCX * PCX * 365 ,$$

$$SCXI = SCX * (PCX - (SPC / EXCH)) * 365 ,$$

/* Oil products.

$$SPXR = SPX * PPX * 365 ,$$

$$SPXI = SPX * (PPX - (SPC + SRC) / EXCH) * 365 ,$$

/* Valuation based on spot market prices for crude oil and Arab Light netback valuation for products.

/* Crude oil.

$$SMCXR = SCX * PMCX * 365 ,$$

$$SMCXI = SCX * (PMCX - SPC/EXCH) * 365 ,$$

/* Oil products.

$$SNPXR = SPX * PNBX * 365 ,$$

$$SNPXI = SPX * (PNBX - (SPC / EXCH)) * 365 ,$$

/* Average government revenue (wholesale price+ taxes) per barrel of domestic refined products.

PR =

$$((PHLP+TXLP)*SHLP + (PHJF+TXJF)*SHJF + (PHASPH+TXASPH)*SHASPH + (PHGA+TXGA)*SHGA + (PHKE+TXKE)*SHKE + (PHDF+TXDF)*SHDF +$$

$(PHLO+TXLO)*SHLO + (PHFO+TXFO)*SHFO + (PHOT+TXOT)*SHOT) /$
 $(SHLP+ SHJF+SHASPH+SHGA+SHKE+SHDF+SHLO+SHFO+SHOT) ,$

/* Domestic energy revenues and income.

$DPR = DPS * PR * 365 ,$

$DPI = DPS * (PR - SPC - SRC) * 365 ,$

$DCR = DCS * (PCS + TXCR) * 365 ,$

$DCI = DCR - DCS * SPC * 365 ,$

$DGR = DGS * (PGS + TXNG) * 365 ,$

$DGI = DGR - DGS * SPG * 365 ,$

$TDER = (DPR + DCR + DGR) / 1000 ,$

$TDEI = (DPI + DCI + DGI) / 1000 ;$

CHANGESYM ENDOGENOUS

CUOPEC DAA DOS DPS DPI DPR DAF DGI DGR DGS DLA DCI DCR DES DME DNA DNE DOE
DOPEC DW SW IOECD IW NGLOPEC NGLS PXAS PXAL PXAM PXAH PMCX PNBX PR PS PSR
PCX PPX RPS SMCXI SNPXR SN SOPEC SOX SCX SPX SPXI SPXR SMCXR SNPXI SCXI SCXR
SS TSOPEC TDEI TDER DCS ;

CHANGESYM COEFFICIENT

DAA.1 DAA.2 DAA.3 DAA.4 DAA.1 DAA.2 DAA.3 DAA.4 DAA.1 DAA.2 DAA.3 DAA.4 DAA.1
DAA.2 DAA.3 DAA.4 DAA.1 DAA.2 DAA.3 DAA.4 DAA.1 DAA.2 DAA.3 DAA.4 DAA.1 DAA.2
DAA.3 DAA.4 DES.1 DES.2 DES.3 DOS.1 DOS.2 DOS.3 IOECD.1 IW.1 NGLOPEC.1 NGLOPEC.2
NGLOPEC.3 NGLS.1 PNBX.1 PPX.1 RPS.1 SN.1 SN.2 SOPEC.1 SOPEC.2 SOPEC.3 SOPEC.4 PCX.1
DAF.1 DAF.2 DAF.3 DAF.4 DCS.1 DLA.1 DLA.2 DLA.3 DLA.4 DME.1 DME.2 DME.3 DME.4
DNA.1 DNA.2 DNA.3 DNA.4 DNE.1 DNE.2 DNE.3 DNE.4 DOE.1 DOE.2 DOE.3 DOE.4 NGLS.2
NGLS.3 PXAH.1 PXAL.1 PXAM.1 PXAS.1;

FILEMOD;

5.1.4. Om95pmmc.inp

option screen off;

/* Input file OM95AQMC.INP.

/* Input file for OM95 with Preserve Market Share policy and endogenous oil price (market clearing mode).

/* This input file is for generating the OM95 into TROLL code.

/* Since the equations are "installed" with the addeq top command, the old version of the model

/* should be deleted before a new version is installed.

usemod om95pmmc;

modedit;

addeq top,

/* World oil demand by region.

/* Demand North America

LOG(DNA) =
DNA.1 * LOG(DNA(-1)) + DNA.2 * LOG(YNA) - DNA.1 * DNA.2 * LOG(YNA(-1)) + (DNA.3 +
DNA.2 * DNA.4) * LOG(P * FNA) - DNA.1 * DNA.4 * DNA.2 * LOG(P(-1) * FNA(-1)) + RESDNA,

/* Demand Latin America.

LOG(DLA) =
DLA.1 * LOG(DLA(-1)) + DLA.2 * LOG(YLA) - DLA.1 * DLA.2 * LOG(YLA(-1)) + (DLA.3 +
DLA.2 * DLA.4) * LOG(P * FLA) - DLA.1 * DLA.4 * DLA.2 * LOG(P(-1) * FLA(-1)) + RESDLA ,

/* Demand OECD-Europe.

LOG(DOE) =
DOE.1 * LOG(DOE(-1)) + DOE.2 * LOG(YOE) - DOE.1 * DOE.2 * LOG(YOE(-1)) + (DOE.3 +
DOE.2 * DOE.4) * LOG(P * FOE) - DOE.1 * DOE.4 * DOE.2 * LOG(P(-1) * FOE(-1)) + RESDOE,

/* Demand non OECD-Europe.

LOG(DNE) =
DNE.1 * LOG(DNE(-1)) + DNE.2 * LOG(YNE) - DNE.1 * DNE.2 * LOG(YNE(-1)) + (DNE.3 +
DNE.2 * DNE.4) * LOG(P * FNE) - DNE.1 * DNE.4 * DNE.2 * LOG(P(-1) * FNE(-1)) + RESDNE,

/* Demand Middle East.

LOG(DME) =
DME.1 * LOG(DME(-1)) + DME.2 * LOG(YME) - DME.1 * DME.2 * LOG(YME(-1)) + (DME.3 +
DME.2 * DME.4) * LOG(P * FME) - DME.1 * DME.4 * DME.2 * LOG(P(-1) * FME(-1)) + RESDME,

/* Demand Africa.

LOG(DAF) =
DAF.1 * LOG(DAF(-1)) + DAF.2 * LOG(YAF) - DAF.1 * DAF.2 * LOG(YAF(-1)) + (DAF.3 + DAF.2 * DAF.4)
* LOG(P * FAF) - DAF.1 * DAF.4 * DAF.2 * LOG(P(-1) * FAF(-1)) + RESDAF,

/* Demand Asia and Australia.

LOG(DAA) =
DAA.1 * LOG(DAA(-1)) + DAA.2 * LOG(YAA) - DAA.1 * DAA.2 * LOG(YAA(-1)) + (DAA.3 +
DAA.2 * DAA.4) * LOG(P * FAA) - DAA.1 * DAA.4 * DAA.2 * LOG(P(-1) * FAA(-1)) + RESDAA,

/* World demand.

DW = DNA + DLA + DOE + DNE + DME + DAF + DAA ,

/* Non - OPEC supply.

LOG(SN) = SN.1 * LOG(SN(-1)) + SN.2 * LOG(P) + RESSN,

/* World oil stocks.

IOECD = IOECD.1 * DW(-1) + RESIOECD,

IW = IW.1 * IOECD + RESIW,

/* Call on opec supply.

DOPEC = DW - SN + (IW - IW(-1)) / 365,

/* OPEC supply.

$$\text{CUOPEC} = \text{QTAOPEC}/\text{CAPOPEC} ,$$

$$\text{SOPEC} = \text{SOPEC.1} + \text{SOPEC.2} * \text{CUOPEC} + \text{SOPEC.3} * \text{D8285} + \text{SOPEC.4} * \text{QTAOPEC} + \text{RESSOPEC} ,$$

$$\text{NGLOPEC} = \text{NGLOPEC.1} + \text{NGLOPEC.2} * \text{CAPOPEC} + \text{NGLOPEC.3} * (\text{SOPEC}/\text{CAPOPEC}) + \text{RESNGLOPEC} ,$$

/* Total OPEC supply.

$$\text{TSOPEC} = \text{SOPEC} + \text{NGLOPEC} ,$$

/* Total supply world.

$$\text{SW} = \text{TSOPEC} + \text{SN} ,$$

/* Market clearing equation.

$$\text{SW} = \text{DW} + \text{RESSW} ,$$

/* Saudi arabia's oil production under preserve market share policy.

$$\text{SS} = \text{QTAS}/\text{QTAOPEC} * \text{SOPEC} ,$$

/* In this equation we state a logical expression to make sure that Saudi Arabias production of
/* NGL don't exceeds the capacity of the 'gas gathering and processing system', GPSCS.

NGLS =

$$\text{IF}(\text{NGLS.1} + \text{NGLS.2} * \text{SS} + \text{NGLS.3} * \text{DNGL6981} + \text{RESNGLS}) \leq \text{GPSCS}$$

$$\text{THEN} (\text{NGLS.1} + \text{NGLS.2} * \text{SS} + \text{NGLS.3} * \text{DNGL6981} + \text{RESNGLS})$$

ELSE GPSCS ,

/* Refined products.

$$\text{RPS} = \text{RPS.1} * \text{RCAPS} + \text{RESRPS} ,$$

/* Saudi domestic energy consumption.

/* Primary energy consumption.

LOG(DES) =

$$\text{DES.1} * \text{LOG}(\text{DES}(-1)) + \text{DES.2} * \text{LOG}(\text{PSR}) + \text{DES.3} * \text{LOG}(\text{YNS}) + \text{RESDES} ,$$

/* Oil consumption.

LOG(DOS) =

$$\text{DOS.1} * \text{LOG}(\text{DOS}(-1)) + \text{DOS.2} * \text{LOG}(\text{PSR}) + \text{DOS.3} * \text{LOG}(\text{YNS}) + \text{RESDOS} ,$$

$$\text{PSR} = \text{DEF} * \text{PS} ,$$

/* Natural gas consumption.

$$\text{DGS} = \text{DES} - \text{DOS} ,$$

/* Average domestic price of refined products.

