Guide for the OCPPC Interregional CGE Model for Morocco Using Customized RunGEM

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1. Introduction

This document explains how to use the Customized RunGEM program to work with the OCPPC ICGE model for Morocco. It was originally designed for use at two short courses held in Banco de la República, Cartagena, Colombia, in 2003 and 2015, and it has been now adapted for use at the "Course in Applied General Equilibrium Modeling" to be held in Rabat in 2017. It draws on the document "Computing Guide for MINIMAL Using Customized RunGEM", by **Mark Horridge**, March 2001.

GEMPACK is a system of software for implementing and solving computable general equilibrium (CGE) models. The OCPPC ICGE model is an interregional CGE model, implemented using GEMPACK and designed for policy analysis in Morocco. RunGEM is a windows program that makes it easy for you to run any CGE model created with GEMPACK. Customized RunGEM is a special version of RunGEM that has been hard-wired to work only with one or a few particular models (such as OCPPC ICGE). In this document, references to *RunGEM* mean *Customized RunGEM*, tailored for use with the OCPPC ICGE model.

This document assumes that you have installed on your computer a recent version of Customized RunGEM (dated March 2001 or later) that contains the OCPPC ICGE model. Instructions for doing this are in Appendix 1.

You should also have studied the CoPS working paper OP-85, *The Theoretical Structure of MONASH-MRF*, by Peter *et al.* (1996), the book *Regional Inequality and Structural Changes: Lessons from the Brazilian Economy*, by Haddad (1999), and the article by Haddad and Hewings (2005), *Market Imperfection in a Spatial Economy: Some Experimental Results*, published in the Quarterly Review of Economics and Finance, Vol. 45. They describe the underlying economic theory of the OCPPC ICGE model. You should also have studied the OCP Policy Center Research Paper (August 2017), *A Practitioner's Guide for Building the Interregional Input-Output System for Morocco, 2013*, to familiarize with the structural database of the model.

As you read this document, you will use RunGEM to work through examples designed to familiarize you with the software and, perhaps more importantly, the OCPPC ICGE model. The instructions are quite detailed. Our aim is to give sufficient detail to enable a new RunGEM user to work through the examples relying solely on this document.

A series of numbered questions appear throughout the text. Write your answers in the margin.

2. Starting RunGEM

To see RunGEM in action, double-click on the Customized RunGEM (OCPPC ICGE Model) icon on your desktop. You should see the following screen:
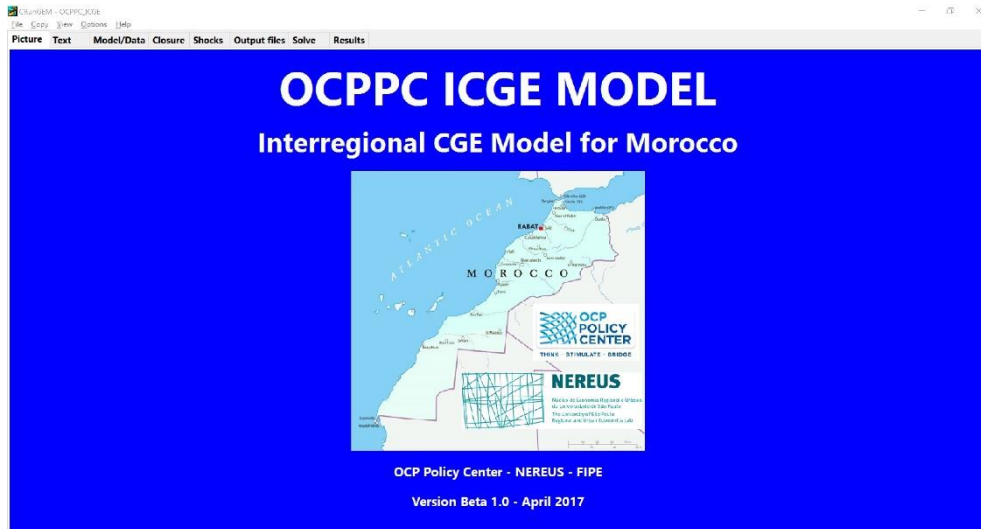
RunGEM uses a tabbed notebook or card index interface. The first two pages (**Picture** and **Text**) contain general information. The third page (**Model/Data**) contains information about files used by the OCPPC ICGE model. The remaining five pages relate to simulations − we explain those in Part 5 below.

The **Help** menu item gives access to extensive online-help about RunGEM. **Customized RunGEM** is a slightly simplified version of RunGEM, so some of the options described there may not apply. There is a special Help menu item, "Customized RunGEM Help", dealing with these differences.

3. The Model/Data page

Have a look at RunGEM's **Model/Data** page. It gives two pieces of information:

- The *model* is OCPPC_ICGE.EXE, an executable program. This has been produced by the GEMPACK program **TABLO** using, as input, the text file OCPPC_ICGE.TAB. To change the model specifications, you need to (a) edit OCPPC_ICGE.TAB, and (b) run TABLO to make OCPPC_ICGE.EXE. That procedure is not covered in this introductory document, and TABLO is not supplied with the **Customized RunGEM** package.

- There are three input data files, MDATA3.HAR, which corresponds to the logical file

MDATA which is mentioned in OCPPC_ICGE.TAB. Similarly, PDATA2.HAR corresponds to the logical file, PDATA, and Terminal.HAR to Terminal.
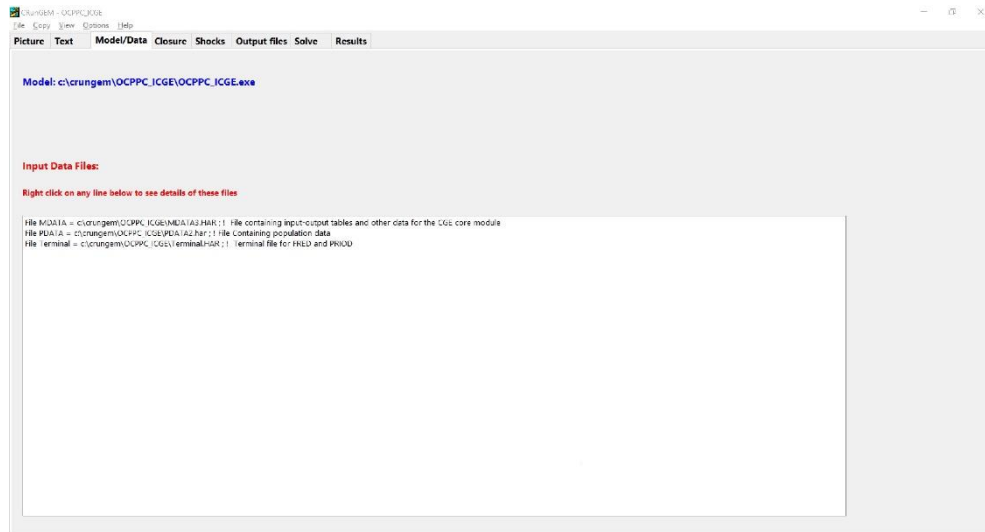
RunGEM and the programs that come with it (TABmate, ViewHAR and others) are parts of the standard GEMPACK system, which allows you to create and modify economic models and data. The customized version of the OCPPC ICGE model is designed as an introduction to the OCPPC ICGE model itself, using GEMPACK: therefore the Customized version of RunGEM does not allow you to alter the model equations or database. To change the equations or data, you would need other GEMPACK components (such as the TABLO program) not supplied with Customized RunGEM.

4. Looking at the data

The data files are given the logical names **MDATA**, **PDATA** and **Terminal** in the TAB file **OCPPC_ICGE.TAB** which lays down the theory of OCPPC ICGE. To see what information is on the MDATA file, for instance, select

View | Input Data files | Original MDATA

in RunGEM's menu. ["Original MDATA" appears to the side of "Input Data files"].

This will start up **ViewHAR,** a windows program for viewing and modifying data held in GEMPACK Header Array files. It will open the MDATA file and show a Contents screen.[2]

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[2] The top of the ViewHAR window shows the actual name (MDATA.HAR) and location of the file which has logical name MDATA in the TAB file.

Each of the rows corresponds to a different array of data on the file. Look at the **Name** column to see what these arrays are.[3] Use the buttons at bottom right to set your preferred font size.

