Technical Note: How to use the GDyn-FS model to simulate the national and sectoral effects of a decline in the desirability of investing in Australia

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Contents

1 Introduction

The purpose of this note is to provide a step-by-step approach to the use of the GDyn-FS model to simulate the 'National and sectoral effects of a decline in the desirability of investing in Australia' (Gretton 2021) using the RunDynam component of GEMPACK software. Ingredients required to complete the simulations are provided in the accompanying zip files. The ingredients include: the database and parameter files; the TABLO code file and the Stored Input file; the model executable file gdynfs.exe created using the TABmate component of GEMPACK; a mapping file to translate simulation results to EXCEL csv files; model closure files; baseline data files and a policy shock file. The modelling files are complemented by an EXCEL spreadsheet file that shows the tables and figures included in the article, supplementary comparative data and the GTAP database aggregation adopted.

[1] The author is grateful for feedback from Michael Jerie and David Vanzetti for helpful comments on draft material. All errors and omissions remain the responsibility of the author. Comments/suggestions welcome.

The ingredients for modelling in Gretton 2021 are provided in: **AER_Scenario1_gdynfs-BASB-BRRR-PRDP.zip**. The baseline for this modelling uses projections of GDP, population, skilled and unskilled labour to 2050 (Foure et al. 2010, Chappius and Walmsley 2011). In addition, two sensitivity tests were conducted. The first a comparative dynamic simulation with only time shocked and the second with a baseline incorporating historical data to 2018, medium-run projections by the ILO and IMF from 2019 to 2022 and SSP2 based projections from 2022 to 2100. The ingredients for these simulations are provided in: **AER_Scenario2_gdynfs-BASB-BRRR-PRDP.zip** and **AER_Scenario3_gdynfs-BASB-BRRR-PRDP.zip**, respectively. While the configurations of each of the baseline scenarios modelled differ, the projected impacts of the policy scenario, the focus of the analysis, broadly align.

The focus of this note is on the central scenario, that is, scenario 1. Once implemented, scenarios 2 and 3 can be modelled using similar procedures. Each scenario was simulated for 100 years to provide a test of model stability over the long run. The focus of reporting is on results over a thirty-year period with 2020 as the year of the policy shock.

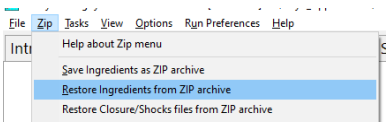
Database and software requirements

- GTAP database release 9 (or above) – required to access the database and create new study-specific data bases.
- RunDynam, Version 3.8 or above recommended – required to undertake simulations described in this note.
- GEMPACK, Release 12.1 or above recommended – required to recompile the executable files and adapt the model in GEMPACK.

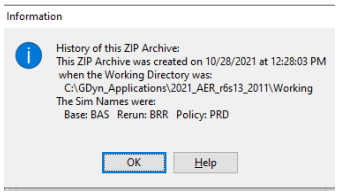
2 Getting started

To set up and run the simulations create a user project directory **GDyn_Applications\2021_TESTGDynFS** and save the zip file **AER_Scenario1_gdynfs-BASB-BRRR-PRDP.zip** containing ingredients of the central scenario to this project directory. The user project directory path referred to in this note is:

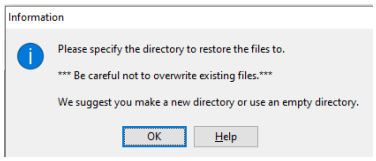
Open **RunDynam** and go to the command **Restore ingredients from zip file**:



View dialogue box:

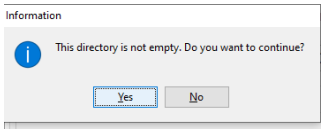


and click **OK.** View the dialogue box:

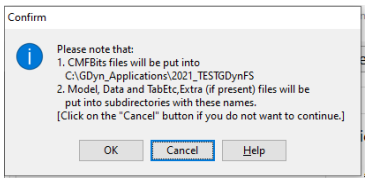


click **OK** and select folder:

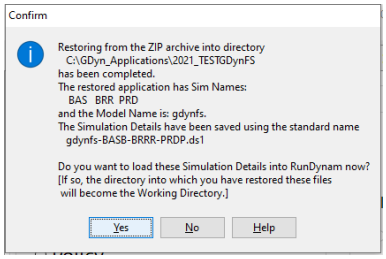
Noting that folder contains the zip file and it not empty, click **Yes** in:



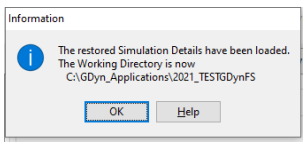
Then note unzipping protocols, confirm by clicking **OK** in:



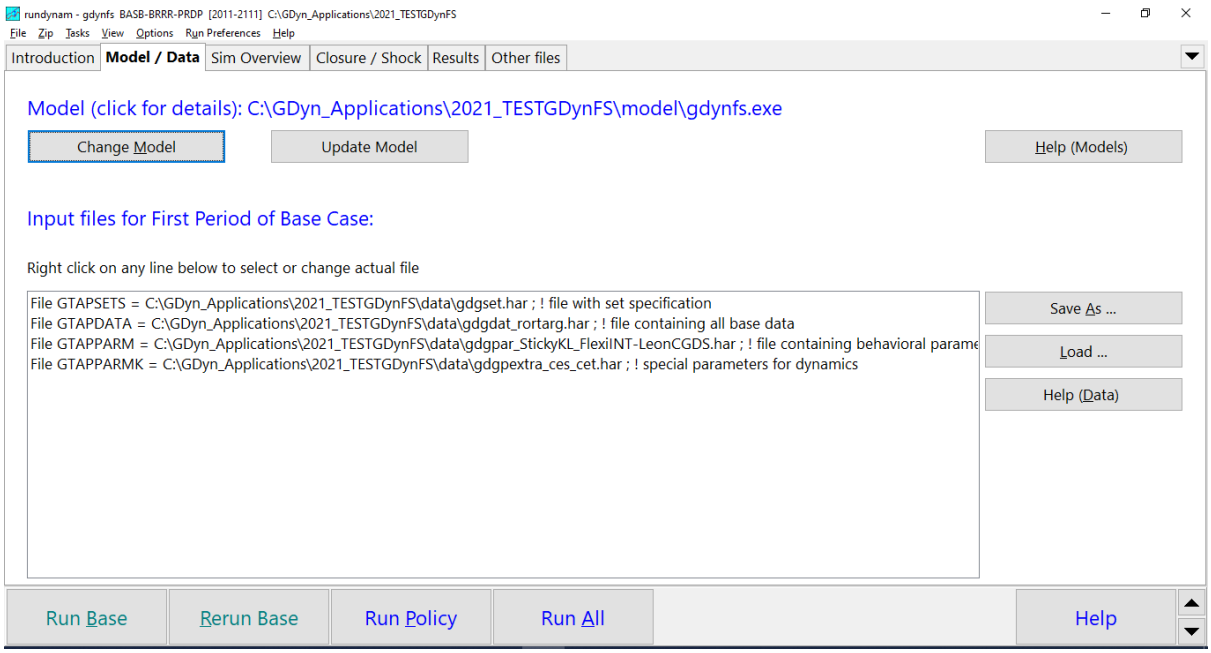
Then click **Yes** to the question ‘Do you want to load simulation details into RunDynam?