PS =

$PDLP * SHLP + PDJF * SHJF + PDKE * SHKE + PDGA * SHGA + PDDF * SHDF + PDFO * SHFO + PDASPH * SHASPH + PDLO * SHLO + PDOT * SHOT,$

/* Crude oil for direct consumption.

$DCS = SHCO * DOS ,$

/* Petroleum product consumption.

$DPS = DOS - DCS ,$

/* Total oil exports of Saudi Arabia.

$SOX = SS + (NGLS - DOS - DCS.1 * RPS + RPS) / 1000 + RESSOX,$

/* Crude oil exports.

$SCX = SOX - SPX ,$

/* Petroleum products exports.

$SPX = (RPS + NGLS - DPS) / 1000 ,$

/* Saudi arabias oil export prices.

$PXAS = PXAS.1 * P + RESPXAS,$

$PXAL = PXAL.1 * P + RESPXAL,$

$PXAM = PXAM.1 * P + RESPXAM,$

$PXAH = PXAH.1 * P + RESPXAH,$

$PCX = PCX.1 * PXAL + RESPCX ,$

/* Average export price of Saudi crude oils based on spot market prices.

$PMCX =$
 $(PXAS * SHAS + PXAL * SHAL + PXAM * SHAM + PXAH * SHAH) /$
 $(SHAS + SHAL + SHAM + SHAH) ,$

/* Petroleum products.

$PPX = PPX.1 * P + RESPPX,$

$PNBX = PNBX.1 * P + RESPNBX,$

/* Saudi arabia's oil export revenues based on SAMA Statistics.

/* Crude oil.

$SCXR = SCX * PCX * 365 ,$

$$SCXI = SCX * (PCX - (SPC / EXCH)) * 365 ,$$

/* Oil products.

$$SPXR = SPX * PPX * 365 ,$$

$$SPXI = SPX * (PPX - (SPC + SRC) / EXCH) * 365 ,$$

/* Valuation based on spot market prices for crude oil and Arab Light netback valuation for products.

/* Crude oil.

$$SMCXR = SCX * PMCX * 365 ,$$

$$SMCXI = SCX * (PMCX - SPC/EXCH) * 365 ,$$

/* Oil products.

$$SNPXR = SPX * PNBX * 365 ,$$

$$SNPXI = SPX * (PNBX - (SPC / EXCH)) * 365 ,$$

/* Average government revenue (wholesale price+ taxes) per barrel of domestic refined products.

PR =

$$\begin{aligned} & ((PHLP+TXLP)*SHLP + (PHJF+TXJF)*SHJF + (PHASPH+TXASPH)*SHASPH \\ & + (PHGA+TXGA)*SHGA + (PHKE+TXKE)*SHKE + (PHDF+TXDF)*SHDF + \\ & (PHLO+TXLO)*SHLO + (PHFO+TXFO)*SHFO + (PHOT+TXOT)*SHOT) / \\ & (SHLP+ SHJF+SHASPH+SHGA+SHKE+SHDF+SHLO+SHFO+SHOT) , \end{aligned}$$

/* Domestic energy revenues and income.

$$DPR = DPS * PR * 365 ,$$

$$DPI = DPS * (PR - SPC - SRC) * 365 ,$$

$$DCR = DCS * (PCS + TXCR) * 365 ,$$

$$DCI = DCR - DCS * SPC * 365 ,$$

$$DGR = DGS * (PGS + TXNG) * 365 ,$$

$$DGI = DGR - DGS * SPG * 365 ,$$

$$TDER = (DPR + DCR + DGR) / 1000 ,$$

$$TDEI = (DPI + DCI + DGI) / 1000 ;$$

CHANGESYM ENDOGENOUS

CUOPEC DAA DOS DPS DPI DPR DAF DGI DGR DGS DLA DCI DCR DES DME DNA DNE DOE
DOPEC DW IOECD IW NGLOPEC NGLS P PXAS PXAL PXAM PXAH PMCX PNBX PR PS PCX PPX
PSR RPS SMCXI SNPXR SN SOPEC SOX SCX SPX SPXI SPXR SMCXR SNPXI SCXI SCXR SS
SW TSOPEC TDEI TDER DCS ;

CHANGESYM COEFFICIENT

DAA.1 DAA.2 DAA.3 DAA.4 DAA.1 DAA.2 DAA.3 DAA.4 DAA.1 DAA.2 DAA.3 DAA.4 DAA.1
DAA.2 DAA.3 DAA.4 DAA.1 DAA.2 DAA.3 DAA.4 DAA.1 DAA.2 DAA.3 DAA.4 DAA.1 DAA.2
DAA.3 DAA.4 DES.1 DES.2 DES.3 DOS.1 DOS.2 DOS.3 IOECD.1 IW.1 NGLOPEC.1 NGLOPEC.2
NGLOPEC.3 NGLS.1 PNBX.1 PPX.1 RPS.1 SN.1 SN.2 SOPEC.1 SOPEC.2 SOPEC.3 SOPEC.4 PCX.1
DAF.1 DAF.2 DAF.3 DAF.4 DCS.1 DLA.1 DLA.2 DLA.3 DLA.4 DME.1 DME.2 DME.3 DME.4
DNA.1 DNA.2 DNA.3 DNA.4 DNE.1 DNE.2 DNE.3 DNE.4 DOE.1 DOE.2 DOE.3 DOE.4 NGLS.2
NGLS.3 PXAH.1 PXAL.1 PXAM.1 PXAS.1;

FILEMOD;

6. Coefficients

The coefficient in the models are presented in the following table. I also present the file that generates the coefficients into the system.

<i>COEFFICIENT :</i>	<i>VALUE:</i>
DAA.1	0.91
DAA.2	0.53
DAA.3	-0.035
DAA.4	-0.027
DAF.1	0.9
DAF.2	0.6
DAF.3	-0.022
DAF.4	-0.03
DCS.1	1.05
DES.1	0.6832
DES.2	-0.09569
DES.3	0.36146
DLA.1	0.9
DLA.2	0.6
DLA.3	-0.022
DLA.4	-0.03
DME.1	0.9
DME.2	0.6
DME.3	-0.022
DME.4	-0.03
DNA.1	0.873
DNA.2	0.754
DNA.3	-0.088
DNA.4	-0.04
DNE.1	0.9
DNE.2	0.6
DNE.3	-0.022
DNE.4	-0.03

<i>COEFFICIENT :</i>	<i>VALUE:</i>
DOE.1	0.84
DOE.2	0.42
DOE.3	-0.061
DOE.4	-0.025
DOS.1	0.6385
DOS.2	-0.155125
DOS.3	0.413813
IOECD.1	54.08983
IW.1	1.26027
NGLOPEC.1	-2.5826958
NGLOPEC.2	0.11032516
NGLOPEC.3	1.93302623
NGLS.1	-240.817
NGLS.2	57.04081
NGLS.3	365.324
PCX.1	0.926154
PNBX.1	0.951186
PPX.1	0.8082262
PXAH.1	0.8
PXAL.1	0.92291
PXAM.1	0.85374
PXAS.1	1
RPS.1	0.8246
SN.1	0.82
SN.2	0.04
SOPEC.1	4.064314
SOPEC.2	-4.45312
SOPEC.3	2.023793
SOPEC.4	0.926616

6.1. Omcoef.inp

Option screen off;

/* Input file OMCOEF.INP.

/* This input file installs the models coefficients into the RAM memory. This file is automatically executed
/* when one of the search files is executed.

/* The notation on the right hand refers to the draft version of the Oil Model (OM95, MAY 1995).

DO DNA.4 = -0.04 ; /* d1 NORTH AMERICA
DO DNA.2 = 0.754 ; /* a1
DO DNA.3 = -0.088 ; /* b1
DO DNA.1 = 0.873 ; /* c1

DO DLA.4 = -0.03 ; /* d1 LATIN AMERICA
DO DLA.2 = 0.6 ; /* a1
DO DLA.3 = -0.022 ; /* b1

DO DLA.1 = 0.9 ;	/* c1
DO DOE.4 = -0.025 ;	/* d1 OECD EUROPE
DO DOE.2 = 0.42 ;	/* a1
DO DOE.3 = -0.061 ;	/* b1
DO DOE.1 = 0.84 ;	/* c1
DO DNE.4 = -0.03 ;	/* d1 NON - OECD EUROPE
DO DNE.2 = 0.6 ;	/* a1
DO DNE.3 = -0.022 ;	/* b1
DO DNE.1 = 0.9 ;	/* c1
DO DME.4 = -0.03 ;	/* d1 MIDDLE EAST
DO DME.2 = 0.6 ;	/* a1
DO DME.3 = -0.022 ;	/* b1
DO DME.1 = 0.9 ;	/* c1
DO DAF.4 = -0.03 ;	/* d1 AFRICA
DO DAF.2 = 0.6 ;	/* a1
DO DAF.3 = -0.022 ;	/* b1
DO DAF.1 = 0.9 ;	/* c1
DO DAA.4 = -0.027 ;	/* d1 ASIA AND AUSTRALIA
DO DAA.2 = 0.53 ;	/* b1
DO DAA.3 = -0.035 ;	/* c1
DO DAA.1 = 0.91 ;	/* d1
DO SN.1 = 0.82;	/* h2
DO SN.2 = 0.04;	/* g2
DO IOECD.1= 54.08983;	/* a3
DO IW.1 = 1.26027;	/* b3
DO SOPEC.1 = 4.064314;	/*
DO SOPEC.2 = -4.45312;	/*
DO SOPEC.3 = 2.023793;	/*
DO SOPEC.4 = 0.926616;	/*
DO NGLOPEC.1 = -2.5826958;	/*
DO NGLOPEC.2 = 0.11032516;	/*
DO NGLOPEC.3 = 1.93302623;	/*
DO NGLS.1 = -240.817;	/* d6
DO NGLS.2 = 57.04081;	/* a6
DO NGLS.3 = 365.324;	/* c6
DO RPS.1 = 0.824621;	/* b6
DO DES.1 = 0.6832;	/*
DO DES.2 = -0.09569;	/*
DO DES.3 = 0.36146;	/*
DO DOS.1 = 0.6385;	/*
DO DOS.2 = -0.155125;	/*
DO DOS.3 = 0.413813;	/*
DO DCS.1 = 1.05;	/* c7

quit;

DO PCX.1 = 0.926154 ;
DO PXAS.1 = 1 ;
DO PXAL.1 = 0.92291 ;
DO PXAM.1 = 0.85374 ;
DO PXAH.1 = 0.8 ;
DO PFX.1 = 0.8082262 ;
DO PNBX.1 = 0.951186 ;

/* a9
/* a(AL)
/* a(AM)
/* a(AH)
/* b9
/* c9

7. Simulating the models

7.1. Introduction

This chapter presents programs developed by Statistics Norway aimed at simplifying the extrapolation and simulation routines, in addition to organize the output from the simulations. The main idea is to write programs that prompt the model user for input, regarding for instance which model to use, which reference scenario and alternative scenario to use, start and end year of simulation, file name where to store output, etc.

