DATA AND MODEL DOCUMENTATION—004 REV-4

ImpactECON Supply Chain Operating Manual: Data and Model Programs

Rev 2: GTAP 9 Data Base,
May 2016

Rev 3: GTAP 10 Data Base,
January 2020

Rev 4: GTAP 11 Data base
June 2023

ImpactECON

ImpactECON Supply Chain Operating Manual: Data and Model Programs

Contents

Table of Tables

Table of Figures

Acronyms

IESC	ImpactECON Supply Chain (data package or model)
GTAP	Global Trade Analysis Project

1 Introduction

The ImpactECON Supply Chain (IESC) Package includes compiled GEMPACK programs (Harrison and Pearson (1996 and Horridge, Jerie, Mustakinov & Schiffmann (2018)) and associated files for:

— transforming the GTAP 11 Data Base[1] into the IESC database (the data programs);

— employing the IESC model within RunGTAP (the model programs).

This operating manual is intended to provide users information on installing and running the IESC Database and Model. Users are strongly encouraged to read the related background documentation on the data construction methodology and IESC Model (Walmsley and Minor, 2019 and 2016).

1.1 Pre-requisites

1.1.1 SYSTEM REQUIREMENTS

IESC Data Programs

The IESC Data Programs require increased storage capacity and computational resources in comparison to the standard GTAP Data Base. Specifically, a system will require at least:

— 32bit operating system;

— 10 Gigabytes (GB) of free disk storage space;

— 4 GB of system memory.

These system resources are available on most consumer computers manufactured in the last five years, but check your system for specifics.

[1] If you wish to transform an earlier version of the GTAP Data Base, please contact ImpactECON (contact@impactecon.com) for an earlier version of this documentation.

ImpactECON Supply Chain (IESC) Model

Running the IESC model with large aggregations (greater then 20x20) has become feasible on a wide range of computers with the proliferation of multi-core processors. We highly recommend the following system specifications for users of the IESC model:

- 64bit operating system and a 64bit compiled version of the IESC Model;
- 8 GB or more of random-access memory (RAM);
- At least 100 GB of storage space.

Many high-end consumer (gaming) computers manufactured in the last five years and most workstations from the last 10 yeast should meet these requirements or can be upgraded to meet them. The explosive growth in ultra-light notebooks has proved a noted exception. "Ultra" books often carry impressive specifications in the number of cores, RAM, and diskspace. However, these light weight, thin computers have CPUs which are designed to "sprint" and then dial down their speed due to thermal restrictions. They also power down when not plugged in. Many laptops sporting top specs can be surprisingly slow when pushed for more than a few minutes on several cores for calculations. Unfortunately, specs alone are not a perfect guide to laptop power computing since manufacturers' designs vary.

1.1.2 LICENSES

Besides having an appropriate IESC license, the user must have an appropriate GTAP Data Base Version 11 license and access to the GTAP data.

Due to the size of the IESC database[2], users of the IESC Model and data will also need a valid GEMPACK license which releases the size limitations imposed by GEMPACK to allow for the running of medium or large-scale models. At the writing of this manual, this can be achieved by purchasing an "Introductory" GEMPACK licenses (http://www.copsmodels.com/gpprice.htm). Those users who wish to change the model code will require an additional license—please contact GEMPACK for details.

GAMS users and users not employing the IESC Model

Users not interested in employing the IESC Model do not require any special GEMPACK license (e.g., GAMS users) to run the IESC Data Program. These users may choose to export the files from their native .har format to an alternative format, such as GAMS or comma separated files.

[2] The usual GEMPACK limit of 10 by 10 is likely to be reduced with the supply chain database.

1.1.3 ASSOCIATED PROGRAMS (BATCH FILES AND GTAPAGG)

IESC Data Programs

Users of the ImpactECON Supply Chain Data Programs are expected to be familiar with the basics of:

- GTAPAgg;
- running DOS batch files and associated programs;
- viewing and converting data in GEMPACK .har file formats.

IESC Model

In addition to the skills required to run the IESC Data Programs, user of the IESC Model should also be familiar with:

- the RunGTAP application;
- running the standard GTAP model and interpretation of results; and
- IESC model documentation (Walmsley and Minor, 2016).

2 IESC Data Programs

2.1 Overview data programs

The IESC data programs convert the GTAP Data Base by splitting import trade flows at the border of a country between the three agents in the standard GTAP model (Hertel and Tsigas, 1997): consumers, firms and investment. In contrast, the GTAP Data Base aggregates imports from all sources by sector before they are divided between agents, removing the strong link between agent and the source country. Details of the resulting IESC Database are documented in Walmsley and Minor (2019). A result of splitting the aggregated imports in the GTAP Data Base is the creation of several new headers in the IESC Database file. These include:

Table 2-1: New headers and coefficients in basedata.har after running IESC Data Package

Government	Households	Firms
IGAS → VIGAS	IPAS → VIPAS	IFAS → VIFAS
IGMS → VIGMS	IPMS → VIPMS	IFMS → VIFMS
IGWS → VIGWS	IPWS → VIPWS	IFWS → VIFWS

Source: IESC Data Package.