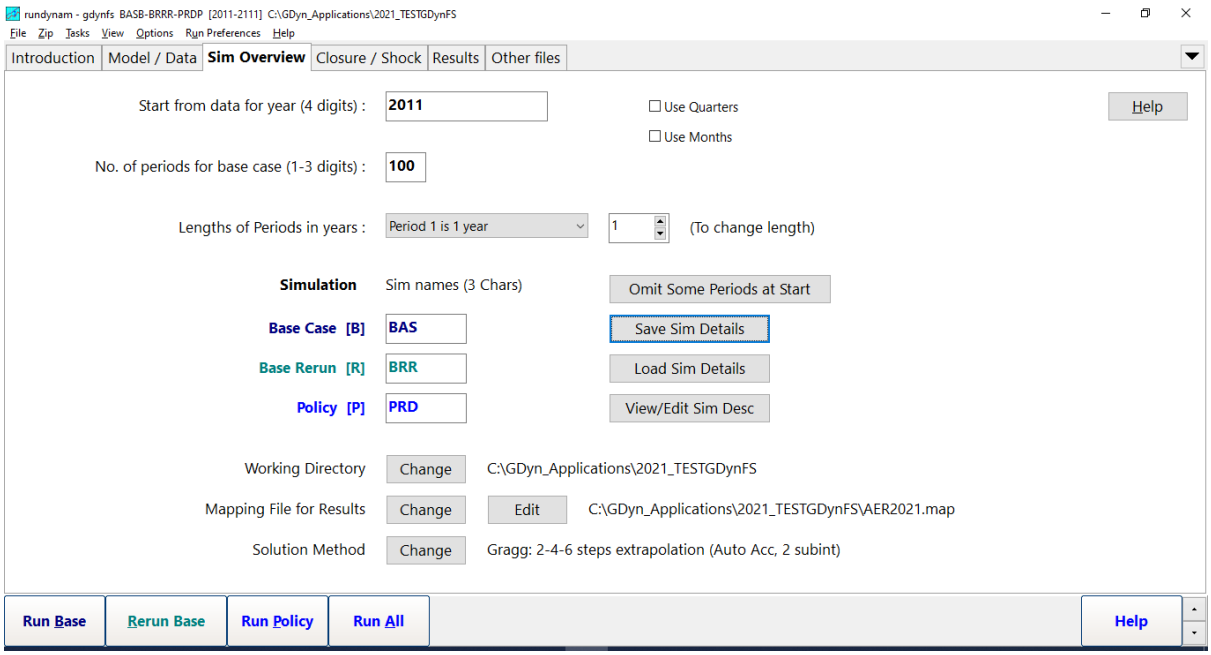


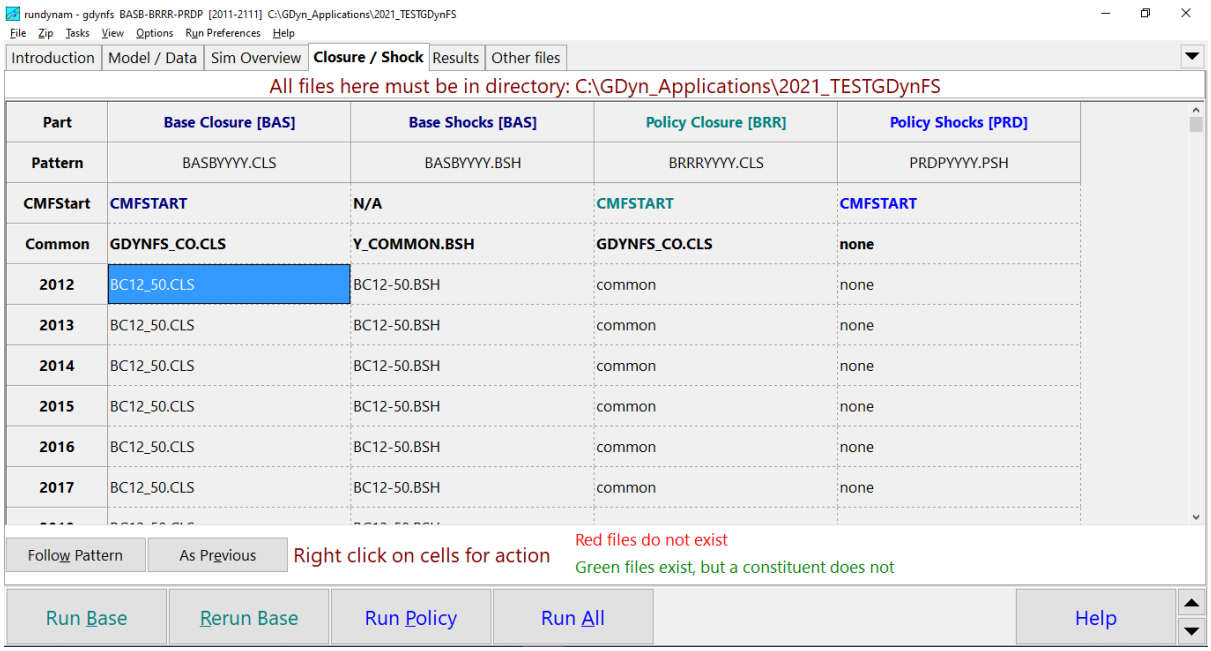
Click **OK** in the dialogue box to recognise that the simulation details are loaded and project directory is in the active working directory.



Finally, check the **Model/Data**, **Sim Overview**, and **Closure/Shock** screens of **RunDynam** for completeness. The pages should appear as follows:







The files in the **Base Closure** and **Base Shocks** columns should extend to the simulation year 2050 (that is, the last year in the simulation period 2012 to 2050 for which projections are included). Thereafter, the closure and shocks are 'common' indicating only **Time** is shocked. The policy shock file should appear in year 2020 in the **Policy Shocks** column.

If this is the case, the model is ready for simulation. If it is not the case, it will be necessary to retrace the above procedures to complete a working model.

Save simulation details

The simulation is given default label **gdynfs-BASB-BRRR-PRDP.ds1** which can be viewed by selecting **Load Sim Details** on the **RunDynam_Sim Overview** page. It is recommended that simulation details be re-saved with a simulation-specific label. To do this go to the **Sim Overview** page, select **Save Sim Details**, edit the generic label to **AER_Scenario1_gdynfs-BASB-BRRR-PRDP.ds1** and **Save.** Confirm the process by going to **Load Sim Details**, selecting the file just saved and checking all ingredients.

Completing this step is particularly advisable if you are intending to go on to undertake the sensitivity tests outlined below or develop a new scenario(s) using the model.

3 Run simulation

Select **Run All** to **Run Base**, **Rerun Base** and **Run Policy** simulations (or select one at a time). Note the simulations are set to run for 100 years (see **Sim Overview)**. This comprises the period to 2050 covered by the forward projections and the period 2051 to 2111 over which the model runs in comparative dynamic mode with only **Time** shocked to confirm model stability. As an indication of required run time, the full simulation using a DELL Latitude E7450 Core i5-5200U processor with 4GB-1600MHz internal memory takes about 25 minutes with the

solution method set at Gragg 2-4-6 steps. With auto accuracy specified (the default) the simulation takes over 30 minutes. (Note: because of differences between solution algorithms, results may differ fractionally between algorithms, and between these and other algorithms).