You can see that array number 22 is the data at Header "LABR". The data at this header is the value of labor payments, measured in millions of 2013 dirhams (DHS). To see the actual data, double-click on the LABR row.

Q1. What is the value of wages in textile and leather industry (D02) in Fès-Meknès (R3)?

Now click on *Contents* in ViewHAR's main menu to return to the list of contents. Similarly, the array number 23 is the data at Header "CPTL". The data at this header is the value of capital payments, measured in millions of 2013 DHS. To see the actual data, double-click on the CPTL row.

Q2. What is the value of capital payments in the construction sector (F45) in Souss-Massa (R9)?

Click on the small yellow rectangle near the top left of the ViewHAR window to transpose the matrix (exchange rows and columns). This makes it easier to see.

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[3] The arrays may be ordered differently from the list in the text. You can set ViewHAR up to either list the headers alphabetically, or to list them in the order they were written to file. ViewHAR's **File…Options** menu command can be used to customize the display in various ways.

MDATA8.HAR in c:\crungem\OCPPC_ICGE
File Contents Edit Sets Export Import History Search Aggregation Programs Help

None ∨ | 1 ∨   All IND ∨ | All REGDEST ∨

CPTL	1 R1	2 R2	3 R3	4 R4	5 R5	6 R6	7 R7	8 R8	9 R9	10 R10	11 R11	12 R12	Total
1 A00	8191,1	8779,5	18779,7	12993,6	14066,4	13656,8	13824,9	6440,2	7354,6	1172,2	0	0	105259,0
2 B05	225,0	47,1	0	26,6	0	95,3	88,2	0	753,4	279,3	272,5	506,7	2294,0
3 C00	0	754,2	131,5	487,8	12877,5	45,1	6873,5	2253,6	19,4	0	1887,4	0	25330,0
4 D01	2132,8	712,2	4036,2	2273,5	1451,6	21210,7	2334,2	160,0	5130,3	276,4	622,5	232,5	40573,0
5 D02	1957,7	77,3	1040,3	932,9	4,3	4967,9	205,3	0	6,4	0	0	0	9192,0
6 D03	209,9	73,9	238,1	394,4	22,6	5790,0	710,9	5,0	119,0	0,0	121,0	0,1	7685,0
7 D04	4690,8	761,2	782,5	1494,0	97,5	9599,4	110,4	8,2	199,6	0	7,2	0,3	17751,0
8 D05	2015,1	375,4	1142,8	1246,8	241,7	12198,8	1123,0	28,5	851,7	40,5	213,1	30,7	19508,0
9 D06	0	0	0	0	0	-562,0	0	0	0	0	0	0	-562,0
10 E00	921,3	556,0	890,5	1686,6	427,1	1774,0	895,7	190,5	567,0	77,2	107,8	22,4	8116,0
11 F45	4046,6	3214,0	2985,3	4277,9	2247,9	6723,7	4928,4	1967,6	1989,2	310,2	764,4	74,7	33530,0
12 G00	5419,7	6047,5	6576,8	7482,4	3518,3	14128,9	6548,4	1235,4	3968,2	723,9	603,3	167,3	56420,0
13 H55	884,1	344,3	790,2	506,7	110,0	1489,5	4556,0	341,3	3271,9	23,3	28,1	27,6	12373,0
14 I01	1734,8	1776,9	2237,2	3104,7	993,1	5973,1	2075,8	551,2	1441,0	330,2	261,0	76,8	20556,0
15 I02	1525,4	1562,5	1967,2	2730,0	873,3	5252,2	1825,3	484,7	1267,1	290,4	229,5	67,6	18075,0
16 J00	1416,4	1430,2	1777,7	6058,7	769,5	12343,0	2430,2	381,7	1375,3	161,2	145,3	41,8	28331,0
17 K00	4034,7	4074,1	5063,8	17258,8	2192,0	35159,9	6922,6	1087,3	3917,6	459,3	413,9	119,2	80703,0
18 L75	516,5	650,1	1018,6	3154,5	536,8	1565,3	967,2	349,7	467,4	411,7	577,0	132,4	10356,0
19 MNO	944,7	1083,4	1819,8	2229,4	813,9	3435,7	1688,5	396,2	1171,2	224,7	234,9	67,6	14110,0
20 OP0	666,7	482,3	682,6	1639,9	361,6	2092,0	1107,9	142,9	462,6	57,4	52,9	15,2	7764,0
Total	41533,2	32810,2	51960,6	69979,3	41605,1	156039,3	59216,2	16023,9	34332,7	4037,8	6542,8	1582,9	517364,0

CPTL Size: IND * REGDEST Capital payments

ViewHAR is able to show you some shares, as well as the actual data. To see this, click the drop-down list boxes near the top left-hand corner of the ViewHAR window, which at present probably says **None** [we call it the **shares list box**]. Select the **row** share.

Q3. What is Rabat-Salé-Kénitra's (R6) share in capital payments to food industry and tobacco (D01)?

Q4. And in agriculture, forestry, hunting, related services (A00)?

Q5. What is Rabat-Salé-Kénitra's share in the economy-wide payments to capital?

Q6. In which region the agriculture, forestry, hunting, related services sector is responsible for the highest share of labor payments?

Q7. Which sector is most capital-intensive in Morocco?

Shares like these are often useful for explaining simulation results.

Now click again on *Contents* in ViewHAR's main menu to return to the list of contents. Look at the BAS1 row (array number 2). You can see that this is a 4-dimensional array of size **COMxALLSOURCExINDxREGDEST**. The data at this header is the basic value of commodity inputs to the production process, also measured in millions of 2013 DHS. To see the actual data, double-click on this BAS1 row. You see a 20x13 matrix of data (plus a totals row and a totals column); the rows have commodity labels and the columns are labelled "R1" up to "R12" plus a 13th column labelled "Foreign". These must be the elements of the sets COM (commodities) and ALLSOURCE (source), respectively. What about the 3rd dimension IND and the 4th dimension REGDEST of this data array? The clue is given by the 4 drop-down lists near the top right-hand corner of the screen which say **All COM; All ALLSOURCE; Sum IND; Sum REGDEST** respectively. Because your computer screen is 2-dimensional, what you are seeing are the IND and REGDEST values **summed across sectors and regions**.

BAS1	1 R1	2 R2	3 R3	4 R4	5 R5	6 R6	7 R7	8 R8	9 R9	10 R10	11 R11	12 R12	13 Foreign	Total
1 A00	5784,2	5621,3	12513,8	10853,9	9630,9	11624,3	10857,5	4100,2	6389,2	877,0	0	0	10191,4	88443,6
2 B05	507,1	80,7	0	67,1	0	215,7	215,8	0	1836,0	666,8	701,1	425,1	509,2	5233,0
3 C00	0	1164,0	202,9	760,6	9767,4	70,0	9539,1	3139,6	29,8	0	2322,2	0	56910,8	83906,3
4 D01	1347,7	461,4	3467,2	1838,5	1399,8	18413,3	1654,8	127,9	4310,8	94,5	380,9	67,4	5994,2	39508,2
5 D02	2464,3	73,5	1384,6	1116,2	7,0	8465,2	280,6	0	12,4	0	0	0	12723,4	26527,3
6 D03	738,1	331,2	1143,6	1931,6	110,9	11718,4	699,8	16,9	560,9	0,1	553,6	0,2	23014,1	40818,4
7 D04	2724,9	2905,1	2181,4	2106,9	261,1	19584,6	283,0	17,2	508,6	0	15,2	0,5	61759,9	91448,3
8 D05	4474,1	953,0	2887,8	3151,2	634,4	30385,2	2639,7	72,0	2089,1	86,0	552,0	48,8	23231,4	71204,7
9 D06	0	0	0	0	0	22699,6	0	0	0	0	0	0	29938,0	52637,6
10 E00	1433,8	826,3	1407,8	3022,5	704,9	3204,5	1468,7	267,9	906,3	132,5	208,1	20,8	1245,1	14849,5
11 F45	333,8	271,3	374,9	676,3	217,0	1107,0	418,1	112,1	230,0	58,2	80,5	15,5	7,4	3902,2
12 G00	985,8	1010.0	1280,3	1939,9	746,5	2838,7	1274,1	214,0	724,9	210,1	186,2	29,2	844,6	12293,2
13 H55	309,6	140,6	336,7	304,3	47,0	810,2	2143,6	127,2	1542,2	16,6	24,6	8,7	381,3	6192,7
14 I01	783,5	326,3	1215,4	1626,6	813,6	1253,4	1238,2	290,7	779,1	136,6	82,5	17,6	4732,2	13295,7
15 I02	344,7	324,5	545,2	1056,5	234,7	1401,0	519,9	109,5	343,8	107,3	90,2	9,9	384,9	5472,1
16 J00	1231,1	1336.0	1578,1	6788,9	681,3	13939,3	2385,0	300,4	1320,5	161,4	159,0	24,6	797,4	30702,9
17 K00	1669,5	1776,1	2371,6	8032,8	938,4	14531,0	3104,3	353,9	1945,4	259,6	205,7	35,8	6719,7	41943,9
18 L75	244,4	207,1	331,0	717,4	175,3	1033,2	346,6	78,1	224,7	57,8	68,1	14,8	46,1	3544,5
19 MNO	118,9	142,6	255,1	242,7	125,2	490,2	230,0	51,0	156,5	20,0	18,2	4,6	0,8	1855,8
20 OP0	189,6	109,7	172,5	551,3	104,8	961,7	323,2	26,2	126,2	14,5	21,1	1,4	43,8	2646,0
Total	25685,4	17168,6	33649,7	46785,4	26600,2	164746,6	39621,1	9405,7	24036,3	2907,1	5619,5	724,9	239475,5	636425,9