7.2. Extrapolating the variables

Before endogenous variables can be simulated there must exist numerical values for the exogenous variables for the whole simulation period. When we perform a historical simulation the values of the exogenous variables are taken from the historical database, but when we want to simulate the endogenous variables ahead in time the exogenous variables must be given future values, or extrapolated. This chapter refers the programs used for extrapolating the exogenous variables. Because the program files (PRG-files) are in TROLL code, and not readable, we show the source files (SRC- files) which are compiled into executable TROLL programs. The source files contain information on how to use the programs.

The gap mode and the market clearing mode differs with respect to exogenous variables. In the gap mode the oil price is exogenous, while it is endogenous in the market clearing mode. This means that we must have different programs to extrapolate the exogenous variables for different mode.

7.2.1. *Forecast.src*

```
/* Source file FORECAST.SRC. Programmed by Rune Johansen, Statistics Norway. Some minor
/* modifications by Robin Choudhury, Statistics Norway.
```

```
/* A general TROLL program for extrapolation of time series. A time serie can be extrapolated with
/* growth rates based on an existing observation. It is possible to specify many sub-periods with different
/* growth rates.
```

```
/* When the program is called it will prompt the user for the name of the variable to extrapolate, number
/* of periods to extrapolate from the last observation, start year of the first sub-period to extrapolate the
/* variable (or END to exit), per cent change in the variable from one period to the next in this sub-period,
/* start year of the next sub-period to extrapolate the variable (or END if finished), per cent change from one
/* year to the next in this sub-period, ... The program will continue to ask for "the start year of the next
/* sub-period" until the user type "END". This is because many pairs of sub-periods and growth rates are
/* possible.
```

```
/* Example: Assume we want to extrapolate the value for government consumption. The last observation is
/* in 1992 and we want to extrapolate 10 years. We want the variable to grow by 1.8 per cent, starting in
/* 1993 with 1996 the last year of this growth rate. Further, from 1998 to 2000, we want the variable to grow
/* by 2.1 per cent, and then, for the rest of the extrapolation period, stay constant (0 per cent growth).
```

```
/* There are two ways of providing this information to the FORCAST program: the program can be called
/* in the usual way from the TROLL command line, the user will then be prompted for the input needed to
/* perform the calculations. This method is all right for a few variables, but, as is often the case, when many
/* variables is to be extrapolated, it is better to provide the information from a file. To do this we need to know
/* the exact syntax of the program because we pass over all the information to the program without waiting for
/* the prompt.
```

```
/* For the above example it will look like this when the program is called from the TROLL
/* command line:
```

```

/* TROLL Command: &forecast
/* Give the name of the time serie to be extrapolated: cg
/* Give the number of periods to extrapolate from the last period: 10
/* Give the start year of the first sub-period to change the variable, or type 'END' to exit: 1993
/* Give the per cent change from one period to the next: 1.8
/* Give the first year of the next sub-period to change the variable, or type 'END' if finished: 1997
/* Give the per cent change from one period to the next: 0
/* Give the next forecasting year, or type 'END' if finished: 1998
/* Give the per cent change from one period to the next: 2.1
/* Give the first year of the next sub-period to change the variable, or type 'END' if finished: 2001
/* Give the per cent change from one period to the next: 0
/* Give the first year of the next sub-period to change the variable, or type 'END' if finished: end

/* When the information for all the variables is passed over from a file, it will look like this for one of them:

/* &forecast; >> cg 10 1993 1.8 1997 0 1998 2.1 2001 0 end

/* Notice that the answers to the prompt in the first alternative is exactly the same as on the line in the
/* second alternative.

addfun main;
procedure main()
begin;
    >>do;delcore all;
    get series"\nGive the name of the time serie to be extrapolated: " ;
    get number num"\nGive the number of periods to extrapolate from the last period: " ;

/* The variable 'num' decides how far beyond the end date of the original series we want to forecast. If
/* the user don't want to forecast beyond the end date of the original series, num may be set equal to zero.

/* 20 years forecasting period.
/* num = 20;

/* "temp" is a temporary time serie where subsequent extrapolated parts of the original series are stored. It is
/* first created as an extension of the original time serie decided by the variable "num".

    >>docore temp = reshape(seq(&(num)+1)*0,enddate(&(series)));
    >>docore temp = overlay(&(series), temp);
    get p2"\nGive the start year of the first sub-period , or type 'END' to exit: ";

/* The macro is running in a loop until the user type 'END'.

    while(p2 <>"END")
        begin;
            p1=convert(p2, "numeric");
            year = p1-1;
            get number fac"Give the per cent change from one periode to the next:";
            fac2=(1+fac/100);
            on warning nomsg;
            on error nomsg;

/* The extrapolation is done by the 'autocum' function.

            >>docore temp = autocum(temp,0,&(year)a,0,&(fac2));
            on error nomsg;
            get p2"Give the first year of the next sub-period, or type 'END' if finished: ";
        end;

```

```

/* The extrapolation is completed, and the temporary series is copied to a new series with the same name as
/* the original series, but belonging to a database specified by the search file.

```

```

    >>do file &(series) = temp;
    >>delcore all;

```

```

/* print("Extrapolation is finished.");

```

```

end;

```

7.2.2. *Gorecast.src*

```

/* Source file GORECAST.SRC. (Programmed by Rune Johansen, Statistics Norway).

```

```

/* Troll program for extrapolation of time series. This program is more robust than the FORECAST program,
/* but it runs more slowly. If the FORECAST program is used twice, the time series will be extrapolated
/* twice. The GORECAST program will always start at the specified date (1990 in the previous program).

```

```

addfun main;
procedure main()
begin;

```

```

    >>do;delcore all;

```

```

    get series "\nGive the name of the timeseries to be forecasted: ";
    get number aar2 "\nGive the latest year for entering data: ";

```

```

/* The variable 'num' decides how far beyond the end date of the original series we want to forecast. If
/* you don't want to forecast beyond the end date of the original series, you may set num equal to zero.

```

```

/* 20 years extrapolation period.
/* num = 20;

```

```

/* 'temp' is a temporary time series where subsequent extrapolated parts of the original series are stored.

```

```

/* First we create 'temp' as an extension of the original series decided by the variable 'num'.

```

```

num=aar2-1990;

```

```

    >>docore en = reshape((seq(&(num)+1)*0)+1,1989a);
    >>docore &(series)=&(series)*en;
    >>docore temp = reshape(seq(&(num)+1)*0,1990a);
    >>docore temp = overlay(&(series), temp);

```

```

    get p1 "\nGive the first year of extrapolation, or type 'END' if finished: ";

```

```

/* The program is running in a loop until the parameter is 'END'.

```

```

    while(p1 <> "END")
    begin;
        p0=convert(p1, "numeric");
        year = p0-1;
        get number fac "\nGive the per cent growth rate: ";
        >>do y=values(temp,&(year)A);

```

```

/* If the initial level of the series is < 0, then the factor is given the opposite sign. Otherwise, a negative
/* annual change to a negative value, would give a positive change, due to the autocum function.

```

```

x = getdata("Y",1);
if (x < 0) then fac= -fac;
fac2=(1+fac/100);
on warning nomsg;
on error nomsg;

>>docore temp = autocum(temp,0,&(year)a,0,&(fac2));
on error nomsg;
get p1 "\nGive the next forecasting year, or type 'END' if finished: ";
end;

```

/* The extrapolation is completed, and the temporary serie is copied to a new serie with the same name as
/* the original series, but belonging to a database specified by the search rules.

```

>>dofile &(series) = temp;
>>delcore all;

```

```
Print("");
```

```
/* print("Finished with forecasting.");
```

```
end;
```

7.2.3. *Foreecon.src*

/* Source file FOREECON.SRC. (Programmed by Rune Johansen, Statistics Norway).

/* Program that is used to set levels of variables ahead in time, instead of growth rates. When the
/* extrapolation is completed, the temporary serie is copied to a new serie with the same name as the
/* original serie, but stored in the database specified by the search rules.

```

addfun main;
procedure main()
begin;

```

```
get series "\nGive the name of the time serie to be extrapolated: ";
```

/* 'temp' is a temporary time serie where subsequent extrapolated parts of the original serie is stored.

```
>>docore temp = &(series);
```

```
get year "\nGive the start year of the first extrapolation sub-period, or type 'END' to exit: ";
```

```
while (year <> "END")
```

```
begin;
```

```
get number val "\nGive the value (level) to extrapolate the variable with: ";
```

```
get number num "\nGive the number of extrapolation years: ";
```

```
>>docore temp2 = reshape(&(val)+seq(&(num))*0,&(year)a);
```

```
>>docore temp3 = overlay(temp2, temp);
```

```
>>docore temp = temp3;
```

```
get year "\nGive the start year of the next extrapolation period, or type 'END' if finished.>";
```

```
end;
```

```
>>dofile &(series) = temp;
```

```
end;
```

7.2.4. Refgap.src

/* Source file REFGAP.SRC, source file for the OM95??GA (gap mode).