To processes the base GTAP data you will need:

— Access and an appropriate license for the GTAP Data Base;

— Access and an appropriate license for the corresponding IESC Data Package.

Detailed steps for converting the GTAP Data Base to an IESC Database follow below. In general, there are five steps (1-5 below) to creating the IESC database, and one step to create a new aggregation.[3] Steps 1 through 5 need only be done once; step 6 will need to be done each time you require a new aggregation.

1. Extract a full unencrypted copy of the GTAP Data Base using GTAPAgg2 (the distribution copy of the GTAP Data Base may be encrypted by default, which means it is not generally accessible to programs outside GTAPAgg2 unless it is extracted using a 1-1 correspondence in sectors, regions and endowments)

2. Unzip data construction programs and files from the ImpactECON Supply Chain zip file;

[3] These steps assume you have a GTAP 11 Data Base corresponding to the IESC Supply Chain Release with GTAPAgg2 loaded on your computer; if you do not, refer to the installation directions for those programs.

3. Move the unencrypted files from Step 1 into the "in" directory of the directory containing the IESC data construction programs;

4. Run the IESC data construction programs (DOS prompt)[4];

5. Copy the output from the IESC data program into the GTAPAg2 directory.

6. Next open the GTAPAgg2 program, select the IESC data and create an aggregation.

The following sections explain each of the five steps in detail.

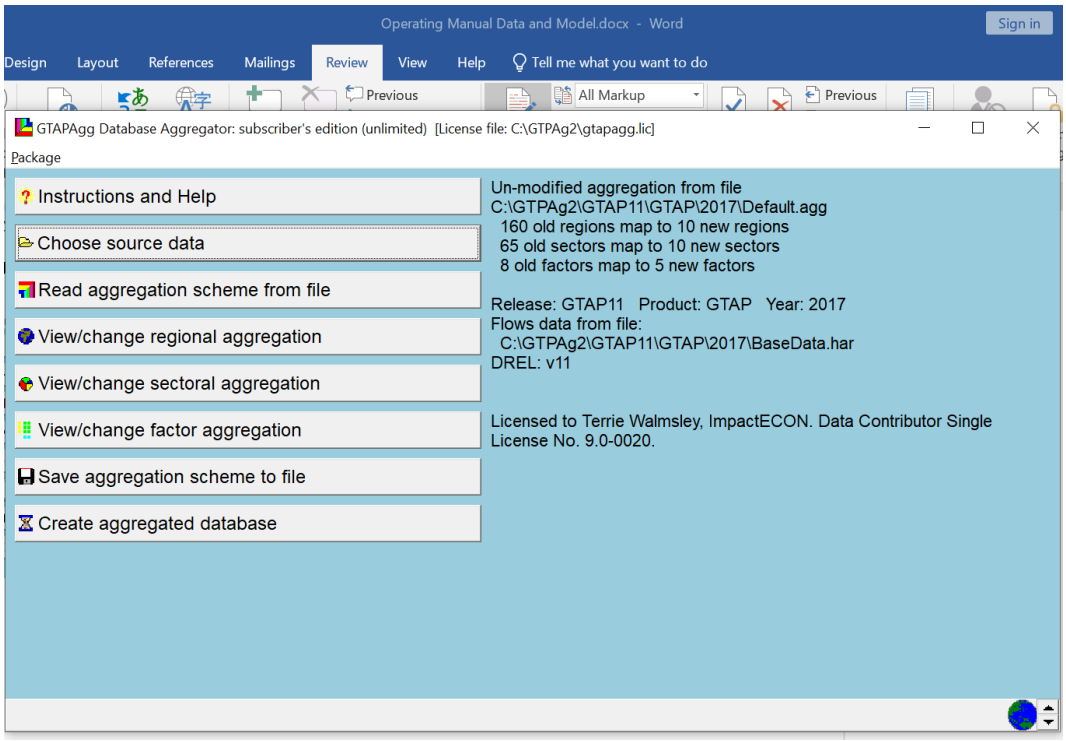
2.2 Create and unencrypted copy of the GTAP Data Base

2.2.1 OPEN GTAPAGG2 AND CHECK THAT THE SOURCE DATA FOLDER IS ASSIGNED TO THE GTAP DATA BASE

In Figure 2-1 "C:\GTAPAg2\GTAP11\GTAP\2017\BaseData.har" is the source of the database. The release is v11 Year 2017. If your database does not contain the same information after the DREL: indicator, you are not using the correct source database. In the case your data release does not match that here, you should click on the second button "Choose source data" and locate the correct version of the GTAP v11 2017 Data Base.

[4] The programs can be run from Microsoft PowerShell command line by adding the required directory prefix and then "run" (e.g., ".\run").

Figure 2-1 GTAPAgg2 screen to create unencrypted database (160 x 65)



2.2.2 ASSIGN A 1-1 CORRESPONDENCE FOR REGIONS, SECTORS AND ENDOWMENTS

If your aggregation scheme suggests anything other than a 1-1 correspondence between regions, sectors and endowments, click on the relevant button ("view/change..") and then click the 1-1 button and then "OK". Your screen should indicate as in Figure 2-1:

- 160 region map to 160 new region;
- 65 sectors map to 65 new sectors;
- 8 old factors map to 8 new factors. There is no 1-1 button, so you may need to adjust this mapping manually, being sure to indicate if your new endowment categories are mobile or sluggish.