Q8. What is the total across all sectors of the value of mechanical, metallurgical and electrical industry goods (D04) produced in Grand Casablanca-Settat (R6) and sold in Tanger-Tetouan-Al Hoceima (R1)?

Q9. What is the total across all sectors and across all regions of the value of imported manufactured inputs (D01-D06)?

How can you see the value of purchases of one specific input (say mining, C00) by just one sector, for example, chemical and parachemical industry (D03), in a given location (e.g. Grand Casablanca-Settat, R6)? To see this, click on the **All COM** drop-down list box near the top right-hand side and select "C00" from the options. Then, click on the **All IND** drop-down list box and select "D03" from the options. Finally, select "R6" from the drop-down list **All REGDEST**. The data will change and now you are seeing how much is purchased just of mining inputs by the chemical and parachemical sector in Grand Casablanca-Settat.

Q10. How much imported mining inputs (C00) is purchased in Grand Casablanca-Settat (R6) by the chemical and parachemical industry (D03)?

Q11. What are the three main sources of mining inputs (C00) to the chemical and parachemical industry (D03) in Grand Casablanca-Settat (R6)?

Q12. And the two main sources of agricultural inputs (A00) to Fès-Meknès's (R3) food industry and tobacco sector (D01)?

Now click again on *Contents* in ViewHAR's main menu to return to the list of contents. Look at the rows BAS2, BAS3, BAS4, BAS5, BAS6 and BAS7. They represent commodity demands by the other users in the OCPPC ICGE model, namely, investors, households, foreigners, regional government, Central government, and changing in stocks. Let us look at household demand (BAS3). You can see that this is a 3-dimensional array of size **COMxALLSOURCExREGDEST**. There are many ways of viewing 2-dimensional slices of a multi-dimensional array.

MDATA5.HAR in c:\crungem\OCPPC_ICGE

File Contents Export History Search Programs Help

None ∨ | 1 ∨ — All COM ∨ All ALLSOURCE ∨ Sum REGDEST ∨

BAS3	1 R1	2 R2	3 R3	4 R4	5 R5	6 R6	7 R7	8 R8	9 R9	10 R10	11 R11	12 R12	13 Foreign	Total
1 A00	6124,4	6120,2	10131,8	8084,1	7293,1	8327,7	8902,9	4188,4	4272,5	811,2	0	0	8354,4	72610,7
2 B05	708,3	166,7	0	77,0	0	300,8	262,2	0	1952,9	600,6	654,7	316,1	573,9	5613,2
3 C00	0	17,3	3,3	5,4	64,8	0,8	64,4	33,6	0,6	0	21,0	0	425,2	636,3
4 D01	5292,2	1925,9	11343,6	5739,3	4202,2	60447,7	4835,4	495,5	11121,3	332,7	1208,4	475,7	19196,6	126616,4
5 D02	1289,6	109,3	951,4	567,7	8,7	6277,1	293,9	0	20,8	0	0	0	8729,9	18248,6
6 D03	248,1	145,1	404,2	515,2	37,1	3848,8	229,6	8,1	221,6	0,1	198,1	0,3	7445,4	13301,6
7 D04	492,2	538,5	601,9	385,1	71,4	4828,2	75,6	6,1	168,7	0	4,6	0,6	14867,1	22040,0
8 D05	1029,2	249,7	763,6	654,6	155,5	7321,0	618,5	19,2	567,7	26,1	109,7	42,6	5558,9	17116,3
9 D06	0	0	0	0	0	13456,0	0	0	0	0	0	0	17746,3	31202,4
10 E00	2187,8	1356,9	2096,0	3614,8	973,1	3727,1	2050,2	478,5	1324,8	171,3	214,6	67,7	1670,9	19933,9
11 F45	502,3	345,4	468,7	534,3	260,7	903,4	513,7	173,7	307,0	46,3	53,4	47,2	7,8	4163,9
12 G00	1177,2	1216,9	1570,5	1627,8	807,0	2269,0	1513,4	309,3	918,1	166,6	100,6	59,7	867,2	12598,3
13 H55	1907,4	742,4	1691,2	995,9	235,2	3012,1	9371,1	747,2	6775,4	43,2	47,4	62,2	1684,1	27314,7
14 I01	2185,9	771,2	2720,7	2999,6	1014,2	2061,5	2389,1	690,4	1740,5	248,3	90,9	99,0	9494,3	26505,4
15 I02	2521,7	1793,8	3151,7	3794,5	1406,1	5753,9	2909,4	800,9	2037,4	356,9	227,3	106,4	1880,8	26740,9
16 J00	1814,7	1729,9	2231,1	5694,1	966,7	11650,6	2825,4	515,8	1633,1	176,9	142,9	64,8	790,9	30436,9
17 K00	2106,0	1948,4	2726,8	6675,1	1052,9	10940,0	3211,9	526,2	2043,0	218,8	145,8	109,4	6055,9	37800,4
18 L75	879,6	697,5	1033,0	1608,4	540,7	1759,7	1016,0	347,2	615,9	149,3	143,5	126,6	115,0	9032,7
19 MNO	1914,4	1457,2	2261,2	1545,1	1051,8	4349,0	2194,4	515,8	1593,6	107,2	86,2	85,0	7,7	17168,6
20 OP0	1278,8	951,9	1331,7	3024,6	691,5	3624,2	2115,4	287,9	893,3	112,0	95,2	32,3	242,1	14681,0
Total	33655,0	22284,2	45482,3	48342,7	20872,9	154858,5	45392,5	10143,6	38208,2	3567,7	3544,2	1695,7	105714,5	533762,0

BAS3 Size: COM * ALLSOURCE [* Sum over REGDEST] Commodity demand by households: basic values

To see another, click on the **ALLSOURCE** drop-down list box (the 2nd of the three) and select **foreign** so that only foreign purchases are shown. Now click on the 3rd, **REGDEST**, list box and select **All REGDEST**.