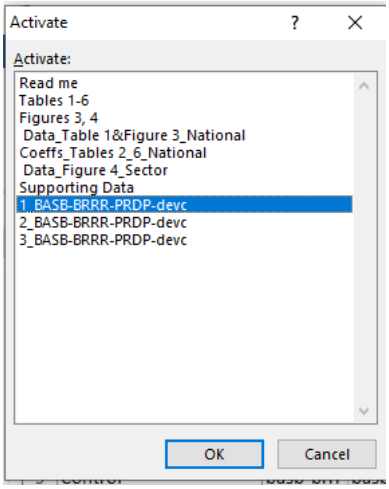
To retain results from a simulation for later reference, you need to save in the 'extras' subdirectory the simulation-specific file:

- **BASB-BRRR-PRDP-devc.csv** with a simulation-specific name such as **Scenario1_BASB-BRRR-PRDP-devc.xlsx** (plus other spreadsheet files of interest); and
- **GDYNVIEW** outputs for the **Base Rerun** and **Policy** simulations with simulation-specific names such as **S1_ GDY-BASB_PRRR-2020-2111.har** and **S1_GDY-BASB-PRRR-PRDP-2020-2111.har**, respectively.

Tables and figures in spreadsheet format

Data for each table and figure presented in Gretton (2021) is included in the EXCEL workbook **AER2021_T1to6_Figs3&4_EffectsOfADeclineInDesirabilityOfInvesting.xlsx**.

This workbook is located in the subdirectory **…\extras**. Data in each table and figure is linked to the output of the policy simulation. The workbook contains one contents page (**Read me**), two sheets showing output tables and figures (**Tables 1-6 and Figure 3,4**), three sheets supporting the transfer of data from model results to publications tables (**Data_Table 1&Figure 3_National**, **Coeffs_Tables 2_6_National**, **Data_Figure 4_Sector**), one sheet with results pertaining to text comments (**Supporting Data**), and three sheets containing detailed model results (**1_BASB-BRRR-PRDP-devc**, **2_BASB-BRRR-PRDP-devc**, **3_BASB-BRRR-PRDP-devc**). The first set of results relates to the central case reported in Gretton (2021) while the second and third relate to the sensitivity tests (see below). To see the list of all spreadsheets in the workbook, right click on the left end of the horizontal scroll bar. This will show:



The projections reported in the workbook files #_**BASB-BRRR-PRDP-devc** refer to the differences in *variables* (**Policy v Rerun**) and are sourced to the respective simulation output file **BASB-BRRR-PRDP-devc.csv** written to the working directory in post simulation

processing. For example, 1_**BASB-BRRR-PRDP-devc** (highlighted), contains the results for the central simulation. The variables included in this output file are specified in the input file **AER2021.map** (see **Sim Overview** page of the **RunDynam** interface). The analysis also refers to differences in *coefficients* between the Policy simulation and the Base rerun. The relevant coefficients are sourced to the **GDYNVIEW** output file and copied to the spreadsheet **Coeffs_Tables 2_6_National**.

4 Additional simulations with alternative baselines

As noted, two simulations were conducted to assess the sensitivity of results to alternative baseline assumptions. The simulations may be completed following the above procedures, but beginning with the relevant zip file, that is, either:

- **AER_Scenario2_gdynfs-BASB-BRRR-PRDP.zip** for the comparative dynamic case; or
- **AER_Scenario3_gdynfs-BASB-BRRR-PRDP.zip** for the composite history transitioning to SSP2 case.

Following the above procedures, these files would be saved to a simulation-specific project directory such as **2021_TESTGDynFS_2** and **2021_TESTGDynFS_3**.[2]

For scenario 2, it is recommended that the sim details be saved as **AER_Scenario2_gdynfs-BASB-BRRR-PRDP.ds1** via the dialogue box **Save Sim Details** on the **Sim Overview** page. The simulation can then be run via the **RunDynam** command **Run All**.

As for the central-case scenario, save to the 'extras' (or other nominated) subdirectory the simulation-specific:

- file **BASB-BRRR-PRDP-devc.csv** with a simulation-specific name such as **Scenario2_BASB-BRRR-PRDP-devc.xlsx** (plus other spreadsheet files of interest); and
- **GDYNVIEW** outputs for the Base Rerun and Policy simulations with simulation-specific names such as **S2_ GDY-BASB_PRRR-2020-2111.har** and **S2_GDY-BASB-PRRR-PRDP-2020-2111.har**.