/* This file is used to extrapolate the exogenous variables. It contains a list of all this variables,
/* including the residuals. This program make a call for the program 'FORECAST', and the information is
/* passed over to it. It is preferable to use the program "FORECAST" in this way, rather than calling it
/* directly from inside TROLL and give the information interactively. Calling the program from another
/* program, and supporting the information this way, means thay the program can be used over and over again.
/* This is advantageou when there exict many variables to be extrapolated.

/* How to use this program:

/* The program is called in the usual way:
/* &refgap

/* The program will give the message
/* Finished with extrapolating.

/* The information is, for instance: AE 10 1995 0 end, where AE is the variable name, 10 means 10 years of
/* extrapolation, 1995 means start year, 0 means per cent growth and end means that we are finished with
/* entering. The "end" command is necessary because many pairs of "years" and "per cent growth" is possible.

/* Note that this file is just an example of one way of extrapolating the exogenous variable. This means
/* that when we changes the growth rate of one or more of the variables (another policy) it should be
/* saved with another name.

```
addfun main;  
procedure main()  
begin;
```

/* Here the exogenous variables are "passed over" to the program FORECAST.

```
&forecast; >>CAPOPEC 10 1995 0 1996 2.5 end  
&forecast; >>D8285 10 1995 0 end  
&forecast; >>DNGL6981 10 1995 0 end  
&forecast; >>DEF 10 1995 0 end  
&forecast; >>EXCH 10 1995 0 end  
&forecast; >>FAA 10 1995 0.3 1996 0 end  
&forecast; >>FAF 10 1995 -0.9 1996 0 end  
&forecast; >>FLA 10 1995 -1.5 1996 0 end  
&forecast; >>FME 10 1995 -1.2 1996 0 end  
&forecast; >>FNA 10 1995 0 end  
&forecast; >>FNE 10 1995 0.3 1996 0 end  
&forecast; >>FOE 10 1995 -8.4 1996 0 end  
&forecast; >>GPSCS 10 1995 0 end  
&forecast; >>P 10 1995 0 1996 3 end  
&forecast; >>PCS 10 1995 0 end  
&forecast; >>PDASPH 10 1995 0 end  
&forecast; >>PDDF 10 1995 208.3 1996 0 end  
&forecast; >>PDFO 10 1995 0 end  
&forecast; >>PDGA 10 1995 71.4 1996 0 end  
&forecast; >>PDJF 10 1995 0 end  
&forecast; >>PDKE 10 1995 0 end  
&forecast; >>PDLO 10 1995 0 end  
&forecast; >>PDLP 10 1995 100 1996 0 end  
&forecast; >>PDOT 10 1995 0 end
```

```

&forecast; >>PGS 10 1995 0 end
&forecast; >>PHASPH 10 1995 0 end
&forecast; >>PHDF 10 1995 0 end
&forecast; >>PHFO 10 1995 0 end
&forecast; >>PHGA 10 1995 0 end
&forecast; >>PHJF 10 1995 0 end
&forecast; >>PHKE 10 1995 0 end
&forecast; >>PHLO 10 1995 0 end
&forecast; >>PHLP 10 1995 0 end
&forecast; >>PHOT 10 1995 0 end
&forecast; >>QTAOPEC 10 1995 0 1996 2.5 end
&forecast; >>QTAS 10 1995 0 1996 2.5 end
&forecast; >>RCAPS 10 1995 0 end
&forecast; >>SHASPH 10 1995 -0.08 1999 0 end
&forecast; >>SHCO 10 1995 4.5 1999 0 end
&forecast; >>SHDF 10 1995 0 end
&forecast; >>SHFO 10 1995 -0.01 1999 0 end
&forecast; >>SHGA 10 1995 0.02 1999 0 end
&forecast; >>SHJF 10 1995 -0.2 1999 0 end
&forecast; >>SHKE 10 1995 -0.02 1999 0 end
&forecast; >>SHLO 10 1995 0 end
&forecast; >>SHLP 10 1995 0.02 1999 0 end
&forecast; >>SHOT 10 1995 -0.08 1999 0 end
&forecast; >>SPC 10 1995 0 end
&forecast; >>SPG 10 1995 0 end
&forecast; >>SRC 10 1995 0 end
&forecast; >>TXASPH 10 1995 0 end
&forecast; >>TXCR 10 1995 0 end
&forecast; >>TXDF 10 1995 500 1996 0 end
&forecast; >>TXFO 10 1995 0 end
&forecast; >>TXGA 10 1995 171.5 1996 0 end
&forecast; >>TXJF 10 1995 0 end
&forecast; >>TXKE 10 1995 0 end
&forecast; >>TXLO 10 1995 0 end
&forecast; >>TXLP 10 1995 240.09 1996 0 end
&forecast; >>TXNG 10 1995 0 end
&forecast; >>TXOT 10 1995 0 end
&forecast; >>YAA 10 1995 2.9 1996 3.0 end
&forecast; >>YAF 10 1995 3.0 end
&forecast; >>YLA 10 1995 2.3 1996 2.5 end
&forecast; >>YME 10 1995 2.2 end
&forecast; >>YNA 10 1995 3.1 1996 1.9 end
&forecast; >>YNE 10 1995 -3.8 1996 0 1998 3 2000 3.5 end
&forecast; >>YNS 10 1995 3.9 end
&forecast; >>YOE 10 1995 2.8 1996 2.5 end
&forecast; >>SHAS 10 1995 0 end
&forecast; >>SHAL 10 1995 0 end
&forecast; >>SHAM 10 1995 0 end
&forecast; >>SHAH 10 1995 -16.32 1996 0 end

```

/* Here the residuals are extrapolated.

```

&forecast; >>RESDAA 10 1995 0 end
&forecast; >>RESDAF 10 1995 0 end
&forecast; >>RESDES 10 1995 0 end
&forecast; >>RESDLA 10 1995 0 end
&forecast; >>RESDME 10 1995 0 end
&forecast; >>RESDNA 10 1995 0 end

```

```

&forecast; >>RESDNE 10 1995 0 end
&forecast; >>RESDOE 10 1995 0 end
&forecast; >>RESDOS 10 1995 0 end
&forecast; >>RESIOECD 10 1995 0 end
&forecast; >>RESIW 10 1995 0 end
&forecast; >>RESNGLOPEC 10 1995 0 end
&forecast; >>RESNGLS 10 1995 0 end
&forecast; >>RESPCX 10 1995 0 end
&forecast; >>RESPNBX 10 1995 0 end
&forecast; >>RESPPX 10 1995 0 end
&forecast; >>RESPXAH 10 1995 0 end
&forecast; >>RESPXAL 10 1995 0 end
&forecast; >>RESPXAM 10 1995 0 end
&forecast; >>RESPXAS 10 1995 0 end
&forecast; >>RESRPS 10 1995 0 end
&forecast; >>RESSN 10 1995 0 end
&forecast; >>RESSOPEC 10 1995 0 end
&forecast; >>RESSOX 10 1995 0 end
&forecast; >>RESDCS 10 1995 0 end

```

```

print("");
print("Finished with extrapolating.");
print("");

```

```
end;
```

7.2.5. *Refmc.src*

/* Source file REFMC.SRC, for the OM95??MC (market clearing mode).

/* This file is used to extrapolate the exogenous variables. It contains a list of all this variables, including the residuals. This program make a call for the program 'FORECAST', and the information is passed over to it. It is preferable to use the program "FORECAST" in this way, rather than calling it directly from inside TROLL and give the information interactively. Calling the program from another program, and supporting the information this way, means that the program can be used over and over again. This is advantageou when there exict many variables to be extrapolated.

/* How to use this program:

/* The program is called in the usual way:
/* &refmc

/* The program will give the message
/* Finished with extrapolating.

/* The information is, for instance: AE 10 1995 0 end, where AE is the variable name, 10 means 10 years of extrapolation, 1995 means start year, 0 means per cent growth and end means that we are finished with entering. The "end" command is necessary because many pairs of "years" and "per cent growth" is possible.

/* Note that this file is just an example of one way of extrapolating the exogenous variable. This means that when we changes the growth rate of one or more of the variables (another policy) it should be saved with another name.

```

addfun main;
procedure main()
begin;