MDATA5.HAR in c:\crungem\OCPPC_ICGE

File Contents Export History Search Programs Help

None ∨ | 1 ∨ — All COM ∨ 13 Foreign ∨ All REGDEST ∨

BAS3	1 R1	2 R2	3 R3	4 R4	5 R5	6 R6	7 R7	8 R8	9 R9	10 R10	11 R11	12 R12	Total
1 A00	997,6	668,1	971,2	1083,1	508,9	1886,2	981,1	325,4	623,1	96,8	95,9	117,0	8354,4
2 B05	68,7	48,8	68,9	77,6	37,2	121,0	69,5	24,7	39,4	5,7	5,6	6,7	573,9
3 C00	50,5	33,7	49,6	54,9	25,8	96,9	50,2	16,3	32,0	4,8	4,9	5,7	425,2
4 D01	2283,4	1536,3	2241,3	2475,9	1175,2	4321,7	2252,2	749,9	1448,5	222,2	219,7	270,4	19196,6
5 D02	1041,7	697,7	1024,4	1127,6	533,4	1957,2	1023,0	340,2	660,1	101,2	99,0	124,6	8729,9
6 D03	886,7	587,2	872,7	955,1	454,9	1699,6	869,0	285,8	560,1	85,7	84,6	104,0	7445,4
7 D04	1774,1	1193,3	1737,9	1917,4	911,3	3328,2	1745,3	582,4	1125,2	172,3	169,9	209,9	14867,1
8 D05	660,4	441,6	646,6	713,2	337,5	1273,9	648,1	215,3	417,2	63,9	63,1	78,1	5558,9
9 D06	2109,5	1423,4	2077,4	2290,6	1089,2	3965,5	2086,1	695,2	1346,8	206,6	203,1	253,0	17746,3
10 E00	198,5	133,7	195,9	215,8	102,5	374,1	196,0	65,1	127,0	19,5	19,0	24,0	1670,9
11 F45	0,8	0,5	1,0	1,0	0,4	2,2	0,7	0,2	0,6	0,1	0,1	0,3	7,8
12 G00	108,1	74,4	95,7	115,8	58,0	183,8	104,2	35,3	59,4	10,3	10,7	11,4	867,2
13 H55	199,1	134,6	196,7	214,3	105,3	378,8	198,5	65,9	127,9	19,3	19,2	23,6	1684,1
14 I01	1121,5	790,4	1161,5	1267,1	632,5	1864,8	1151,6	384,7	746,0	116,9	108,9	148,3	9494,3
15 I02	223,4	150,8	220,0	242,6	115,7	420,6	221,2	73,7	142,7	21,9	21,5	26,7	1880,8
16 J00	94,2	63,6	92,6	101,9	48,6	176,3	93,2	31,1	60,0	9,2	9,1	11,2	790,9
17 K00	720,4	485,8	708,8	780,7	371,6	1354,0	712,0	237,3	459,6	70,3	69,1	86,2	6055,9
18 L75	20,2	8,8	11,2	5,8	6,3	33,6	13,4	4,0	10,2	0,3	0,3	0,8	115,0
19 MNO	1,4	0,6	0,7	0,4	0,4	2,3	0,9	0,3	0,6	0,0	0,0	0,1	7,7
20 OP0	28,6	19,4	27,9	31,4	14,7	54,9	28,5	9,5	18,1	2,8	2,9	3,3	242,1
Total	12588,8	8492,8	12402,2	13672,1	6530,5	23495,4	12444,7	4141,9	8004,4	1229,6	1206,7	1505,2	105714,5

BAS3 Size: COM [* Foreign] * REGDEST Commodity demand by households: basic values

Q13. What is the value of imported agriculture, forestry, hunting, and related services goods (A00) consumed by households in Dakhla-Oued Eddahab (R12)?

Q14. What is the total value of imported manufactured goods (D01-D06) consumed by Moroccan households?

Let's look now at the structure of household consumption embedded in the model. First, click on the **ALLSOURCE** drop-down list box and select **Sum ALLSOURCE**, so that only total purchases are shown. Click on the **REGDEST** drop-down list box and select **ALLREGDEST**.

Click on the small yellow rectangle near the top left of the ViewHAR window to transpose the matrix (exchange rows and columns). From the shares list box, select **row** shares. Now you are seeing consumption shares.

Q15. What do you notice about regional structure of consumption?

Q16. What commodity is responsible for the highest share of household expenses in Morocco?

We saw that all regions have the same structure of consumption. This is a hypothesis used to construct the database of the OCPPC ICGE model. However, the model allows for different structures of regional dependence on suppliers. Let's check it!

Q17. What share of household consumption of agricultural goods (A00) in Rabat-Salé-Kénitra (R4) is supplied by producers within the Moroccan capital? And what is the share of agricultural products consumed by households in Oriental (R2) is supplied regionally?

In the OCPPC ICGE model, domestic output is directed to sales to intermediate use (BAS1), capital creation (BAS2), household consumption (BAS3), exports (BAS4), regional governments (BAS5), and sales to Central government (BAS6). There is also a final user associated with changes in stocks (BAS7). In addition, trade (G00) and transport (I01) are also consumed as margin-commodities, used to facilitate transactions between origin-destination pairs. Total sales for margin usage, by different users, are found in the arrays MAR1, MAR2, MAR3, MAR 4, MAR5 and MAR6. Notice that there is no margin consumption associated with changes in stocks.

To answer the following questions, you may use Excel to help you. You can easily copy from ViewHAR and paste to Excel. Note in the main menu that you can decide whether or not to export details from the arrays [***Export |Options** (labels, totals)*].

Q18. Which sector has the highest export share in the country?

Q19. Which sector sells the greatest proportion of its output to households?

Q20. And which is the most investment-oriented in its sales pattern?

Q21. What is the total output of transport (I01)? Do not forget to add margin sales!

Q22. If exports of agriculture goods (A00) increased by 10%, what would be the percent increase in agriculture output (assuming other sales unchanged)?

Q23. What might happen to mining output (C00) if its exports went up 10%?

Just to refresh, answer the following:

Q24. Which sector uses the greatest proportion of imports in its material inputs?

Sector	Import share
A00	
B05	
C00	
D01	
D02	
D03	
D04	
D05	
D06	
E00	
F45	
G00	
H55	
I01	
I02	
J00	
K00	
L75	
MNO	
OP0	

Q25. And which final demander (no need to include margins)?

User	Import share
Investors	
Households	
Exports	
Regional government	
Central government	

Now close the ViewHAR window by selecting **File / Exit** from ViewHAR's (not RunGEM's) menu.

Binary files (such as Header Array files) cannot be looked at in a text editor. To see this, select

View | Other Text File from RunGEM's main menu and select MDATA3.HAR (the data file). RunGEM tells you that it is unable to open this as a text file (and even suggests that you try to open it with ViewHAR).

5. Looking at the TAB file[4]

To see the model equations use the **View** menu item at the top of the **RunGEM** window and select

View | Main TABLO file

A text editor will appear, with the file OCPPC_ICGE.TAB visible. This will probably be the TABmate editor used by GEMPACK. It will be in read-only mode so that you cannot change the TAB file. The TAB file uses the TABLO language to specify the equations and variables of the CEER model.

TABmate colours items in the TAB file according to their function:

- black for words that are part of the TABLO language;
- green for variables and other items that are specific to this model;
- blue for comments which GEMPACK ignores;
- *italics* for strings that GEMPACK uses as labels or descriptions.

You might also see line numbers in the left-hand margin.

Now search for MDATA. Select *Search | Find...* from the editor's menu, type in "MDATA", and click **OK** (or press Enter). To search again after you have found the first occurrence, you can either again click OK, or you can close the Search dialog and touch the **F3** key (near the top

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[4] The term **TAB file** is shorthand for **TABLO input file**.

of your keyboard). Close the Search dialog and press **F3** to see the first 3-4 occurrences of MDATA. You will see that various pieces of data are read from this file. [Note: where several **Read** statements occur together, the keyword "Read" is only needed for the first Read statement in the group.]

Click on the word MDATA, then click the button above marked **Gloss**. A window will appear, showing each line that contains that word. Line numbers appear in red – you can click on these red numbers to go to that line. Click to go to the line where **LAB_OCC_IND** is read from file.

You will see that the matrix LAB_OCC_IND is read from the header "LABR". The **header** is a short key (up to 4 letters) which identifies the location of LAB_OCC_IND, within the MDATA file (in fact you previously used ViewHAR to examine the values of LAB_OCC_IND in that file). Now click on the word LAB_OCC_IND, then again click the **Gloss** button to see all occurrences of it. You will see that LAB_OCC_IND is declared as a **COEFFICIENT** and that it holds the value of labor payments. It is used in numerous equations and formulae. Click on the line number for equation E_p0a (zero pure profits in current production) to go there. Click on the word "Equation" and press **Gloss** again. This time you get a list defining all the variables and coefficients in the equation. Press spacebar to close the Gloss window.

You have learned two ways to use the **Gloss** button:

- click on a variable, coefficient or filename: **Gloss** shows every occurrence of that symbol;
- click elsewhere in a statement: **Gloss** shows the first occurrence of each symbol used there.

Both techniques can be very useful to find your way about the TAB file.

Now close TABmate (click the X button at top right of window) and return to RunGEM

6. Running a *numéraire* simulation

In this simulation, the usual *numéraire*, **natphi** (the exchange rate), is increased by 10 per cent.