The procedure may be repeated for scenario 3 by going to the (new) subdirectory **2021_TESTGDynFS_3** and selecting **AER_Scenario3_gdynfs-BASB-BRRR-PRDP.zip**. Again, save the simulation details as **AER_Scenario3_gdynfs-BASB-BRRR-PRDP.ds1** via the dialogue box **Save Sim Details** on the **Sim Overview** page **Save Sim Details**. Because baseline shocks across the historical and forward projection period are year-specific, closure and shocks are entered by year, for example:

[2] As the model, common closures and policy shock do not vary between simulations, an alternative is to load just the closure and shock elements specific to the baseline scenario. This required additional steps and is not covered in this note.

Part	Base Closure [BAS]	Base Shocks [BAS]	Policy Closure [BRR]	Policy Shocks [PRD]
Pattern	BASBYYYY.CLS	BASBYYYY.BSH	BRRRYYYY.CLS	PRDPYYYY.PSH
CMFStart	CMFSTART	N/A	CMFSTART	CMFSTART
Common	GDYNFS_CO.CLS	Y_COMMON.BSH	GDYNFS_CO.CLS	none
2012	BA12_16.CLS	BH12-16.BSH	common	none
2013	BA12_16.CLS	BH12-16.BSH	common	none
2014	BA12_16.CLS	BH12-16.BSH	common	none
2015	BA12_16.CLS	BH12-16.BSH	common	none
2016	BA12_16.CLS	BH12-16.BSH	common	none
2017	BA17_18.CLS	BH17_18.BSH	common	none

In this case, the baseline closure and shocks extend to 2100, the time horizon of the SSP2 projections. From 2100 to 2011, the final year of the 100 period simulation, only **Time** is shocked.

Run the simulation via the **RunDynam** command **Run All**.

As for the previous scenarios, you may wish to save simulation results to the 'extras' (or other nominated) subdirectory for the simulations-specific:

- file **BASB-BRRR-PRDP-devc.csv** with a simulation-specific name such as **Scenario3_BASB-BRRR-PRDP-devc.xlsx** (plus other spreadsheet files of interest); and
- **GDYNVIEW** outputs for the Base Rerun and Policy simulations with simulation-specific names such as **S3_ GDY-BASB_PRRR-2020-2111.har** and **S3_GDY-BASB-PRRR-PRDP-2020-2111.har**.

6 Project sub-directory structure and file location

The above procedures adopt the default sub-directory structure provided by the **RunDynam ZIP-RESTORE** utility. They do not necessarily reflect the original subdirectory structure or a structure that may be desired by the user. Recognizing that a more nuanced sub-directory structure than the default may be preferred, this section provides one possibility cross-referenced to the default sub-directories.

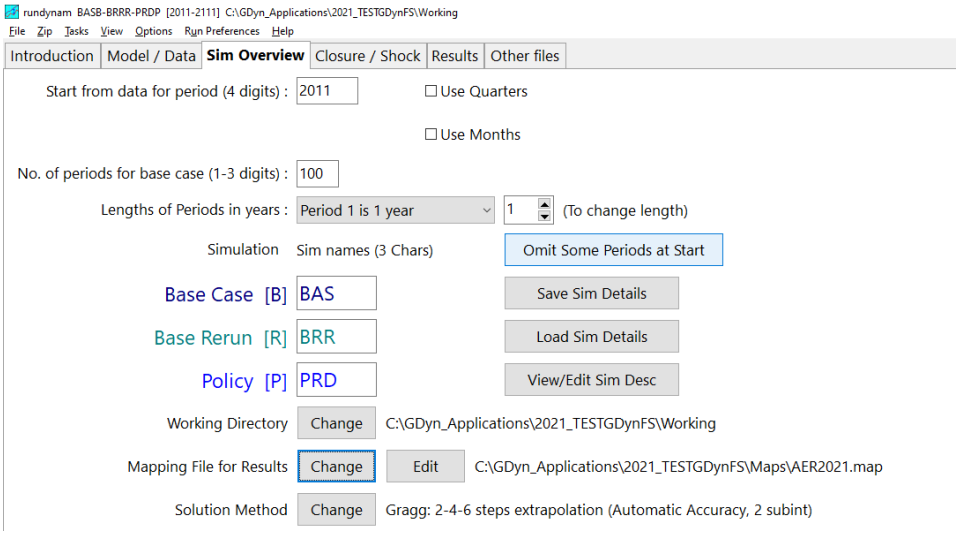
Special attention to the location of the executable, TABLO (***.tab**) and stored input (***.sti**) files is warranted. In the default restore procedure, the executable image and related model files are restored to the \model subdirectory while the **tab** and **sti** files are restored to the …\tabetc subdirectory. To re-create the executable image from the model theory contained in the **tab** file according to the process defined in the **sti** file, it is necessary to re-locate the **tab** and **sti** files (that is, **gdynfs.tab** and **gdynfs.sti**) to the …\model subdirectory.[3]

[3] Note the executable image provided is created in the GEMPACK utility **Tabmate** (**TABLO STI** button, then the **TABLO LTG** button). This approach preserves the nominated name of the *.STI file through the **RunDynam Zip-Restore** process. The alternative is to create the image via the **winGEM** utility which does not preserve the nominated name through the **RunDynam Zip-Restore** process. This alternative assigns a default name commencing with the letter 'wg' and gives rise to additional text being included in the sti file.