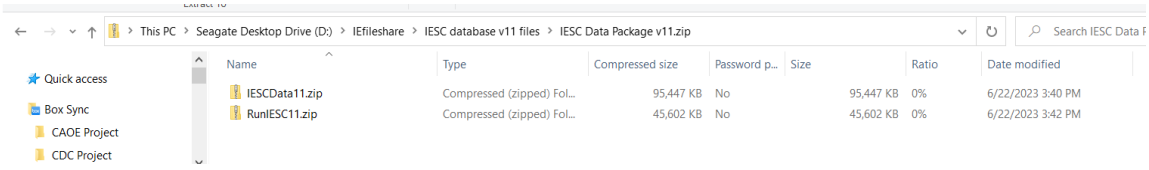
Save the aggregation scheme (if you do not save it, GTAPAgg2 will prompt you to).

Click "Create aggregated database." In this case, the database you will be saving is not aggregated, but this is not a distinction GTAPAgg2 cares to make. You will be prompted to save the ZIP archive; do so and write down or remember where you saved it. You will need it below.

2.3 Extract the ImpactECON Supply Chain Data construction programs to your computer

When you purchased the IESC Supply Chain Package, you were provided a ZIP file containing two zip files each containing a directory: iescdata11 and runIESC11(see Figure 2-2). Extract the IESCDATA directory from the IESCData11.zip file to a suitable location on your computer.

Figure 2-2: IESC Package—data and model programs



2.4 Prepare IESC database for first time use

2.4.1 COPY THE UNENCRYPTED VERSION OF THE GTAP DATA BASE INTO THE IESC DATA CONSTRUCTION PROGRAM "IN" DIRECTORY

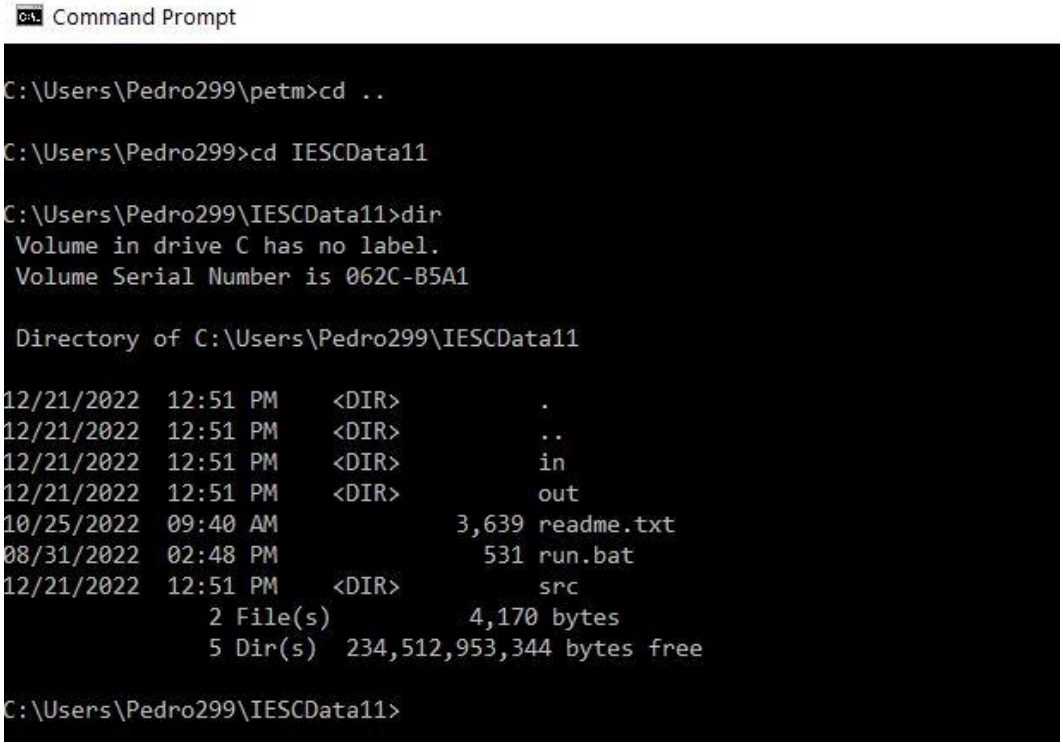
Open the ZIP file you created in Step 2.2 and extract all the data files into the "iescdata11\in" on your computer.

2.4.2 RUN IESC CONVERSION PROGRAM (RUN.BAT)

Exit from the ZIP file extraction program and switch to Windows Explorer. In Windows Explorer, navigate to the directory containing the IESCData11 programs. Open a command window in the IESCDdata11 directory. You can do this by typing command prompt in your windows search. The command window should open and will look something like Figure 2-3. You will then need to change directories to move to the directory containing the IESC package.[5] If you type **dir** you will get the list of directories and files included.

[5] The command **cd..** will take you back a directory and **cd subdir** will move you into a subdirectory named subdir. See the example provided in Figure 2-3.