For simulations, the last pages **Closure - Shocks - Output files - Solve - Results** are usually accessed in that order (from left to right).

First, click on the **Closure** page of RunGEM. You will see a list of the exogenous variables in the currently selected closure. You can choose between several different closures when running a simulation. The panel below shows which variables are exogenous in the selected closure. RunGEM allows you to load different closures already prepared.[5] To see this, use the **Load Closure** button to load the **short run** closure file (OCPPC_ICGE.cls). Notice that **natphi** is one of the exogenous variables.

Now go to the **Shocks** page. Click on the **Clear Shocks List** button to remove whatever shocks

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[5] You can also edit the closure shown on the Closure page, and can save this edited closure.

are shown. Now you will specify a shock to variable **natphi**. To do this, click on the **down arrow** to the right of the label **Variable to shock** near the top of the Shocks page. A drop-down list of all the exogenous variables in this standard closure will appear. Click on **natphi**. A new edit box entitled **Value of Shock** will appear. Click in this and type in **10**. Then click on the button **Add to Shock List**. The line

Shock natphi = 10;

should appear in the Shocks memo which occupies the bottom half of the Shocks page. This is the only shock for the *numéraire* simulation.

Have a look at the **Output files** page. It controls the names of output files produced by the simulation. Don't change anything now. Go to the **Solve** page of RunGEM.

1 First, click on the topmost **Change** button (the one with **Solution method** before it). Click on **Johansen** to select Johansen's method. You will learn more about the different solution methods available later in this document.

2 If it is not already there, insert the text **Numéraire simulation** in the text box labelled **Verbal description**.

3 Now click on the **Solve** button. A "Please Wait" window will appear while the model is solved. Then RunGEM will show you a box telling you how long the solution took. Just press OK.

The next natural step is to look at the results.

7. Looking at the results

Click on the Results page of RunGEM. This page allows you to inspect the variable values computed during the **last** successful solution process. You will see the Contents page listing many of the variables of the model. The first row, **Macros**, refers to the rows which have no subscripts (i.e., just one element). The other rows correspond to individual vector and matrix variables. Slowly move the mouse pointer (without clicking) over the various buttons and controls to get a hint about their purpose.

Double-click on the **macros** row to see the results for these variables. Select 3 decimal places.

Exogenous variables are shown in red, including the shocked variable, **natphi**. Notice that all the quantity variables are unchanged (zero), while variables measured in currency units such as prices and values have all increased by 10%. In other words, the single exogenous price (called *numéraire*) serves to determine the absolute level of prices but does not affect relative prices or, therefore, the behaviour of any agents.

Click the **Contents** button to return to the contents list.

To see the effects of another useful way of listing the variables in the **Contents** page, click on the **V** between the two drop-down list boxes near the top of the screen. You should see something like:

To see the results for all variables with a single argument ranging over the set **IND**, double-click on the sixth of the rows above (Vectors size: 20 IND). This time you will see the percent-change results for the 3 such variables (**natlabind**, **naty** and **natz**). When you have finished looking at these results, double-click on any number to return to the Contents list. Return to the other view of the Contents list by clicking again on the **V** button.

Q26. Which variable shows percentage changes in industry output (activity level)?

7.1. Looking at the updated data

As well as producing percent change simulation results, the simulation above produced an updated version of the MDATA file for the model (and also for PDATA). This updated database reflects the state of the economy as it would be after the shock (10 per cent increase in the *numéraire*). You can see this updated data by selecting

View | Updated Data | Updated MDATA

from the RunGEM menu. As usual, RunGEM opens ViewHAR to show you this data set. Double-click on the Contents row "BAS1". You should see the values of intermediate consumption of inputs from different sources, summed over all sectors and destination regions. Now click **(carefully)** in the **left** side of the ⊐ button near the bottom right-hand corner of the ViewHAR window, to make this occupy just the **left** half of the screen.

Now, for the original (pre-simulation) version of this data, go back to RunGEM and select

View | Input Data | Original MDATA.

Again double-click to select the **USE** data and this time click carefully on the **right** side of the ⊐ button to make this ViewHAR occupy the right-hand half of your screen.

Then (via the **Taskbar** or **Alt**+**Tab**), bring the other ViewHAR window (the one in the left-hand half of the screen) to the top.

When you have got both the original and the updated data side-by-side on your screen, take a moment to pat yourself on the back. You are truly a Windows wizard! Now look at a particular cell, say that corresponding to the value of intermediate usage of agriculture product from Tanger-Tetouan-Al Hoceim (the top-left cell). Think what has happened to prices and to quantities in this simulation, and hence deduce what must have happened to values. Check that the pre- and post-simulation BAS1 values are consistent with this.[6] You might like to repeat this for some other cells in this or other headers. Close the two ViewHAR windows when you are finished.

Remember that the flows in the updated data are measured in terms of post-simulation prices. By comparing original and updated data, we can make deductions about values, but not about quantities.

8. Simulating the short-run effects of a drought in Northern Morocco

Most years, one or more regions of Morocco suffer from low rainfall. As a continuing result of

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[6] You should be able to confirm that the post-simulation value is exactly 10% greater than the original value. Right-click on the original value. A small window should appear: click first the **Copy** button, then the **Close** button. This puts the number in the Windows clipboard. Now use ViewHAR's **Help...Calculator** menu command to launch the Windows calculator, and then **Edit...Paste** to enter in the number from ViewHAR. Multiply by 1.1 (***1.1=**) and you should see the same number as in the updated data. You can also do this in Excel.

climate change, during 2016 an unusually severe drought in Fès-Meknès is expected to affect farmers all over the region. Agricultural outputs will fall sharply, with an expected loss of 10%. We simulate the effects of such a drought using the OCPPC ICGE model. Questions are scattered through the instructions. Write down answers to the questions onto the instruction sheet.

The simulation in the next example is one in which the shock is a

10% decrease in technical efficiency

Now look again at the TABLO Input file for the OCPPC ICGE model.

Search | Find for the variable name **a1**. The first occurrence is the variable definition:

```
(all,j,IND)(all,q,REGDEST)
a1(j,q) # All input augmenting technical change #;
```

The "(all,j,IND) (all,q,REGDEST)" means that **a1** is a vector variable with one value for each sector in each region. Click on **a1** and press the *Gloss* button (at top middle of the screen). You can see that a1prim appears in 4 equations: the three demand equations E_x1o, E_x1oct and E_x1prim, and later on the long E_a equation. Click on the red line number at left of equation E_x1o and you should see:

```
E_x1o # Demand for dom./for. composite inputs, User 1 #
(all,i,COM)(all,j,IND)(all,q,REGDEST)
x1o(i,j,q)=z(j,q)+a1(j,q)+a1s(i,j,q);
```

Click on the = sign in the equation above and press the **Gloss** button to see a definition of each symbol that is used.

The terms "(all,i,COM)(all,j,IND)(all,q,REGDEST)" mean that Equation E_x1o is actually a group or block of equations: there is one equation for each "commodity composite"[7] used by each industry in each region. So if there were 20 commodities, 20 industries and 12 regions in the database there would be 4800 (=20*20*12) separate equations. Each of the variables **x1o**, **z**, **a1**, and **a1s** is a percentage change: if **z("D04","R6")** had value 5, that would mean that output of the mechanical, metallurgical and electrical industry in Grand Casablanca-Settat would be 5% greater than in the initial equilibrium described by the input data files. The "a" variables are technological change variables, normally exogenous (values fixed outside the model). Suppose output were fixed (**z**=0), a shock of 10% to **a1("D04","R6")** would mean that for each commodity c, the values of **x1o(c, "D04","R6")** must also increase 10% to keep the equation balanced. If you looked at the other equations where **a1** appears, you would find that a shock of

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[7] An example of a "commodity composite" might be mining used by the manufaturing sectors. Mining is potentially a mixture of local and imported mining products, so we call it a "dom/imp composite".

10% to **a1("D04","R6")** would mean that 10% more of *all* inputs were needed to produce a given D04 output in Grand Casablanca-Settat [note: positive **a1** implies technical *regress*].

Press ESC or spacebar to close the Gloss window.

Exit from TABmate in the usual Windows way by *File / Exit*. (There are usually alternatives in terms of keystrokes instead of the mouse action. For example, you can use keystrokes *Alt* followed by *F* followed by *X* in order to exit.)