```

/* Here the exogenous variables are "passed over" to the program FORECAST.

```
&forecast; >>CAPOPEC 10 1995 0 1996 2.5 end
&forecast; >>DEF 10 1995 0 end
&forecast; >>D8285 10 1995 0 end
&forecast; >>DNGL6981 10 1995 0 end
&forecast; >>EXCH 10 1995 0 end
&forecast; >>FAA 10 1995 0.3 1996 0 end
&forecast; >>FAF 10 1995 -0.9 1996 0 end
&forecast; >>FLA 10 1995 -1.5 1996 0 end
&forecast; >>FME 10 1995 -1.2 1996 0 end
&forecast; >>FNA 10 1995 0 end
&forecast; >>FNE 10 1995 0.3 1996 0 end
&forecast; >>FOE 10 1995 -8.4 1996 0 end
&forecast; >>GPSCS 10 1995 0 1996 2.5 end
&forecast; >>PCS 10 1995 0 end
&forecast; >>PDASPH 10 1995 0 end
&forecast; >>PDDF 10 1995 208.3 1996 0 end
&forecast; >>PDFO 10 1995 0 end
&forecast; >>PDGA 10 1995 71.4 1996 0 end
&forecast; >>PDJF 10 1995 0 end
&forecast; >>PDKE 10 1995 0 end
&forecast; >>PDLO 10 1995 0 end
&forecast; >>PDLP 10 1995 100 1996 0 end
&forecast; >>PDOT 10 1995 0 end
&forecast; >>PGS 10 1995 0 end
&forecast; >>PHASPH 10 1995 0 end
&forecast; >>PHDF 10 1995 0 end
&forecast; >>PHFO 10 1995 0 end
&forecast; >>PHGA 10 1995 0 end
&forecast; >>PHJF 10 1995 0 end
&forecast; >>PHKE 10 1995 0 end
&forecast; >>PHLO 10 1995 0 end
&forecast; >>PHLP 10 1995 0 end
&forecast; >>PHOT 10 1995 0 end
&forecast; >>QTAOPEC 10 1995 0 1996 2.5 end
&forecast; >>QTAS 10 1995 0 1996 2.5 end
&forecast; >>RCAPS 10 1995 0 end
&forecast; >>SHASPH 10 1995 -0.08 1999 0 end
&forecast; >>SHCO 10 1995 4.5 1999 0 end
&forecast; >>SHDF 10 1995 0 end
&forecast; >>SHFO 10 1995 -0.01 1999 0 end
&forecast; >>SHGA 10 1995 0.02 1999 0 end
&forecast; >>SHJF 10 1995 -0.2 1999 0 end
&forecast; >>SHKE 10 1995 -0.02 1999 0 end
&forecast; >>SHLO 10 1995 0 end
&forecast; >>SHLP 10 1995 0.02 1999 0 end
&forecast; >>SHOT 10 1995 -0.08 1999 0 end
&forecast; >>SPC 10 1995 0 end
&forecast; >>SPG 10 1995 0 end
&forecast; >>SRC 10 1995 0 end
&forecast; >>TXASPH 10 1995 0 end
&forecast; >>TXCR 10 1995 0 end
&forecast; >>TXDF 10 1995 500 1996 0 end
&forecast; >>TXFO 10 1995 0 end
&forecast; >>TXGA 10 1995 171.5 1996 0 end
&forecast; >>TXJF 10 1995 0 end
&forecast; >>TXKE 10 1995 0 end
```



```

&forecast; >>TXLO 10 1995 0 end
&forecast; >>TXLP 10 1995 240.09 1996 0 end
&forecast; >>TXNG 10 1995 0 end
&forecast; >>TXOT 10 1995 0 end
&forecast; >>YAA 10 1995 2.9 1996 3.0 end
&forecast; >>YAF 10 1995 3.0 end
&forecast; >>YLA 10 1995 2.3 1996 2.5 end
&forecast; >>YME 10 1995 2.2 end
&forecast; >>YNA 10 1995 3.1 1996 1.9 end
&forecast; >>YNE 10 1995 -3.8 1996 0 1998 3 2000 3.5 end
&forecast; >>YNS 10 1995 3.9 end
&forecast; >>YOE 10 1995 2.8 1996 2.5 end
&forecast; >>SHAS 10 1995 0 end
&forecast; >>SHAL 10 1995 0 end
&forecast; >>SHAM 10 1995 0 end
&forecast; >>SHAH 10 1995 -16.32 1996 0 end

```

/* Here the residuals are extrapolated.

```

&forecast; >>RESDAA 10 1995 0 end
&forecast; >>RESDAF 10 1995 0 end
&forecast; >>RESDES 10 1995 0 end
&forecast; >>RESDLA 10 1995 0 end
&forecast; >>RESDME 10 1995 0 end
&forecast; >>RESDNA 10 1995 0 end
&forecast; >>RESDNE 10 1995 0 end
&forecast; >>RESDOE 10 1995 0 end
&forecast; >>RESDOS 10 1995 0 end
&forecast; >>RESIOECD 10 1995 0 end
&forecast; >>RESIW 10 1995 0 end
&forecast; >>RESNGLOPEC 10 1995 0 end
&forecast; >>RESNGLS 10 1995 0 end
&forecast; >>RESPCX 10 1995 0 end
&forecast; >>RESPNBX 10 1995 0 end
&forecast; >>RESPPX 10 1995 0 end
&forecast; >>RESPXAH 10 1995 0 end
&forecast; >>RESPXAL 10 1995 0 end
&forecast; >>RESPXAM 10 1995 0 end
&forecast; >>RESPXAS 10 1995 0 end
&forecast; >>RESRPS 10 1995 0 end
&forecast; >>RESSN 10 1995 0 end
&forecast; >>RESSOPEC 10 1995 0 end
&forecast; >>RESSOX 10 1995 0 end
&forecast; >>RESSW 10 1995 0 end

```

```

print("");
print("Finished with extrapolating.");
print("");

```

end;

7.2.6. *Alt1ref1.src*

/* Source file ALT1REF1.SRC. (Programmed by Rune Johansen, Statistic Norway).

```

/* This program is used for changing one or more of the exogenous variables from the reference path, to
/* make an alternative scenario. It passes information about the exogenous variables to the program DEVIAT,
/* where they are given shift in user specified sub-periods.

```

```
/* Example: Assume we have already extrapolated the exogenous variables, and made a reference simulation
/* with these as input for the periode 1990 to 2010. In this extrapolation, and thus as input to the reference
/* simulation, the government consumption was extrapolated with a 0 per cent growth rate. We are interested
/* in studying the effects of government consumption growing 2.3 percent in the period 1998 to 2003. This will
/* be our alternative scenario. The necessary information passed over to the program DEVIAT with the
/* following syntax: CG 1998 2003 2.3 end
```

```
/* The 'END' statment is needed because it indicates that we are finished entering pairs of sub-periods and
/* growth rates relative to the reference scenario.
```

```
/* The variable CG will be extrapolated in the same way as it was as input to the reference simulation, apart
/* from the period 1998 - 2003, where it will stay 2.3 per cent above the extrapolated variable used in the
/* reference simulation. The shift will be from 1997 to 1998, so that 1998 is the first year CG is 2.3 per cent
/* higher. Thereafter, until 2003, CG will grow by 0 per cent, or, it will stay constant 2.3 per cent above than
/* in the reference case (paralell). In 2004 CG will "be back" to the reference value.
```

```
/* Notice that the name of this file (source file) is arbitrary, a different scenario should be given a different
/* name.
```

```
addfun main;
procedure main()
begin;
```

```
    &deviat; >> capopec 1998 2003 2.3 end
```

```
    print("");
    print("Finished changing exogenous variables.");
    print("");
```

```
end;
```

7.2.7. *Deviat.src*

```
/* Source file DEVIAT.SRC. (Programmed by Rune Johansen, Statistic Norway).
```

```
/* This program makes changes in variables over user specified sub-periods. The main purpose of the program
/* is to change (extrapolated values of) exogenous variables to be used in simulations.
```

```
/* Example: Assume there exist a time serie CG which is extrapolated from 1990 to 2010 with 1.2 per cent
/* growth. This could be input to a reference simulation. We want to study the effects of a 2 per cent growth,
/* rather than 1.2, in the sub-period 1998 - 2003.
```

```
/* In TROLL this example would look like this:
```

```
/* TROLL Command: &deviat
/* Give the name of the time serie to change: cg
/* Give the first year of the sub-period to change the variable, or type 'END' to exit: 1995
/* Give the last year of this sub-period: 2000
/* Give the per cent change: 10
/* Give the start year of the next sub-period, or type 'END' if finished: end
```

```
/* This example will increase CG from 1994 to 1995 by 10 per cent. CG will then stay at this level
/* until 2000, and, in year 2001, it will "be back" to the previous value.
```

```
/* It should be noticed that multiple pairs of sub-periods and per cent growth are possible.
```

```
addfun main;
procedure main()
begin;
```

```

>>do;delcore all;
get series"\nGive the name of the time serie to change: ";

/* Make a variablename 'temp', where subsequent parts parts of the original series are temporarily stored.

>>docore temp = &(series);

get p1"\nGive the first year of the sub-period to change the variable, or type 'END' to exit: ";

/* The program is running in a loop until the user type 'END'.

    while(P1<> "END")
        begin;
            year1 = p1;
            get year2"\nGive the last year of this sub-period: ";
            get number percent"\nGive the per cent change: ";
            on warning nomsg;
            on error nomsg;
            >>docore temp2 =
            >>((100+&(percent))/100)*subrange(temp,&(year1)a,&(year2)a);
            >>docore temp3 = subrange(temp,startdate(&(series)),&(year1)a);
            >>docore temp4 = subrange(temp,&(year2)a,enddate(&(series)));
            >>docore temp = overlay(temp2, temp3, temp4);
            on error nomsg;
            get p1"\n Give the start year of the next sub-period, or type 'END' if finished: ";
        end;

/* The new time serie is stored under it's original name, but at the database specified by the search file.

    >>dofile &(series) = temp;
    >>delcore all;

/* print("Finished with changing exogenous variable");

end;

```

7.2.8. *Changexa.src*

/* Source file CHANGEXA.SRC. (Programmed by Rune Johansen and Einar Bowitz, Statistics Norway).

/* This program makes absolute changes in variables over user specified sub-periods. The user gives
/* variable name, start year of first sub-period, end year of first sub-periode, and absolute change in values for
/* that period, start year of next sub-period, end year of next sub-period, absolut change in this sub-period,
/* The user type 'END' if he don't want to specify another sub-periode (start year and end year). So multiple
/* sub-periods and changes in leves are allowed.

/* The change in the variables is only kept in the troll memory and will be deleted when leaving troll or
/* by typing delsave all.

```

addfun main;
procedure main()
begin;
    >>do; delcore all;
    get series"\nGive the name of the time serie to change: ";

```

/* 'temp' is a temporary timeseries where subsequent parts parts of the original series are stored.

```

    >>docore temp = &(series);
    get p1"\nGive the start year of the first sub-period to change the variable, or type 'END' to exit: ";

/* The macro is running in a loop until the user types 'END'.

while(p1 <> "END")
    begin;
        year1 = p1;
        get year2"\nGive the last year of this sub-period: ";
        get number absol"\nGive the absolute change: ";
        on warning nomsg;
        on error nomsg;
        >>docore temp2 =
        >> &(absol)+subrange(temp,&(year1)a,&(year2)a);
        >>docore temp3 = subrange(temp,startdate(&(series)),&(year1)a);
        >>docore temp4 = subrange(temp,&(year2)a,enddate(&(series)));
        >>docore temp = overlay(temp2, temp3, temp4);
        on error nomsg;
    get p1"\nGive the start year of the next sub-period to change the variable, or type 'END' if finished:";

    end;

    >>do &(series) = temp;
    >>delcore all;

/* print("Finished changing the variable.");
end;

```

7.2.9. *Changexp.src*

/* Source file CHANGEXP.SRC.