Figure 2-3: Run the data construction program



Run the data construction program by typing "run" and enter at the command prompt. The data construction program will start running. If the program fails for some reason, for example, if you failed to copy the GTAP Data Base to the "in" directory, the program will notify you of the failure and the log file to examine, if it did fail. The log file will provide some clues as to why your program failed.

If your program completed successfully, your command window should look like Figure 2-4. You are now ready to create an aggregation utilizing the GTAPAgg2 program as outlined in the next section. Close out of the command prompt by typing exit.

Figure 2-4: Successful run of the data program

```
C:\Users\Pedro299\IESCData11>echo finished OK
finished OK

C:\Users\Pedro299\IESCData11>dir/od out\*.har
 Volume in drive C has no label.
 Volume Serial Number is 062C-B5A1

 Directory of C:\Users\Pedro299\IESCData11\out

12/21/2022  01:00 PM            25,447 sets.har
12/21/2022  01:00 PM        66,414,321 matrix.har
12/21/2022  01:00 PM     1,461,688,078 basedata.har
12/21/2022  01:00 PM        18,678,659 chks.har
               4 File(s)  1,546,806,505 bytes
               0 Dir(s)  234,473,222,144 bytes free

C:\Users\Pedro299\IESCData11>goto endbat

C:\Users\Pedro299\IESCData11>
```

2.5 The IESC Data files

The directory "..\iescdata11\out" contains the IESC database as well as some supplementary files that users may find useful for analysis. The files contained in this directory are:

- IESCv11.zip is the file required for GTAPAgg2. It is the IESC package for GTAPAgg2, similar to the GTAP package for GTAPAgg you received from the GTAP center.

- Sets.har, Basedata.har and Default.prm are similar to their GTAP Data Base equivalents, containing sets, base data (including new supply chain data) and parameters respectively. They are also contained in IESCv11.zip.

- Chks.har provides a summary of the checks made to the database to ensure it is consistent with the final GTAP Data Base. The program calculates various differences between the GTAP and supply chain data. The numbers shown here are usually small (less than 0.5) indicating that the two datasets are consistent. If they are not small, then you may have used inconsistent GTAP and IESC releases. You should contact ImpactECON if you have concerns. Differences are most likely due to not using the correct GTAP database and are likely to lead to homogeneity issues in your modelling.

- Matrix.har provides additional trade and tariff data for those who build scenarios using HS6 trade and tariff data. The IESC database provides tariffs by BEC category and agent, which are based on estimates from MAcMaps of tariffs by BEC category. In order to convert tariffs by BEC category into tariffs paid by agent you need to know

how much of each BEC category is purchased by each agent.[6] Matrix.har provides the information needed to make this link between BEC categories and GTAP agents. It contains the following headers:

- VIWS shows the value of trade at c.i.f prices of commodity i, allocated to BEC category b according to the BEC concordance, which is purchased by agent a, by source and destination.

- DTARis the tariff paid on commodity i, allocated to BEC category b according to the BEC concordance, which is purchased by agent a, by source and destination. These tariffs are consistent with the average tariffs by agent given in the IESC and GTAP databases.

- ATAR is the tariff paid on commodity i, allocated to BEC category b according to the BEC concordance, which is purchased by agent a, by source and destination, obtained from the MAcMaps database. These tariffs differ slightly from those used in the IESC and GTAP databases, and reflect differences between the GTAP and MAcMaps tariff rates. When using HS6 tariff data users are advised to use the altertax facility (Malcom, 1998) to alter the tariffs in the IESC database to the MAcMaps tariff rates. Experiment files are provided in the RunGTAP IESC application to undertake this altertax simulation.

2.6 Making an aggregation

You are now ready to make your first aggregation employing the IESC Database you just constructed. In general, the procedure is similar to aggregating standard GTAP Data Bases, but you must first install the IESC into a new folder under the corresponding GTAP Data Base version in GTAPAgg2.

First locate the two key data folders:

- GTAPag2 directory;
- IESCData11\out\iescv11.zip" located in the out subfolder of the IESCData11 directory.