8.1. Implementing the shock

Start up RunGEM with the OCPPC ICGE model. Go to the *Closure* page. As in the previous example, use the *Load closure* button to select the **short run** closure file (OCPPC_ICGE.cls). Notice that the variable **a1** (all input augmenting technical change) is exogenous.

In this simulation, we shock the variable **a1** to increase by 10% for the agricultural sector (**A00**) in Fès-Meknès (**R3**). **a1** is a measure of overall technical efficiency – the 10% means either that with inputs held constant output will be 10% less, or that 10% more inputs will be needed to produce the original output. This shock is used to simulate the main effect of the drought: agricultural productivity in Fès-Meknès is reduced.

Go to the *Shocks* page and delete any existing shocks by clicking **Clear Shocks List**. Then specify the shock as follows:

1 Use the combo box[8] at the top to choose which **variable to shock**: click on the arrow at the right. This will show you a list of variables. Click on **a1**. This variable has dimensions **INDxREGDEST**.
2 Select the elements to shock: from the **ALL IND** drop-down list box choose **A00**. And from the **ALL REGDEST** list box, select **R3** (Fès-Meknès).
3 In the edit box labelled **value of shock**, type 10, meaning a 10% decrease in primary factors technical efficiency in the agriculture sector in Fès-Meknès. Then click the *Add to shock list* button.

In this simulation, only one variable is shocked. If you wanted more shocks you would repeat steps 1, 2 and 3 for each variable that was to be shocked.

The shock list underneath should now contain:

Shock a1("A00","R3") = 10;

You may edit it directly if necessary
.

---

[8] A **drop-down list box** is also called a **combo box**.
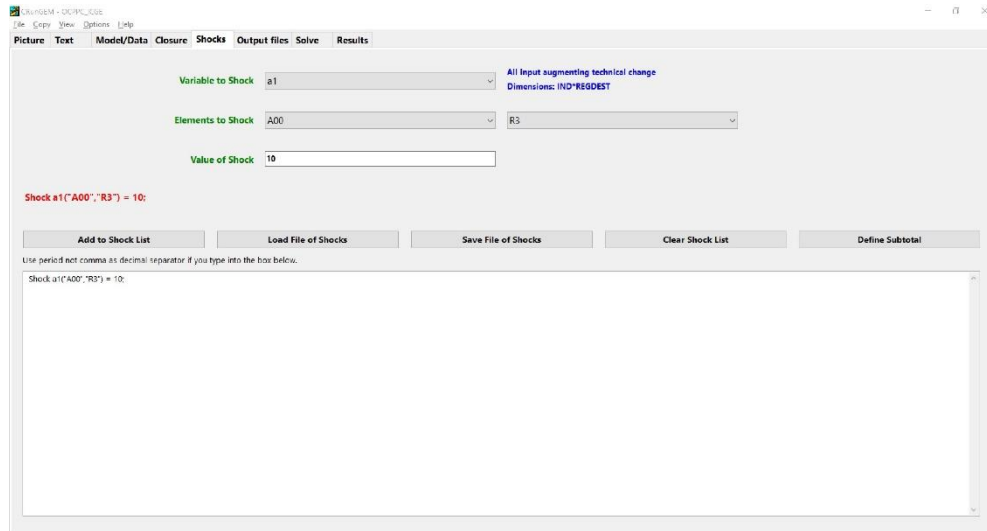
When you have finished with the shocks, go to the Output Files page.

8.2. Choosing a special name for output files

Later, we want you to compare the solution file from this simulation with another solution file. If you want to preserve solution files for later reference, you have to give a unique name for simulation output files. To do this, go to the Output Files page, and click on the line beginning

Solution file =

A file dialog will appear; type in a new name. This time, type **drought.SL4** [the suffix SL4 is compulsory]. Then click Save.
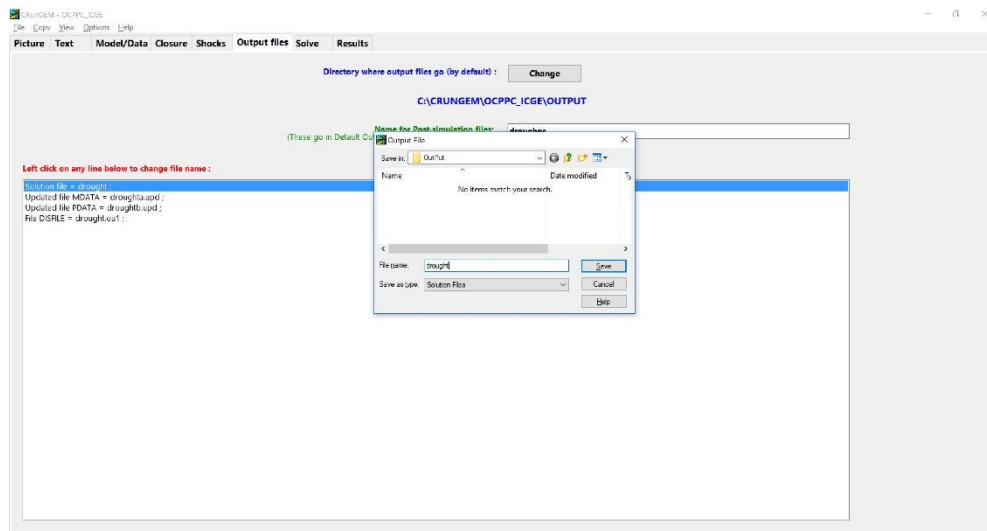
When you have set the name for output files, go to the Solve page.

8.3. Choosing the solution method and running the simulation

From the Solve page:

1 First, select the solution method to use. To do this, you would need to click on the ***Change*** button to the right of the **Solution method** label. [This button is the top-most button on the page.] In the ***Method*** part select **Euler.** [We will discuss the alternative methods later.]

2 Next notice the ***Verbal description*** label and the edit box to its right. It is good practice to enter a few words summarizing the simulation you are about to carry out. So first select the existing entry with your mouse and then replace it by

   10% decrease in productivity in the agricultural sector in Fès-Meknès

3 Now click the Solve button to start the solution process.

RunGEM runs the TABLO-generated program OCPPC_ICGE.EXE to solve the OCPPC ICGE model.

Once it has solved, RunGEM displays an accuracy summary chart showing how many variables are accurate in the levels to 1, 2, 3, 4, 5, or 6 figures. A little face summarizes overall accuracy – hopefully, it is smiling. Accuracy of the updated data is summarized in the same way. Click **Help** to learn more, then **OK** to proceed. Another message now tells how long the solution took.

8.4. Looking at the results

When the solution has been obtained, RunGEM will present you with a box telling you how long it took to obtain the solution. Close this and go directly to the ***Results*** page.

This page allows you to inspect the variable values computed during the **last** successful solution process. Initially, a **Contents** window is displayed, listing the model variables. You can double-click on the row containing the variable you are interested in to see its results in this simulation. As you saw previously, you can also use the button marked **"V"** to arrange the contents list in two ways:

- variables listed individually;
- variables ranging over the same set grouped together.

You can also look at the results using ViewSOL. First click on the button

View | Solution via ViewSOL

The Contents screen shows the names of the variables. To see the values of a variable, double-click on its name. To return to the Contents screen, double-click on any number (or select Contents in the ViewSOL menu).

Start by double clicking on the first Contents row: **Macros** (Macros are scalar variables or variables with just one component). You should see a list of macro variables and the value of their changes. You can click on the variable names – a description will appear at the bottom of ViewSOL. Use the decimal places combo box at top right to set the number of decimal places to 3.

Most of the variables are percentage changes, but some are ordinary changes, measured in million-DHS. Values for exogenous variables are shown in red. Scroll down the list to find price indices, nominal values, and quantity indices.

Q26. Write down below what happened to:

> **natexpvol**: export volumes
> **natgdpreal**: real GDP from expenditure side
> **natemploy**: national employment
> **natimpvol**: import volume
> **natxi4**: exports price index
> **natxi3**: consumer price index
> **natpwage**: aggregate nominal wages to workers

Double-click on any number to return to the Contents screen. Then scroll down until you find the variable **natz** (activity level). Double-click to view the numbers.

Q27. Which manufacturing sector (D01-D06) was most affected?

Return to Contents and view regional results for:

x4r: export volume
xi3: regional consumer price index

Q28. Compare the results for **c** (nominal total household consumption) and **yd_r** (household disposable income). What do they suggest? Can you find in the OCPPC_ICGE.TAB file the relevant equation?