/* Program that makes changes in variables over user specified sub-periods. The user gives variable
/* name, start year of sub-period, end year of sub-period, per cent change in values for that period, and, if
/* finished the user type 'END'. The 'END' is necessary because many pairs of sub-periods and per cent
/* growth is allowed.

/* The changes is only kept in the TROLL memory and will be deleted when leaving TROLL or by typing
/* delsave all.

```

addfun main;
procedure main()
begin;

```

```

    >>do;delcore all;
    get series"\nGive the name of the time serie to change: ";

```

/* 'temp' is a temporary timeseries where subsequent parts parts of the original series are stored.

```

    >>docore temp = &(series);

    get p1"\nGive the start year of the first sub-period to change the variable, or type 'END' to exit: ";

```

/* The macro is running in a loop until the user type 'END'.

```

    while(p1 <> "END")

```

```

begin;
    year1 = p1;
    get year2"\nGive the last year of this sub-period: ";
    get number percent"\nGive the per cent change: ";
    on warning nomsg;
    on error nomsg;
    >>docore temp2 =
    >>((100+&(percent))/100)*subrange(temp,&(year1)a,&(year2)a);
    >>docore temp3 = subrange(temp,startdate(&(series)),&(year1)a);
    >>docore temp4 = subrange(temp,&(year2)a,enddate(&(series)));
    >>docore temp = overlay(temp2, temp3, temp4);
    on error nomsg;
get p1"\nGive the start year of the next sub-period to change the variable, or type 'END' if finished: ";

end;

>>do &(series) = temp;

>>delcore all;

/* print("Finished with changing the variable.");

end;

```

7.2.10. Devia2.src

/* Source file DEVIA2.SRC. (Programmed by Rune Johansen and Einar Bowitz, Statistics Norway).

/* This program makes changes in variables over user specified sub-periods. The user gives variable
/* name, start year of sub-period, end year of sub-period, absolute change in values for that period, and, if
/* finished, the user type 'END'.

/* This program is usually called upon from program of the type ALT1REF1.

/* The 'END' commend is necessary because many pairs of sub-periods and absolute changes are
/* allowed.

```

addfun main;
procedure main()
begin;

```

```

    >>do;delcore all;
    get series"\nGive the name of the timeseries: ";

```

/* 'temp' is a temporary timeseries where subsequent parts parts of the original series are stored.

```

    >>docore temp = &(series);

    get p1"\nGive the first year of the sub-period, or type 'END' if finished: ";

```

/* The macro is running in a loop until the user type 'END'.

```

    while(p1 <> "END")
    begin;
        year1 = p1;
        get year2"\nGive the end year of the sub-period: ";
        get number absol"\nGive the absolute change: ";
        on warning nomsg;

```

```

on error nomsg;
>>docore temp2 =
>> &(absol)+subrange(temp,&(year1)a,&(year2)a);
>>docore temp3 = subrange(temp,startdate(&(series)),&(year1)a);
>>docore temp4 = subrange(temp,&(year2)a,enddate(&(series)));
>>docore temp = overlay(temp2, temp3, temp4);
on error nomsg;
get p1 "\nGive the start year of the next period of change, or type 'END' if finished: ";

end;

>>dofile &(series) = temp;
>>delcore all;

```

```
/* print("finished");
```

```
end;
```

7.3. Simulating the variables

The previous section presented the program files aimed at extrapolate, and make changes in, the exogenous variables. When the extrapolation is completed, this variables will be used as input to a simulation model. This section present the main programs developed for organizing the simulations.

7.3.1. Refsim.src

```
/* Source file REFSIM.SRC.
```

```
/* This is the main program to organise the reference simulations. The program requires that the program used
/* to extrapolate the exogenous variables have been prepared in advance, and that it is ready to be called from
/* this program.
```

```
/* The program ask for which model to use, the name of the file (program) containing the exogenous variables
/* to extrapolate, and the start and end year of the simulation period.
```

```
/* This program compile and execute the program used to extrapolate the exogenous variables. Then these
/* variables are used as input to the model, which is used to simulate the endogenous variables for the specified
/* period.
```

```
/* The program automatically gives search to the directory for the simulation output. The results will be saved
/* in a formdata file at this directory. The name of this file will be the same as of the file used to extrapolate the
/* exogenous variables, but it will have extension DAT.
```

```
addfun main;
procedure main()
begin;
```

```
/* First we delete all searches and accesses eventually given, before we give the correct ones.
```

```

>>delaccess all;
>>delsearch all;
>>input accessom;
>>input srchsiom

```

```
/* We ask for the names to be used.
```

```
get modname "\nGive the name of the model: ";
```

```

get refname"\nGive the name of the file containing the exogenous variables to be extrapolated: ";
get stperiod"\nGive the start year of the simulation period (four digits only) : ";
get endperiod"\nGive the end year of the simulation period (four digits only) : ";

/* We open the database for the simulation output, and create a new formdata file with the same name
/* as the file that generates the reference path. The internal name of this database is REF.

    >>access ref type formdata id d:\saudi\om\simres\&(refname).dat mode create;

/* Here we give writeable search to this formdata file, so that the simulation result will be store here.
    >>Search data ref w;

/* Here we give search to the historical database, to be used when extrapolating the exogenous variables.
    >>search first data omdata;

    >>compile &(refname);
    &(refname);
    >>search first data ref w;
    >>usemod &(modname);
    >>simulate;
    >>simstart &(stperiod)a;
    >>dotil &(endperiod)a;
    >>filesim &(refname);
    >>quit;
print("");
    print("Finished with simulation.");
    print("The reference simulation is saved in D:\SAUDI\OM\SIMRES\",refname, ".DAT.\nwith the
prefix ",refname);
print("");

end;

```

7.3.2 *Altsim.src*

/* Source file ALTSIM.SRC.

/* Main program that organises the simulations scenarios. Scenarios is defined as deviations from a reference
/* path due to changes in one or more of the exogenous variables.

/* This program requires an existing reference path (made for instance by the program REFSIM), and that a file
/* (program) which will be used for making change in one or more of the exogenous variables, has been
/* prepared.

/* The program ask the user for model name, the name of the reference path, the name of the alternative
/* scenario, and the start and end year of the simulation period.

/* When the necessary information has been provided the reference simulation is copied to a new name, then
/* the changes in the exogenous variables are undertaken and the endogenous variables are simulated.

```

addfun main;
procedure main()
begin;

    >>delsearch all;
    >>delaccess all;
    >>input accessom;
    >>input srctiom;

```

```

get modname"Give the name of the model: ";
get refname"Give the name of the reference path: ";
get sn"Give the name of the alternative scenario: ";
get stperiod"Give the start year of the simulation period (four digits only): ";
get endperiod"Give the end year of the simulation period (four digits only): ";

>>host "command.com /c copy d:\saudi\om\simres\&(refname).dat d:\saudi\om\simres\&(sn).dat";

/* Simulation input and output are stored here.
   >>access senn type formdata id d:\saudi\om\simres\&(sn).dat mode w;

/* The reference simulation is stored here (the reference path).
   >> access ref type formdata id d:\saudi\om\simres\&(refname).dat mode r;

   >>search data senn w;
   >>compile &(sn);

/* Call macro that contains exogenous variables that is changed.
   &(sn);

   >> usemod &(modname);
   >> simulate;
   >> simstart &(stperiod)a; dotil &(endperiod)a;
   >> filesim &(sn);

   >>quit;

print("");
print("End of simulation.");
print("The simulation results are stored in D:\SAUDI\MOM\SIMRES\", sn, ".DAT." );
print("The variables in the reference simulation has the prefix ", refname, " while the variables in the
alternative simulation has the prefix ", sn, ".");

print("");

end;

```

7.3.3. *Sim.src*

/* Source file SIM.SRC. (Programmed by Robin Choudhury, Statistics Norway).

/* The purpose of this program is to prompt the user for the information needed to perform both
/* a reference and an alternative simulation. This information is: a file name to save the result in,
/* the name of the file (program) containing the exogenous variables to extrapolate, the model name, the
/* start and end year of the simulation period, the name of the file (program) containing the variable(s) to
/* shift.

/* What distinguishes this program from the other simulation programs, is that it will save the results in a
/* user specified file (formdata), and that it performs both a reference and an alternative simulation.

```

addfun main;
procedure main()
begin;

get file"Give a file name to save simulations results in (max. 8 characters, no extension): ";

>>access rrr type formdata id d:\saudi\om\simres\&(file).dat mode w;
>>search data rrr w;

```



```

get refname"\nGive the name of the file containing the exogenous variables to extrapolate: ";

>>option screen off;
>>compile &(refname);
&(refname);
>>option screen on;

get modname"\nGive the name of the model: ";

print("");

>>usemod &(modname);
>>simulate;

print("");

get first"\nGive the first year of the simulation period: ";
get last"\nGive the last year of the simulation period: ";
get altname"\nGive the name of the file containing the exogenous variable(s) to shift: ";

print("");

>>option screen off;

>>simulate;
>>simstart &(first)a;
>>dotil &(last)a;
>>filesim &(refname);

>>compile &(altname);
&(altname);
>>simulate;
>>simstart &(first)a;
>>dotil &(last)a;
>>filesim &(altname);

>>option screen on;

print("");

print("End of simulations.");
print("The simulations results are saved as D:\\SAUDI\\OM\\SIMRES\\", file, ".DAT.");
print("The variables simulated using the file: ", refname, ".PRG has got prefix ", refname, ".");
print("The variables simulated using the file: ", altname, ".PRG has got prefix ", altname, ".");

print("");
>>quit;

end;

```

7.4. Miscellaneous programs

7.4.1. *Eqeval.src*

/* Source file EQEVAL.SRC. (Programmed by Robin Choudhury, Statistics Norway).