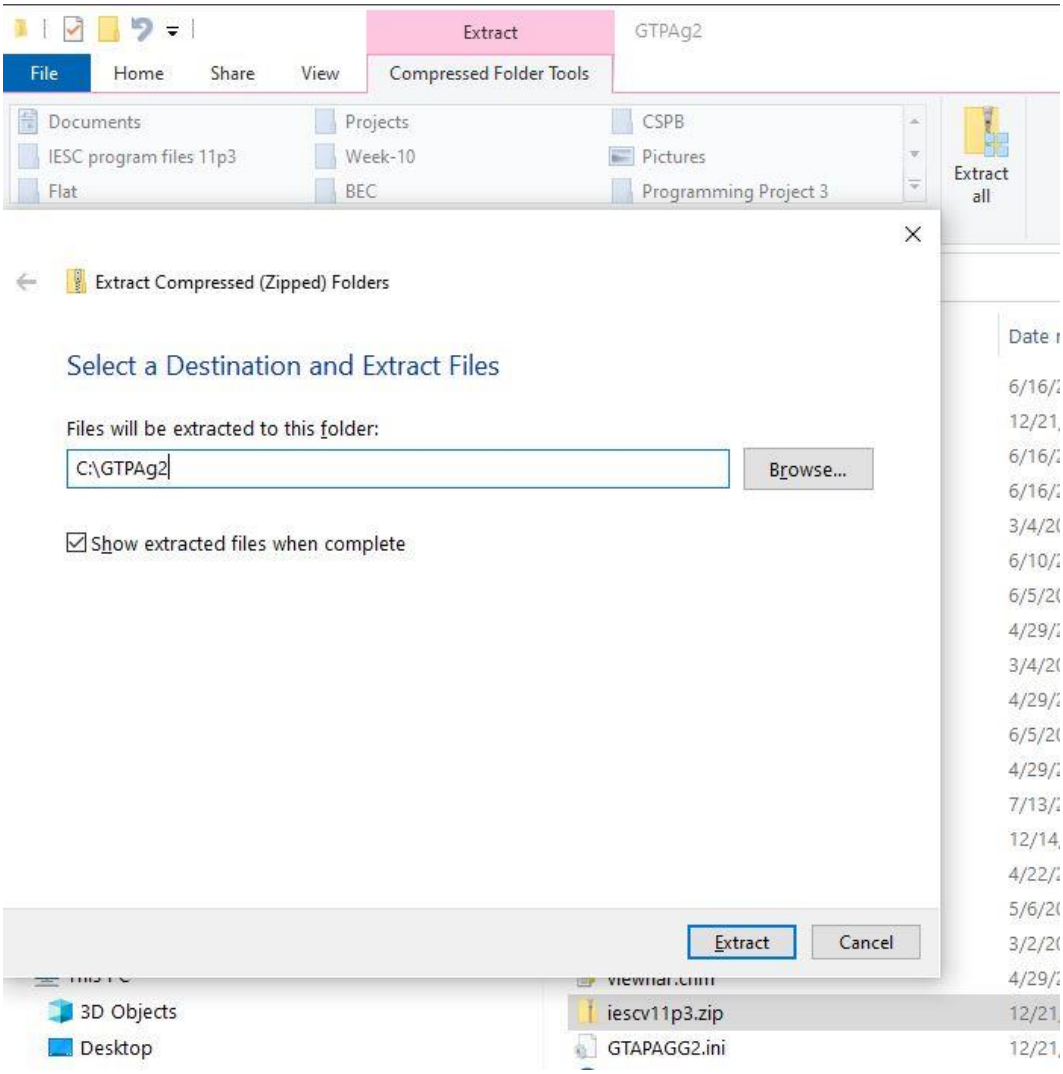
Open the zip file using "extract" from within windows explorer. The zip extraction program will open and ask where you would like to unzip the files to. Change the directory in the dialogue box to the GTAPAg2 directory (Figure 2-5)[7]. The location of your GTAPAg2 directory may differ, depending on your installation of that application.

---

[6] This is a fundamental difference between the IESC database and other produced MRIO datasets, where agents and BEC are assumed equivalent.

[7] The extraction program will look for the "GTAP11" directory and install the files there, under a new IESC directory.