Q29. Look at the results for **yr** (real GRP), **l** (aggregate employment) and **z** (activity level by sector). Which region is the main loser? Which regions were relatively less affected in real GDP terms? Can you think why?

8.5. Changing the solution method

In this example, you will tell RunGEM to solve the model using Johansen's method. With Johansen's method, only approximate solutions are obtained to the nonlinear levels equations of the model. GEMPACK also provides multi-step solution procedures referred to as **Euler's** and **Gragg's solution methods.** Coupled with **extrapolation** (a standard numerical method used in various branches of science and engineering), these are able to provide accurate solutions of the levels equations of the model, as was the case in the example above.

To change the solution method in RunGEM go to *Solve* and click on the *Change* button to the right of the **Solution method** label. [This button is the top-most button on the page.] In the *Method* part select **Johansen**. Then click *Ok*, and go to the Output Files page.

8.6. Choosing a special name for output files

Later we want you to compare results from this simulation with those from the previous simulation that used the **Euler** solution method. This means that you must specify a unique name for the output files that the next simulation will produce. To do this, go to the Output Files page, and click on the line beginning **solution file =**. A file dialog will appear; type in the name droughtj.SL4. Then click Save.[9]

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[9] If you do not give a new name for the SL4 file, RunGEM uses the same name as before, and so overwrites the previous solution file. This might be annoying! You can use Explorer to delete files in the Output directory (maybe to save disk space).

8.7. Running the Johansen simulation

Now go to the *Solve* page and click the *Solve* button. A "Please Wait" window will appear while the model is solved. Then RunGEM will show you a box telling you how long the solution took. Just press OK.

8.8. Using ViewSOL to compare two sets of results

The RunGEM Results page lets you see only the most recently-computed solution. Sometimes you want to view 2 solutions at once. You can do that using the ViewSOL program which comes with RunGEM.

We assume that RunGEM is open and you have just successfully completed the steps described in previous sections.

Now select the menu item *View / Solution via ViewSOL*. The ViewSOL program will open the most recent solution[10] and show a Contents page. In general, ViewSOL works very like the **Results** page of RunGEM. For example, you can double-click on a variable to see its values.

Now, use the ViewSOL menu command *File / Open* to open the solution file **drought.SL4**. This ought to contain results from the previous, Euler 1-2-4, simulation.

ViewSOL Contents will again appear. ViewSOL offers a choice of formats for this Contents list. Select *Format.* from ViewSOL's main menu and there click on *Arrange vectors by name* (in the panel headed Vector options); also click the button *Order Variables alphabetically*; then click *Ok* which will put you back to the Contents list. Now double-click on the **macros** row and you should be able see both solutions together.

---

[10] ViewSOL displays a short quotation (either inspiring or corny) while it is loading the solution file.

Q30. Do you think that the differences between Johansen and Euler solutions are significant?

Go back to the ViewSOL contents list and double click on the row for **z,** a matrix variable (this will be near the end of the contents list). This time you will only see results for one simulation. But you can use the **solution list box** (see picture) to switch between the two solutions. The Description menu item gives details of the currently selected solution.

Now use the Filtering list box to select only the **R3** (Fès-Meknès) component of matrices. This takes you back to the contents screen. Double-click on the **z[*,R3]** row (probably the last row). You should see results for the Euler and Johansen simulations side-by-side:

When you have finished looking at the results, exit from ViewSOL.

8.9. Copying results into a spreadsheet

RunGEM makes it easy for you to copy simulation results (or data) into other windows programs such as spreadsheets or word processors. You will find this invaluable when you are preparing reports.

As an example, below we set out the simple steps needed to copy the **yr** results from the previous simulation into Excel (or another spreadsheet).

Go to the Contents page of the *Results* and then select the **yr** results. You should see something like:

Now click on *Copy* from RunGEM's main menu. A message **Data copied to Clipboard** will appear for a moment.

Now start Excel (or your favourite spreadsheet program) running. In a new sheet, click on the top left-hand cell and then select *Edit / Paste* from the main menu. You should see the above table appear in Excel. Note that the number of decimal places selected in RunGEM affects the exact numbers copied.

[If you want to check whether there is a correlation between regional performance in terms of GRP and the share of agriculture in total value added, as suggested in Q29, open the file **Shares.xlsx** and create a scatter plot using the appropriate variables – exclude the observation for Fès-Meknès].

Close Excel.

In ViewHAR and ViewSOL, the **Export** command lets you copy data to Excel in just the same way.

When you have finished looking at the results, exit from RunGEM and other related programs.

9. An experiment with more complicated shocks: transport investment in Morocco

General equilibrium modellers need to explain their results. A general equilibrium model has various main mechanisms that produce the results. The modeller is required to identify and quantify those that are important for a particular simulation. To analyse the results in this way, the modeller must bring together details of several different information sources: the equations of the model, the base data, consequences of that data such as totals and shares, and the simulation results (percentage changes or ordinary changes). For this exercise, you can find the story behind the simulation (told in the Egyptian context) in the companion paper "Accessibility, Transportation Cost, and Regional Growth: A Case Study for Egypt", by Elshahawany, Haddad, and Lahr (*Middle East Development Journal*).

This section presents another example with the OCPPC ICGE model: a transport project simulation. The example is presented as exercises for the reader to follow. Before we proceed, it is important to understand the specification and calibration of transportation costs in the model.

9.1. Modelling of transportation costs in the OCPPC ICGE

An important feature of the OCPPC ICGE model is its ability to explicitly estimate costs of moving products based on origin-destination pairs according to transportation margins. That is, the model accounts for the specific cost structure of the flow of each traded commodity. The model physically constrains that structure by the available transportation network, which is modelled in a geo-coded transportation module.

The model's integration with a GIS network helps quantifying the spatial effects of transportation cost change. Moreover, it enables us to explicitly model commodity-based transportation costs within the ICGE model. Thus, the model intrinsically accounts for the spatial structure of the Moroccan economy. That is, inclusion of the transportation network within the OCPPC ICGE augments the general model framework for understanding the equilibrating role of transportation (and hence transportation investments) in regional economic development. The transport module measures minimum travel times between regions using actual road routes. The OCPPC ICGE model estimates the short and long-run spatial spread of national GDP, as well as other measures of economic activity, caused by expected changes in regional accessibility. The figure below summarizes the main methodological aspects of our modelling strategy.
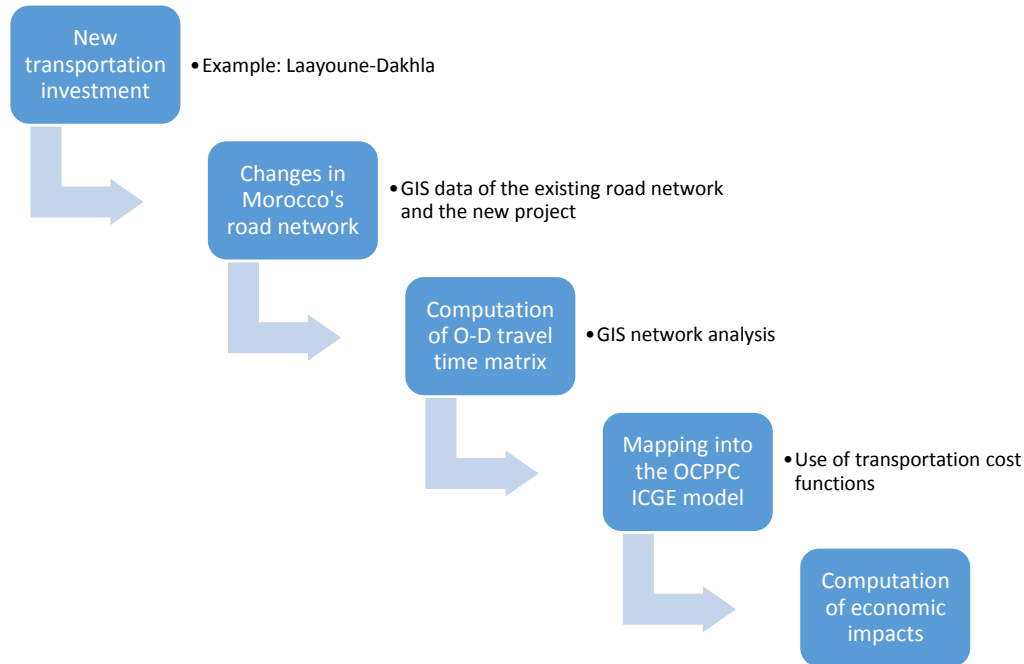
The set of equations that specify purchasers' prices in the OCPPC ICGE model imposes zero pure profits in the *distribution* of commodities to different users. Prices paid for commodity i from source s in region q by each user equate to the sum of its basic value and the transportation costs associated with the use of the relevant margin-commodity.