/* The eqeval program evaluates the equations in a model by calling the built in eqeval TROLL function.
 /* This is very useful to see that no errors prevent the left hand sides to be equal to the right hand sides. The

```

/* program prompt the user for: the model name, the number of the first equation, the number of the last
/* equation, and one of three possible choices: evaluation of the right hand side, the left hand side or the
/* residuals.

addfun main;
procedure main()
begin;

    on warning nomsg;
    get modname"\nGive the name of the model: ";
    get number eqfrom"\nGive the number of the first equation: " ;
    get number eqto"\nGive the number of the last equation: ";
    start1:

get code"\nType '0' if you want to evaluate the right hand side, '1' for the left hand side or '2' for residuals: ";

    if (code <> "0" and code <> "1" and code <> "2") then
    begin;
    print(" ");

    print("ERROR. Not an option.");

    /* Retype if the choice is not 0, 1 or 2.
    goto start1;
end;

/* This is to make two extra line feed.
print("");
print("");

>>usemod &(modname);

if (code == "0") then
print("Evaluation of the right hand side: ");

else if (code == "1") then
print("Evaluation of the left hand side: ");

else if (code == "2") then
print("Evaluation of the residuals: ");

for(i= eqfrom; i<= eqto; i=i+1)
begin;
>> do prt.( eqeval(&(i), &(code) ) );

end;

print("\nFinished with eqeval.");

end;

```

7.4.2. Db.src

/* Source file DB.SRC. (Programmed by Robin Choudhury and Knut A. Magnussen, Statistics Norway).

```

/* Program to open an unaccessed database.
/* When a simulation is performed and the results are saved in the database, we are given temporarily
/* access and search to this. But as soon as we stop TROLL or type delaccess all anddelsearch all we loose
/* this access and search. This program can be used to avoid typing the long access and search commands.

```

```

addfun main;
procedure main()
begin;

    get database"Give the name of the database to open (no extension): ";
    get nickname"Give a nickname for the database to open: ";

    >>access &(nickname) type formdata id d:\saudi\om\simres\&(database).dat mode w;
    >>search data &(nickname) w;

end;

```

7.4.3. *Prtref.src*

/ Source file prtref.src.*

/ This program prints output from a simulation. The only information needed is the name of the simulation. The program prompt the user for the name of the variable, and when program REFSIM has been used the simulation has the same first name as the file extrapolating the exogenous variables. The simulated variables has a prefix with the same name, but the user shall not give this prefix, only "original" variable name.*

/ The program print out the value and the per cent change in the variable from last periode.*

```

addfun main ;
procedure main()
begin;
    on warning nomsg;
    get rs "Give the name of reference simulation: " ;

    >> access rssea TYPE formdata id d:\saudi\om\simres\&(rs).dat MODE r;
    >> search FIRST data rssea ;

    start1:
        get va "Give the name of the variable (without prefix), or type 'END' if finished: ";
        if (va <> "END") then
            begin;
                >> do prt.(truncate(&(rs)_&(va),3));
                >> do print("Per cent change from last periode is: ");
                >> do prt.(truncate(100*(&(rs)_&(va)/&(rs)_&(va)(-1)-1),3));
            end;
        else
            goto start2;
    goto start1;
    start2:

    >> delsearch rssea ;
    >> delaccess rssea ;
    >> quit;

end;

```

References

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Annex A. Analyzing the models

Introduction

To increase efficiency of the simulation task, TROLL analyzes the model the first time it is simulated, and the «simulation code» is stored together with the model. This analysis is also useful for understanding the functioning of the model. The analysis consists of the following parts:

- An «incident matrix» that identifies which endogenous variable appearing in which equations.
- A «normalization» which provides a one-to-one pairing of equations with the endogenous variable solved from the respective equation.
- A «block ordering» which partitions the model into the smallest possible block of truly simultaneous equations.

The models with exogenous oil price (gap mode)

The following table shows which variable appears in which equation for the two models with exogenous oil prices (gap mode).

Variable	Used in Equations (* cannot be solved for var)				
CUOPEC	13	14			
DAA	7	8			
DAF	6	8			
DCI	51	55			
DCR	50	51	54		
DCS	26	27	50	51	
DES	21	24			
DGI	53	55			
DGR	52	53	54		
DGS	24	52	53		
DLA	2	8			
DME	5	8			
DNA	1	8			
DNE	4	8			
DOE	3	8			
DOPEC	12				
DOS	22	24	26	27	28
DPI	49	55			
DPR	48	54			
DPS	27	30	48	49	
DW	8	12			
IOECD	10	11			
IW	11	12			
NGLOPEC	15	16			
NGLS	19	28	30		
PCX	35	39	40		
PMCX	36	43	44		
PNBX	38	45	46		
PPX	37	41	42		
PR	47	48	49		
PS	23	25			
PSR	21	22	23		
PXAH	34	36			

<i>Variable</i>	<i>Used in Equations (* cannot be solved for var)</i>					
PXAL	32	35	36			
PXAM	33	36				
PXAS	31	36				
RPS	20	28	30			
SCX	29	39	40	43	44	
SCXI	40					
SCXR	39					
SMCXI	44					
SMCXR	43					
SN	9	12	17			
SNPXI	46					
SNPXR	45					
SOPEC	14	15	16	(18 in preserve market share mode)		
SOX	28	29				
SPX	29	30	41	42	45	46
SPXI	42					
SPXR	41					
SS	18	19*	28			
SW	17					
TDEI	55					
TDER	54					
TSOPEC	16	17				

In the next table we present the normalization and the block ordering of the model with gap mode. The normalization pairs endogenous variables to the equation used to solve for that particular variable, while the block ordering «breaks down» the model to the smallest possible number of equation that need to be solved simultaneously. If the largest block is one (consist of one equation), as is the case in the gap mode, the model is completely recursive (solved equation by equation). If the smallest block is greater than one, as is the case in the model with the market clearing mode, the equations in that block needs to be solved simultaneously.

The model has 55 blocks, including 0 simultaneous blocks. The largest block has 1 equations and the next largest has 1.

<i>Block</i>	<i>Size</i>	<i>Eqn</i>	<i>Var</i>
1	1	1	DNA
2	1	2	DLA
3	1	3	DOE
4	1	4	DNE
5	1	5	DME
6	1	6	DAF
7	1	7	DAA
8	1	8	DW
9	1	9	SN
10	1	10	IOECD
11	1	11	IW
12	1	12	DOPEC
13	1	13	CUOPEC
14	1	14	SOPEC
15	1	15	NGLOPEC
16	1	16	TSOPEC
17	1	17	SW
18	1	18	SS
19	1	19	NGLS
20	1	20	RPS

<i>Block</i>	<i>Size</i>	<i>Eqn</i>	<i>Var</i>
21	1	25	PS
22	1	23	PSR
23	1	21	DES
24	1	22	DOS
25	1	24	DGS
26	1	26	DCS
27	1	27	DPS
28	1	28	SOX
29	1	30	SPX
30	1	29	SCX
31	1	31	PXAS
32	1	32	PXAL
33	1	33	PXAM
34	1	34	PXAH
35	1	35	PCX
36	1	36	PMCX
37	1	37	PPX
38	1	38	PNBX
39	1	39	SCXR
40	1	40	SCXI
41	1	41	SPXR
42	1	42	SPXI
43	1	43	SMCXR
44	1	44	SMCXI
45	1	45	SNPXR
46	1	46	SNPXI
47	1	47	PR
48	1	48	DPR
49	1	49	DPI
50	1	50	DCR
51	1	51	DCI
52	1	52	DGR
53	1	53	DGI
54	1	54	TDER
55	1	55	TDEI

The models with endogenous oil price (market clearing mode)

The following table shows which variable appears in which equation for the two models with endogenous oil prices (market clearing mode).

<i>Variable</i>	<i>Used in Equations (* cannot be solved for var)</i>		
CUOPEC	13	14	
DAA	7	8	
DAF	6	8	
DCI	52	56	
DCR	51	52	55
DCS	27	28	51 52
DES	22	25	
DGI	54	56	
DGR	53	54	55
DGS	25	53	54
DLA	2	8	
DME	5	8	
DNA	1	8	
DNE	4	8	
<i>Variable</i>	<i>Used in Equations (* cannot be solved for var)</i>		

<i>Block</i>	<i>Size</i>	<i>Eqn</i>	<i>Var</i>
1	1	13	CUOPEC
2	1	14	SOPEC
3	1	15	NGLOPEC
4	1	16	TSOPEC
5	11	1	DNA
		2	DLA
		3	DOE
		4	DNE
		5	DME
		6	DAF
		7	DAA
		8	DW
		9	P
		17	SN
		18	SW
6	1	10	IOECD
7	1	11	IW
8	1	12	DOPEC
9	1	19	SS
10	1	20	NGLS
11	1	21	RPS
12	1	26	PS
13	1	24	PSR
14	1	22	DES
15	1	23	DOS
16	1	25	DGS
17	1	27	DCS
18	1	28	DPS
19	1	29	SOX
20	1	31	SPX
21	1	30	SCX
22	1	32	PXAS
23	1	33	PXAL
24	1	34	PXAM
25	1	35	PXAH
26	1	36	PCX
27	1	37	PMCX
28	1	38	PPX
29	1	39	PNBX
30	1	40	SCXR
31	1	41	SCXI
32	1	42	SPXR
33	1	43	SPXI
34	1	44	SMCXR
35	1	45	SMCXI
36	1	46	SNPXR
37	1	47	SNPXI
38	1	48	PR
39	1	49	DPR
40	1	50	DPI
41	1	51	DCR
42	1	52	DCI
43	1	53	DGR
44	1	54	DGI
45	1	55	TDER
46	1	56	TDEI

Annex B. Examples

Example 1. Simulation without using the programs

In this example we simulate the variables in the model where Saudi Arabia adhere to its official OPEC quota, and the price is determined inside the model (market clearing mode). We have extrapolated and simulated the variables without using the programs specially made for this purpose. The reason not to use the programs could be that we are in a process of modifying the model. It would then be easier to detect and identify errors than if we use the programs, where isolating each event is much more difficult.