Figure 2-5: IESC Extracting Zip file into GTAPAgg2

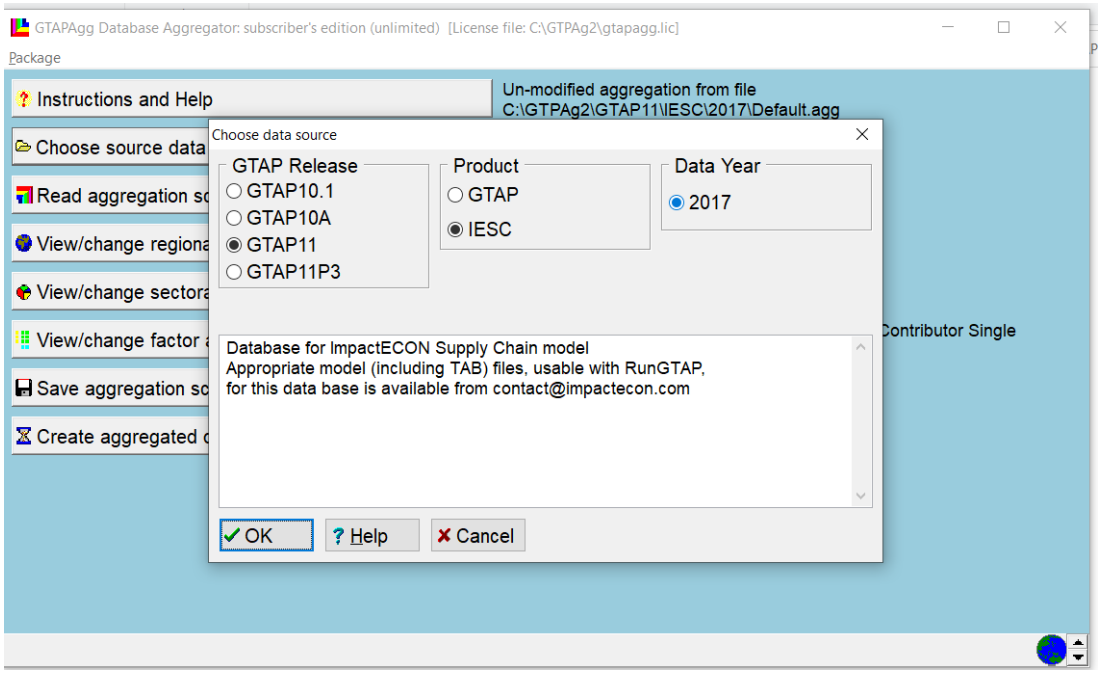


After extracting the IESC files into the GTAPAg2 directory, you will be able to select the IESC data as "Source Data" within GTAPAgg2 (Figure 2-6) by selecting the correct GTAP Release (v11 in this case). The IESC will present itself as an alternative product to the standard GTAP database.

You may now proceed to make an aggregation as you would normally do. You can use the same aggregation files (default.agg etc) constructed for the aggregation of the standard GTAP Data Base. A default.agg is provided in the directory.

IF USING THE IESC MODEL, PROCEED TO THE NEXT STEP. IF YOU ARE NOT USING THE ISEC MODEL, FOR EXAMPLE, YOU ARE USING A GAMS MODEL, EXPORT YOUR DATA AS YOU WOULD NORMALLY DO. YOU DO NOT NEED TO GO FURTHER IN THIS MANUAL.

Figure 2-6 Verify IESC is Loaded into GTAPAgg2 and Select for Aggregation



3 IE Supply Chain Model

3.1 Overview of IESC Model

The IESC Database includes several new headers detailing the flow trade between exporters and importing agents (see Table 2-1). To account for these additional flows, the ImpactECON import demand equations must account for these new trade flows. Additionally, analysis tools, such as the welfare decomposition and tax files are not conventionally setup to account for the new data and supporting analysis. The ImpactECON Supply Chain Model includes these new equations in the model and adapts standard data files and analytical tools, such as the tax data and welfare decomposition to account for these new developments in the model and data

The IESC Model is produced in the form of a RunGTAP application in the GEMPACK programming language. After installing the IESC Model and Data into the RunGTAP system, user can expect a familiar environment, similar to other GEMPACK based models. The new linkages between importing agents and exporting countries does increase the size of any solution set for a given aggregation. Solution times will likely increase significantly, particularly if certain sectors, such as dwellings (DWE), raw milk (RMK), and paddy rice (PDR), which included minimal trade flows in the original GTAP Data Base, are disaggregated. In general, with these considerations in hand, most users will be provided with a wealth of new data and analysis in the IESC Model.

To employ the IESC Model, the user will have to follow several steps to create a new RunGTAP "version." It's important that these steps are followed for each new version a user wishes to create. The standard "new" version feature of RunGTAP does not support many of the auxiliary programs required for the IESC Model. Still, the additional steps required to install the IESC model are relatively simple and are as follows:

1. Unzip the RunIESC11 directory in the IESC Package zip file into a new folder (note that the new folder should not contain more than 8 characters) in your RunGTAP directory;

2. Copy data files created in the previous step with the IESC Data programs into the new folder you created in the RunGTAP directory;

3. Run the IESC Model batch program SCAux.bat to create required data files;

4. Open RunGTAP and switch to the new version.

The following sections provide details on carrying out these steps. For more information on the model structure and use, please see the IESC Model Documentation (Walmsley and Minor 2016).

3.2 UnZip IESC RunGTAP application file

Using windows explorer navigate to your RunGTAP folder, usually c:\RunGTAP. Create a sub-directory for your RunGTAP applications. You should name the directory something related to the purpose of your project to differentiate it from any other versions of the IESC you may create in the future (note, RunGTAP recognizes version names of eight characters or less). We will name the directory "IESC" (i.e., c:/RunGTAP/IESC).

Open the IESC Package as seen in Figure 2-2: IESC Package—data and model programs. Extract the contents of the folder "RunIESCv11" into your runGTAP application folder "IESC".

Next copy the aggregated IESC data files created with the IESC Data Package. The previous chapter, chapter 2, provided instructions to create the IESC Database and an aggregation. If you have not already done so, create an aggregation per chapter 2. GTAPAgg will provide a zip file containing the aggregation. Unzip the contents of the zipped data to the same directory (in our case c:/RunGTAP/IESC. You should now have the IESC Model and Data aggregation in the same directory.