Default directory sub-directory structure	*Possible alternative*	*Comment*
…\data	…\Data	No change. Sets, data and parameters files.
…\model	…\Model	Executable image of the model and other information files; plus TABLO and STI files if the exe file is to be recreated.[4].
…\extra	…\Aggregation	Aggregation scheme adopted.
	…\ChartsTables	Final output in publication format.
	…\Results	Repository for results from successive simulations.
…\tabetc	…\Tabetc	TABLO and STI files (see Model subdirectory entry and f/n 2).
…\	…\Map	Map(s) file for results.
…\	…\Working	Simulation details, closure and shocks files; working directory during simulations; simulation output directory.
…\	…\Zip	Zip files created in RunDynam.

If an alternative directory structure is adopted, the **Sim Overview** page of **RunDynam** would need to be adjusted. For example, if the map, and simulation details, closure and shocks files were to the placed in Maps and Working subdirectories, respectively, the **Sim Overview** entries would to be edited to appear as follows:

[4] As noted, to generate a new executable image, it is necessary to place the *.tab and *.sti files in the …\model subdirectory in both the default and an alternative directory structure. Also, see footnote 1.



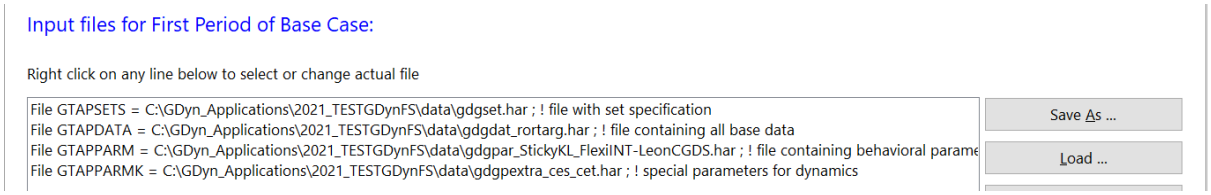
It should be noted that even if you adopt an alternative subdirectory structure, subsequent zipping via the **RunDynamic** utility will return the structure to the default setting shown above.

Appendix GDyn-FS database and parameters

The database used is a six region by thirteen sector aggregation of the GTAP 9-GDyn database for 2011 (release R9.0__2011_May2015). The aggregation scheme is provided in the accompanying file **Agg13x6_GDynAER.agg (**see **…\extras** subdirectory). The aggregation provides a sets file, a year-specific database and two parameter files, one relating to standard GTAP parameters and another for additional parameters required for GDyn-FS.[5] The initial files were re-named as follows.

Initial name	*Study-specific name*	*Comment*
sets.har	gdset.har	-
basedata.har	gdat_rorgtarg.har	Renamed to reflect region-specific target rates of return in place of a generic rate
default.prm	gdgpar_StickyKL_FlexiINT-LeonCGDS.har	Renamed to reflect treatment of labour, capital and intermediates. File extension *.har adopted.
gdgpextra.har	gdgpextra_ces_cet.har	Renamed to reflect inclusion of CES/CET parameters for investor behaviour, and the CES parameters for consumption-saving behaviour.

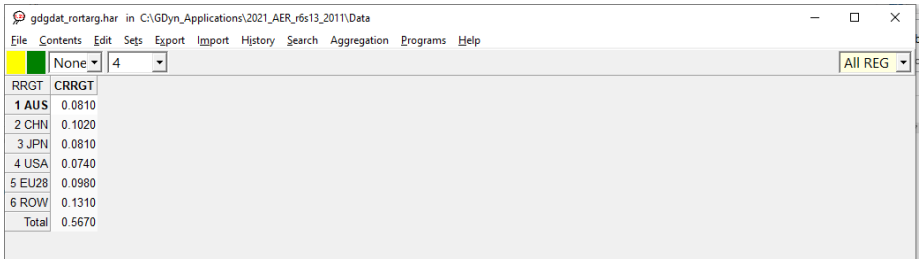
The input files for the first period of a base case appear in the **RunDynam Model/Data** screen as:



[5] As noted, the aggregation has 6 regions and 13 sectors. Greater regional or sectoral detail may be warranted for individual applications. Applications requiring more detailed combinations of regions and sectors may need to take account of disequilibria or idiosyncrasies in the originating data base requiring nuanced baseline assumptions, data revisions or additional theory. For example, in the current study, the historically high saving rate for China in the originating data base was projected to converge to the neighbourhood of rates for other regions. The incidence of negative saving rates (not evident at the aggregation adopted in this study), which are not allowed for in the basic model, may require separate treatment. Data analysis and checks for long-run stability provide a means of identifying disequilibria and idiosyncrasies requiring attention and is recommended. As a rule of thumb, the model should provide meaningful solutions over 100 or more years and exhibit convergence towards longer-run stability.