Simulating in this way means that we have to direct the output from the simulation to the place we want to save it, and not to mix it with the historical data. This is done by using the search file SRCHSIOM. We also have to save the output with a prefix, in this example the simulated variables are saved with the prefix EXAMPLE1. Then we print out the simulated values of the market clearing price and the world demand of oil, which should be equal to the world supply.

```
TROLL Release 0.94
Copyright (C) Intex Solutions, Inc. 1993-1994
Copyright (C) Massachusetts Institute of Technology 1978-1987

TROLL Command: input accessom
TROLL Command: option screen off;
TROLL Command: input srchsiom
TROLL Command: option screen off;
TROLL Command: usemod om95aqmc
TROLL Command: &refmc

Finished with extrapolating.

DO Command: simulate;
Simulations can start from 1992A to 1995A and must end by 2004A.
SIMULATE Command: simstart 1994a;
SIMULATE Command: dotil 2004a;
SIMULATE Command: filesim example1;
SIMULATE Command: do ptime(example1_p, example1_dw, example1_sw);

      EXAMPLE1_P  EXAMPLE1_DW  EXAMPLE1_SW
1994A   15.9      68.55      68.45
1995A  17.696512  69.269636  69.169636
1996A  16.806876  70.429651  70.329651
1997A  16.951364  71.533212  71.433212
1998A  17.454247  72.628419  72.528419
1999A  17.799458  73.703431  73.603431
2000A  18.132439  74.76329   74.66329
2001A  18.416232  75.808823  75.708823
2002A  18.676428  76.843434  76.743434
2003A  18.918703  77.870674  77.770674
2004A  19.145097  78.89384   78.79384

DO Command:
```

Example 2. Simulating using the programs

In this example we simulate the same version of the model as in the previous example, the model with «adhere to quota policy» and endogenous oil price (market clearing). We use the same assumptions about the future growth in the exogenous variables, or, to put it another way, we use the same file to

```
TROLL Release 0.94
Copyright (C) Intex Solutions, Inc. 1993-1994
Copyright (C) Massachusetts Institute of Technology 1978-1987
```

```
TROLL Command: input accessom
TROLL Command: option screen off;
TROLL Command: input srchtiom
TROLL Command: option screen off;
TROLL Command: &refsim
TROLL Command: option screen off;
Give the name of the model: om95aqmc
```

```
Give the name of the reference path: refmc
```

```
Give the start year (four digits only ): 1994
```

```
Give the end year (four digits only ): 2004
```

```
REFMC 2004
```

```
TROLL Compiler: rel. 0.933
```

```
END OF COMPILATION
```

```
ERRORS: 0
```

```
WARNINGS: 0
```

```
Finished with extrapolating.
```

```
Simulations can start from 1992A to 1995A and must end by 2004A.
```

```
End of simulation.
```

```
TROLL Command: do prtime(refmc_p, refmc_dw, refmc_sw);
```

	REFMC_P	REFMC_DW	REFMC_SW
1994A	15.9	68.55	68.45
1995A	17.696512	69.269636	69.169636
1996A	16.806876	70.429651	70.329651
1997A	16.951364	71.533212	71.433212
1998A	17.454247	72.628419	72.528419
1999A	17.799458	73.703431	73.603431
2000A	18.132439	74.76329	74.66329
2001A	18.416232	75.808823	75.708823
2002A	18.676428	76.843434	76.743434
2003A	18.918703	77.870674	77.770674
2004A	19.145097	78.89384	78.79384

```
DO Command:
```

extrapolate the exogenous variables (the file REFMC). In this example we call the program REFSIM, that organize the reference simulation. It prompt the user for the model name, the name of the file that is used to extrapolate the exogenous variables, the simulation start year and the simulation end year. Then the program that extrapolates the exogenous variables is compiled, before the model is simulated with this variables as input. Note that the variables is automatically given the same prefix as the name of the file that extrapolate the exogenous variables.

Annex C. Variable list

Endogenous

CUOPEC	OPEC's capacity utilisation factor
DAA	oil demand from Asia and Australia
DAF	oil demand from Africa
DCI	crude oil for direct combustion, income
DCR	crude oil for direct combustion, revenue
DCS	crude oil for direct consumption
DES	primary energy consumption
DGI	natural gas, income, in thousand SR
DGR	natural gas, revenue, in thousand SR
DGS	natural gas consumption, Saudi Arabia
DLA	oil demand from Latin America
DME	oil demand from Middle East
DNA	oil demand from North America
DNE	oil demand from non-OECD Europe
DOE	oil demand from OECD Europe
DOPEC	call on OPEC supply
DOS	oil consumption, Saudi Arabia
DPI	domestic income from petroleum products
DPR	domestic revenue from petroleum products
DPS	petroleum products consumption, Saudi Arabia
DW	total world oil demand
IOECD	oil stock in OECD countries
IW	oil stock in world
NGLOPEC	NGL supply from OPEC
NGLS	NGL supply from Saudi Arabia
PCX	average FOB price of crude oil exports based on the sales and volum statistics of CDS, in USD/bbl.
PMCX	weighted average price of crude oil barrel based on the spot market quotations of various Saudi crudes
PNBX	price based on average netback valuation of Arab light
PPX	price based on official export statistics
PR	domestic weighted average wholesale price plus taxes for refined products, in SR/bbl.
PS	average domestic oil price
PSR	average domestic oil price, deflated with the non-oil GDP deflator
PXAH	FOB spot price on Arabian Heavy
PXAL	FOB spot price on Arabian Light
PXAM	FOB spot price on Arabian Medium
PXAS	FOB spot price on Arabian Super Light
RPS	average daily output of Saudi oil refineries, in thousand barrels per calender day
SCX	crude oil exports
SCXI	crude oil export income, based on official export statistics
SCXR	crude oil export revenue, based on official export statistics
SMCXI	crude oil export income, based on official export statistics
SMCXR	crude oil export revenue, based on official export statistics
SN	supply from non-OPEC countries
SNPXI	oil products export income, based on official export statistic
SNPXR	oil products export revenue, based on official export statistic
SOPEC	crude oil production in OPEC countries, in mbd
SOX	total petroleum export
SPX	petroleum products exports
SPXI	oil products export income, based on official export statistic
SPXR	oil products export revenue, based on official export statistic
SS	Saudi Arabias oil production
SW	total world supply of oil

TDEI	total domestic energy income
TDER	total domestic energy revenue
TSOPEC	total supply from OPEC

Exogenous

CAPOPEC	OPEC's sustainable crude oil production capacity
D8285	dummy variable, equal to 0 for the years 1982-1985, equal to 1 otherwise
DEF	non-oil GDP deflator
DNGL6981	dummy variable, equal to 0 for the years 1969-1981, equal to 1 otherwise
EXCH	exchange rate of Saudi Riyal (S:R:) per USD
FAA	adjustment factor for the exchange rate vs. USD, Asia and Australia
FAF	adjustment factor for the exchange rate vs. USD, Africa
FLA	adjustment factor for the exchange rate vs. USD, Latin America
FME	adjustment factor for the exchange rate vs. USD, Middle East
FNA	adjustment factor for the exchange rate vs. USD, North America
FNE	adjustment factor for the exchange rate vs. USD, non-OECD Europe
FOE	adjustment factor for the exchange rate vs. USD, OECD Europe
GPSCS	NGL capacity of the gas processing system of Saudi Arabia
P (gap mode)	average world oil price
PCS	domestic price of crude oil in SR/bbl.
PGS	domestic price of dray natural gas in SR/bbl. of oil equivalent
PHASPH	domestic wholesale price of asphalt
PHDF	domestic wholesale price of diesel & fuel
PHFO	domestic wholesale price of fuel oil
PHGA	domestic wholesale price of gasoline
PHJE	domestic wholesale price of jet fuel
PHKE	domestic wholesale price of kerosine
PHLO	domestic wholesale price of lube oils
PHLP	domestic wholesale price of LPG
PHOT	domestic wholesale price of other
QTAOPEC	OPEC's official crude oil production quota
QTAS	Saudi production quota, in mbd
RCAPS	primary distillation capacity of Saudi refineries in thousand barrels per calendar day
SHASPH	share of asphalt in domestic consumption
SHDF	share of diesel & fuel in domestic consumption
SHFO	share of fuel oil in domestic consumption
SHGA	share of gasoline in domestic consumption
SHJE	share of jet fuel in domestic consumption
SHKE	share of kerosine in domestic consumption
SHLO	share of lube oils in domestic consumption
SHLP	share of LPG in domestic consumption
SHOT	share of other in domestic consumption
SPC	average production cost of Saudi crude oils in SR/bbl.
SPG	production and handling cost of natural gas in S.R/bbl. of crude oil equivalent
SRC	average refining cost in Saudi Arabia in SR/bbl.
SHASPH	share of asphalt in domestic consumption
SHDF	share of diesel & fuel in domestic consumption
SHFO	share of fuel oil in domestic consumption
SHGA	share of gasoline in domestic consumption
SHJE	share of jet fuel in domestic consumption
SHKE	share of kerosine in domestic consumption
SHLO	share of lube oils in domestic consumption
SHLP	share of LPG in domestic consumption
SHOT	share of other products in domestic consumption
TXASPH	domestic taxes on asphalt, S.R/bbl of oil equivalent
TXCR	domestic taxes on crude oil in SR/bbl.
TXDF	domestic taxes on diesel & fuel, S.R/bbl of oil equivalent

TXFO	domestic taxes on fuel oil, S.R/bbl of oil equivalent
TXGA	domestic taxes on gasoline, S.R/bbl of oil equivalent
TXJE	domestic taxes on jet fuel, S.R/bbl of oil equivalent
TXKE	domestic taxes on kerosine, S.R/bbl of oil equivalent
TXLO	domestic taxes on lube oils, S.R/bbl of oil equivalent
TXLP	domestic taxes on LPG, S.R/bbl of oil equivalent
TXOT	domestic taxes on other products, S.R/bbl of oil equivalent
TXNG	domestic taxes on natural gas in SR/bbl. of oil equivalent
YAA	GDP in constant USD, Asia and Australia
YAF	GDP in constant USD, Africa
YLA	GDP in constant USD, Latin America
YME	GDP in constant USD, Middle East
YNA	GDP in constant USD, North America
YNE	GDP in constant USD, non-OECD Europe
YNS	non-oil GDP in real terms in million SR
YOE	GDP in constant USD, OECD Europe

RES*varname* syntax for the residuals, where *varname* is the left hand side variable

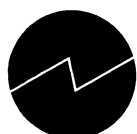
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