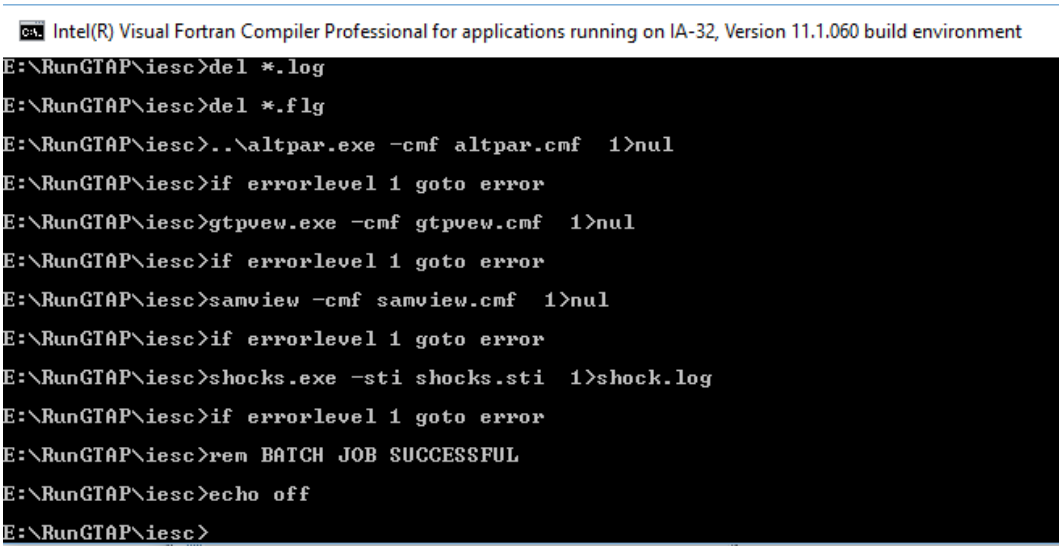
3.3 Run SCAux.bat

With the data files and the model files installed, open a DOS command prompt in the directory you have copied the IESC Model files too. Again, this can be done by opening Windows Explorer and selecting the directory while holding the shift key while depressing the right mouse button and selecting the directory. A menu will appear—select "Open command window here." At the command prompt, type:

SCaux.bat

The program will run and if it completes successfully, it will look like Figure 3-1.

Figure 3-1: Successful run of SCAux.bat



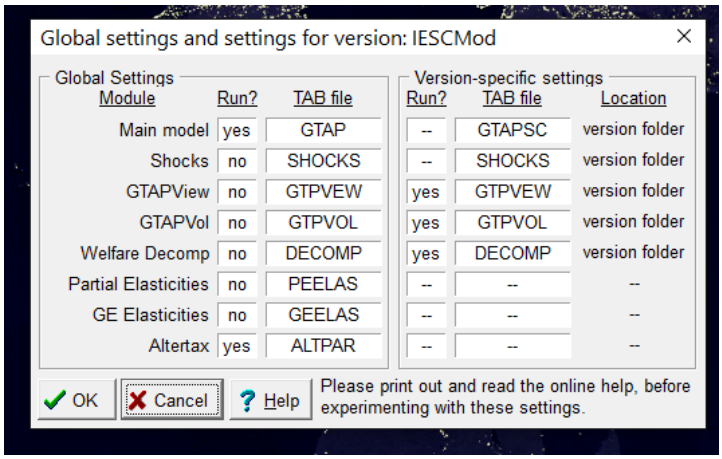
If the program fails for some reason, for example, if you failed to copy the IESC Database to the directory, the program will notify you of the failure and the log file to examine, if it did fail. The log file will provide some clues as to why your program failed. If the program ran successfully, then you may exit the command window by typing exit and return or simply closing the window.

3.4 Open IESC Model in RunGTAP

Open RunGTAP. From the main menu. Select "Version→Change." You will see a list of model versions loaded on your computer under the RunGTAP directory. Select the version which is consistent with the directory name (in our case "IESC") you chose in step 3.2. RunGTAP will change to that version.

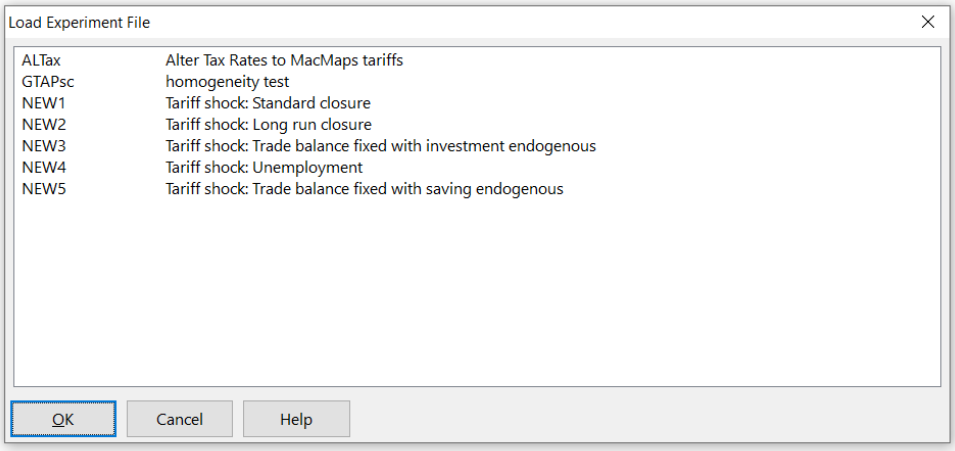
As a first step, we recommend checking the version modules. Select Version | modules from the main menu in RunGTAP. The version settings should look like Figure 3-2. This shows which of the auxiliary files are being taken from the IESC version.