Database change

Calibrate target rate of return to regional gross rate of return to recognize differences in regional risk and institutions as represented in the starting database.



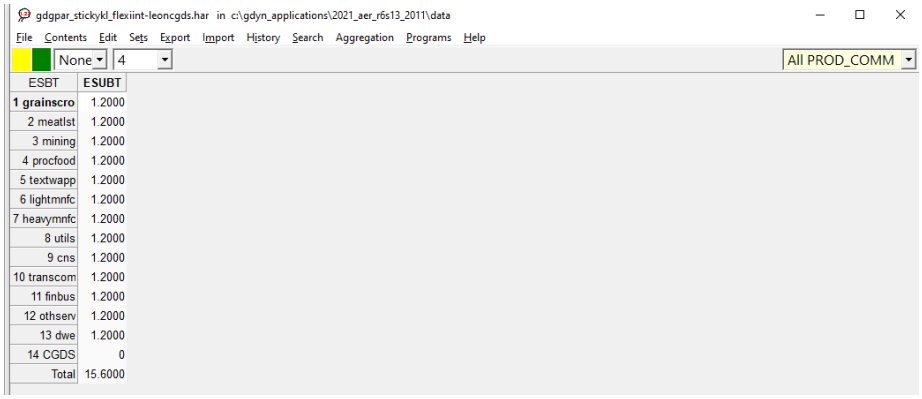
RRGT	CRRGT
1 AUS	0.0810
2 CHN	0.1020
3 JPN	0.0810
4 USA	0.0740
5 EU28	0.0980
6 ROW	0.1310
Total	0.5670

Parameter changes

Parameter file - gdgpar_StickyKL_FlexiINT-LeonCGDS.har

Relax the Leontief assumption on intermediate input use between inputs and between total intermediate inputs and value adding inputs via parameter ESUBT. The more flexible case is represented by a substitution elasticity of 1.2 which replaces the database value of zero (see Gretton 2021, section 2.3). The Leontief assumption is maintained for inputs to capital-goods supply (investment).

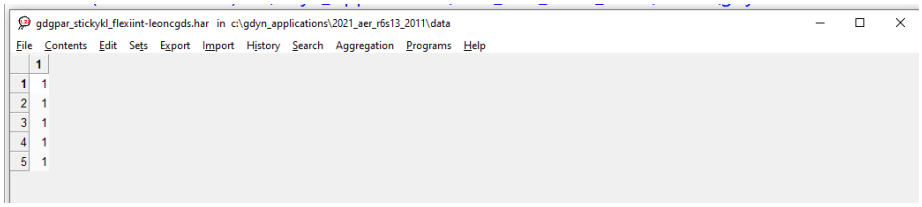
The values for the parameter ESUBT in the revised file appear as:



ESBT	ESUBT
1 grainscro	1.2000
2 meatlst	1.2000
3 mining	1.2000
4 procfood	1.2000
5 textwapp	1.2000
6 lightmnfc	1.2000
7 heavymnfc	1.2000
8 utils	1.2000
9 cns	1.2000
10 transcom	1.2000
11 finbus	1.2000
12 othserv	1.2000
13 dwe	1.2000
14 CGDS	0
Total	15.6000

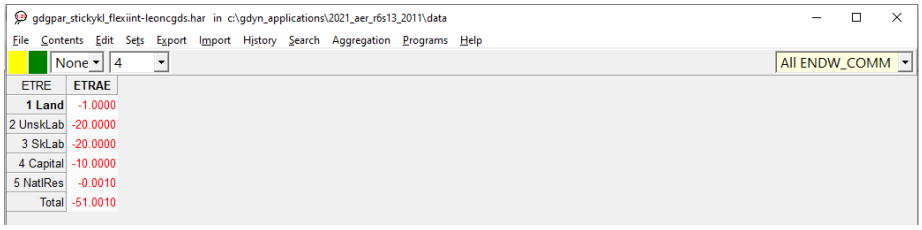
Treat labour and capital as imperfectly mobile between sectors (ie sluggish) in place of the database assumption of perfect mobility (see Gretton 2021, section 2.3). This treatment is effected by setting the parameter SLUG flags for labour and capital inputs (inputs 2,3,4) to 1 from zero in the parameters file of the starting database. Land and natural resources (inputs 1 and 5) are classified as sluggish indicated by a parameter value of 1 in the starting database.

The values for the parameter SLUG in the revised file appear as:



Condition the rate of transformation of labour and capital between sectors via the parameter ETRE with values of 20 for labour and 10 for capital from zero in the starting database (see section 2.3 Gretton 2021).

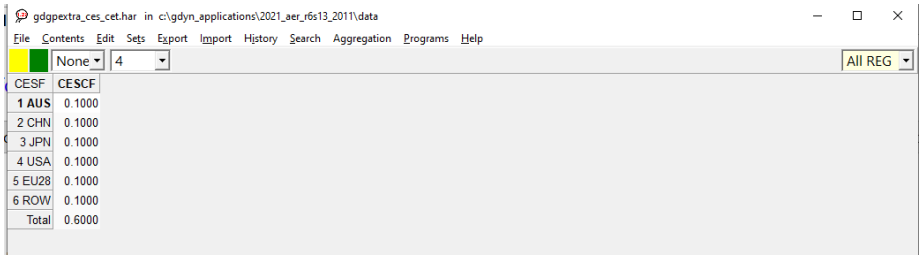
The values for the parameter ETRAE in the revised file appear as:



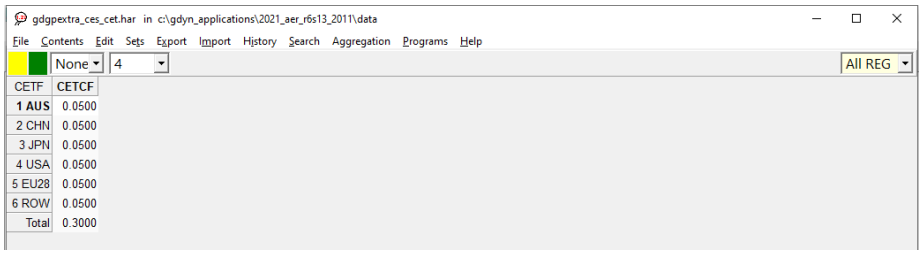
Parameter file - gdgpextra_CES_CET

Introduce CES modelling of firms sourcing of finance via parameter CESCF and CET modelling of regional households' allocation of capital funds via the parameter CETCF (see Gretton 2021, section 2.3 and Appendix section A.3.3). Consistent with the home country bias effect in the literature, the CESCF and CETCF parameters are set relatively close to the Cobb-Douglas case of zero (in the value function) of 0.1 and 0.05, respectively. The relativity between parameters reflects the notion that regional households have a greater bias towards investing at home than regional firms have in sourcing funds locally.

The values for the parameter CESCF in the extended file appear as:

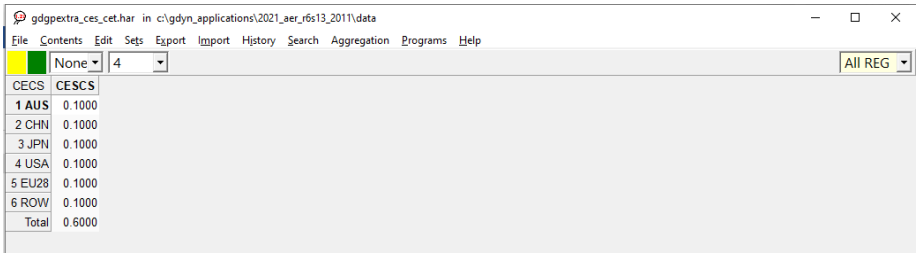


The values for the parameter CETCF in the extended file appear as:



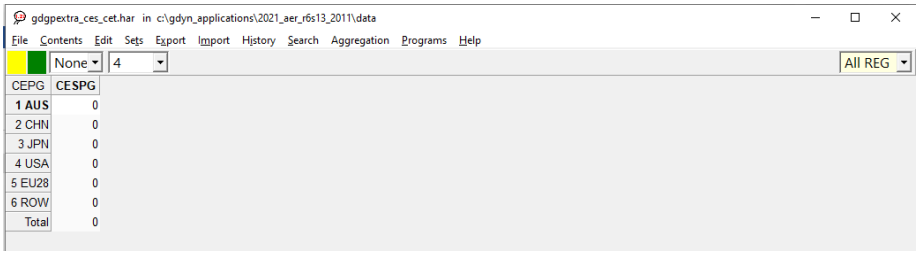
Introduce CES utility function in consumption-saving choices via parameter CESCS and private-government consumption choices via parameter CESPG (see Gretton 2021, section 2.3 and Appendix section A.4.2). In the case of the consumption-saving choice a parameter value (in the indirect utility function) of 0.1 is adopted. In the case of the private-government choice, the Cobb-Douglas constant share assumption of the original model is followed, that is, a parameter value of zero is adopted.

The values for the parameter CESCS in the extended file appear as:



CECS	CESCS
1 AUS	0.1000
2 CHN	0.1000
3 JPN	0.1000
4 USA	0.1000
5 EU28	0.1000
6 ROW	0.1000
Total	0.6000

The values for the parameter CESPG in the extended file appear as:



CEPG	CESPG
1 AUS	0
2 CHN	0
3 JPN	0
4 USA	0
5 EU28	0
6 ROW	0
Total	0