Figure 3-2: Version | Module settings



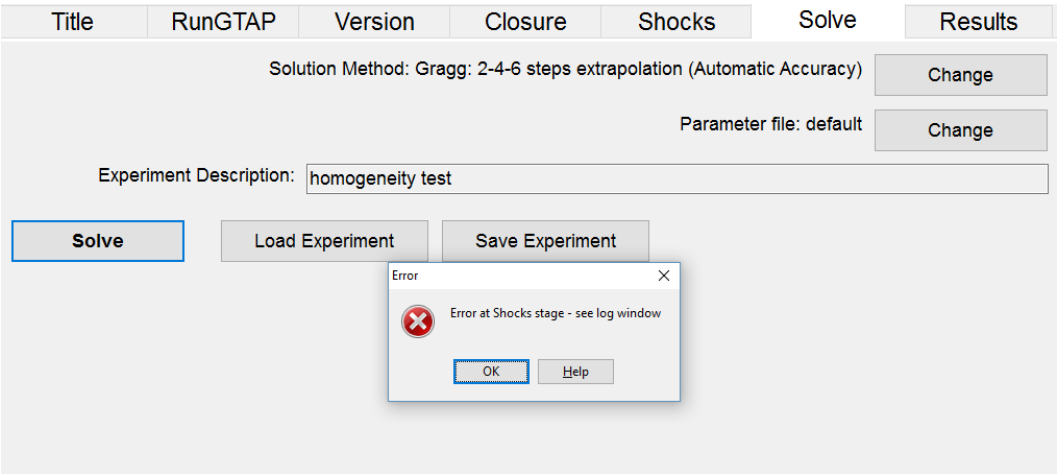
As a next step, we recommend running a homogeneity test. Select the "Solve" tab in RunGTAP, then select the "Load Experiment" button. You will see a dialogue box appear with several sample simulations (Figure 3-3). Select the "GTAPsc—homogeneity test" experiment. Click "OK". Then select the "Solve" button.

Figure 3-3: Sample simulations in IESC Model



The first time you run a simulation, an error box may appear (Figure 3-4). Click on the "OK" button and rerun the homogeneity experiment as in the previous paragraph.

Figure 3-4: First time run error in RunGTAP



If all the files were installed properly, the error will not appear again and is a onetime occurrence after the first solution is requested. After the simulation has run, check the variable walraslack under the Macro header and be sure that it is zero or very small.

3.5 Running the Model and Analysis

After checking the homogeneity of the model, you may proceed to incorporate your own shocks and carry out analysis. It may be helpful to open some of the sample experiments (see "Solve" page: load experiments) and review the code adapted for the IESC Model to create tariff shocks, since they will be different than the standard GTAP model in some cases. In particular, note that the agent specific tariff shocks are now in three different coefficients—tt_pms, tt_gms and tt_fms. Also note that tt_fms takes on four dimensions, so you will not be able to employ RunGTAP's shock constructor tool, since that tool is limited to three dimensional matrices.

The new IESC application shocks facility creates three new files – ttfms.shk, ttgms.shk and ttpms.shk – that can be used for implementing shocks to tt_fms, tt_gms and tt_pms respectively. For example:

Shock tt_fms(TRAD_COMM,PROD_COMM,REG,REG) = rate% -100 from file ttfms.shk;

Several alternative closures are also provided in the experiment files for those interested in fixing employment or the trade balance. Note that the other features, such as the GTAPView output, tax rates, welfare decomposition and altertax, are also available through RunGTAP, although they use the special tab files constructed for the IESC version and listed in the module settings in Figure 3-2.

Finally, there is also an ALTax experiment that provides the experiment file for altering the tariffs to match the MAcMaps tariffs. The shocks refer to a HAR file called macmaps.har,

produced during the IESC construction process, containing the shocks required to alter the tariffs for all agents for your particular aggregation.

For further information on the IESC model, please refer to the Model documentation (Walmsley and Minor 2016b).

Bibliography

Harrison, W. H., and K.R. Pearson (1996). "Computing Solutions for Large General Equilibrium Models Using GEMPACK", *Computational Economics*, Vol. 9, pp.83-127.

Hertel, T. and M. Tsigas (1997). Structure of GTAP. Global Trade Analysis Modeling and Applications. T. Hertel, Cambridge University Press**:** 13-73

Horridge J.M., Jerie M., Mustakinov D. & Schiffmann F. (2018), GEMPACK manual, GEMPACK Software, ISBN 978-1-921654-34-3

Malcom, G., 1998, "Adjusting Tax Rates in the GTAP Data Base"**,** GTAP Technical Paper No. 12, Center for Global Trade Analysis, West Lafayette, IN, USA

Narayanan, G., B., A. Aguiar and R. McDougall, (Eds) 2014), *Global Trade, Assistance, and Production: The GTAP 8 Data Base*, Center for Global Trade Analysis, Purdue University

Walmsley T. L., and P. Minor, (2019). "ImpactECON Supply Chain Database: Documentation of data sources and the construction process of IE-SC_v2.0", ImpactECON Supply Chain Package, ImpactECON data and model documentation No. 2, ImpactECON: Boulder, CO, USA

Walmsley T. L., and P. Minor, (2016). "ImpactECON Supply Chain Model: Documentation of model changes", ImpactECON Working Paper No. 6, ImpactECON: Boulder, CO, USA