The role of the margin-commodity is to facilitate flows of commodities from points of production or points of entry to either domestic users or ports of exit. The margin-commodity, or, simply, margin, includes transportation services. Combined, they take account of transfer costs in a broad sense.[11] The margin demand equations in the model show that the demands for margins are proportional to the commodity flows with which the margins are associated; moreover, a technology change component allows changes in the implicit transportation rate.[12]

The model uses a general functional form for the equations of margin demand, for different users. Let x be a flow of some good i from some region s to region r, and m the quantity of the required transportation margin.[13] Assuming $m = A\eta x$, with parameter η specific to i, s and r, and A, specific to i, s and r, being a shift variable used to rescale the reference estimates of η. Thus, an integration scenario, reducing transportation costs from region s to region r by say 10%, is modeled by reducing A by 10% for all goods i.[14]

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[11] Hereafter, transportation services and margins will be used interchangeably.

[12] In the case of international imported goods, the implicit transportation margin is interpreted as the costs at the port of entry plus land transportation costs to the consuming region, while for foreign exports it includes transportation costs from the producing region and the costs at the port of exit.

[13] Similarly, one can think about flows of exports from the producing region to the port, or flows of imports from the port to the consuming region.

[14] The process of calibration of transportation costs assumes $A = 1$ for all i, s and r in the benchmark year. Thus, η can be calibrated by calculating the relationship between m and x directly from the interregional input-output database.

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In integrating the network and ICGE models, we assume that the locus of production and consumption in each region is its main city; moreover, for tractability, it is assumed international trade transpires only through Casablanca. Thus, travel times associated with the flows of commodities from points of production (or port of entry) to points of consumption (or port of exit) are, again for the sake of model tractability, restricted to a matrix of travel times among Morocco's regional capitals. Moreover, to account for intra-regional transportation costs, the model lets trade within each region take place at a "distance" that is time-wise half that to the one other capital city that is most readily accessed. The transportation module then calculates the minimum interregional (path) times, considering the road network as connected. Travel times are then associated via a gravity model formulation to the transportation costs implicit in the transactions of the ICGE database, and tariff functions using data on general cargo prices (for domestic trade flows) and container prices (for international trade flows).

General equilibrium effects occur within a system of market relationships that is stable and relatively well understood. According to the model structure (Haddad et al., 2011), this may represent a margin-saving change, i.e. the use of transportation services per unit of output is reduced, implying a direct reduction in the output of the transportation sector, which frees resources for the economy (technical change channel).

The reduction in transport cost also decreases the price of composite commodities, with positive implications for real regional income (price change channel): in this cost-competitiveness approach, firms become more competitive – as production costs go down (inputs are less costly); investors foresee potential higher returns – as the cost of producing capital also declines; and households increase their real income, envisaging higher consumption possibilities. Higher income generates higher domestic demand, while increases in the competitiveness of national products stimulate external demand. This creates room for increasing firms' output – directed for both domestic and international markets – which requires more inputs and primary factors. Increasing demand puts pressure on the factor markets for price increases, with a concomitant expectation that the prices of domestic goods would increase.

Second-order prices changes go in both directions – decrease and increase. The net effect is determined by the relative strength of the countervailing forces. The figure below summarizes the transmission mechanisms associated with major first-order and second-order effects in the adjustment process underlying the model's aggregate results.

Price change channel	Technical change channel
Reduction in transport cost →	Reduction in transport requirement per unit sold
Decrease the price of composite goods	Output of transport sector declines
Increase (decrease) real regional income: firms, investors, households	Free capital and labor resources from transport sector (shipments less resource-intensive)
Firms: more (less) competitive Investors: potential higher (lower) returns Households: "richer" ("poorer")	Excees supply of primary factors
Higher (lower) domestic demand Higher (lower) external demand	
Higher (lower) output by firms	
Higher (lower) demand for primary factors	
Pressure on primary factor prices to increase (decrease)	Decrease prices of primary factors
Prices increase (decline)	Prices decline

9.2. Preparing the shock file

The simulation shows the long-run effects of a project consisting of the duplication of the existing road link between Laayoune and Dakhla.

Investment in transportation is an important element of the range of regional policies available for the Moroccan government. To explore the effects of such policies, the OCPPC ICGE model is used to simulate the impacts of a specific intervention in the southern part of the country.

We start by calculating the project's effect on the travel times among regions.[15] We record the minimum impedance paths in minutes among the prime cities of Morocco's regions. We show time savings by pairs of regions. They reflect the reduction in travel time that the duplication of the corridor between Laayoune and Dakhla engenders on the accessibility of a region to/from all other regions. We have changed the speed limit in the corridor from 80 km/h to 110 km/h. The main results are shown below. Notice that regions that face higher reductions in travel time are in the direct area of influence of the project – R11 and R12. However, network effects spread the benefits of higher accessibility to other regions in the country. The table presents the specific travel time changes for every pair of origin-destination. The change in the travel-time matrix associated with the operation of the new transport infrastructure project provides the basis for integrating the transport module to the ICGE model.

Change in travel time to/from regions due to the project (in percentage change)

			DESTINATION											
			R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12
ORIGIN	Tanger-Assilah	R1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.10	-7.61
	Oujda	R2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.09	-6.67
	Fès	R3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.10	-7.37
	Rabat	R4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.13	-8.68
	Béni Mellal	R5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.13	-8.98
	Casablanca	R6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.14	-9.06
	Marrakech	R7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.15	-9.82
	Errachidia	R8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.10	-7.47
	Agadir-Ida-Ou-Tanane	R9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.21	-11.88
	Guelmim	R10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.31	-14.42
	Laâyoune	R11	-0.10	-0.09	-0.10	-0.13	-0.13	-0.14	-0.15	-0.10	-0.21	-0.31	-10.97	-26.12
	Dakhla	R12	-7.61	-6.67	-7.37	-8.68	-8.98	-9.06	-9.82	-7.47	-11.88	-14.42	-26.12	-26.12

We then proceed to calculate the change in transportation cost dependent on the change in travel time. The change in transportation cost among regions is considered the primary direct impact of the improvement in the Laayoune-Dakhla corridor, which should be followed by other economic impacts on the economy as discussed above. We use the change in travel time to calculate the change in cost for domestic and international trade flows using the following two estimated functions:

$$Tariff_i = 3.79998 * Time^{0.85257}{}_i \qquad \text{(Domestic trade cost function)}$$
$$Tariff_i = 3.55169 * Time^{0.88635}{}_i \qquad \text{(International trade cost function)}$$

where *Tariff* is the change in transportation cost, *Time* is the change in travel time due to the project. We present below the change in transportation cost to/from all regions and to other countries. This information serves as the shocks (changes in margins) to the OCPPC ICGE model.

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[15] See *Technical Note 1: Morocco GIS Data* and *Technical Note 2: Morocco OD Matrix Tutorial*.

Change in transportation cost to/from regions due to the project (in percentage change)

		DESTINATION												
		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	EXP
ORIGIN	Tanger-Assilah R1	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-0,04	-2,89	0,00
	Oujda R2	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-0,03	-2,53	0,00
	Fès R3	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-0,04	-2,80	0,00
	Rabat R4	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-0,05	-3,31	0,00
	Béni Mellal R5	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-0,05	-3,42	0,00
	Casablanca R6	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-0,05	-3,46	0,00
	Marrakech R7	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-0,06	-3,75	0,00
	Errachidia R8	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-0,04	-2,83	0,00
	Agadir-Ida-Ou-Tanane R9	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-0,08	-4,57	0,00
	Guelmim R10	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-0,12	-5,60	0,00
	Laâyoune R11	-0,04	-0,03	-0,04	-0,05	-0,05	-0,05	-0,06	-0,04	-0,08	-0,12	-4,21	-10,61	-0,05
	Dakhla R12	-2,89	-2,53	-2,80	-3,31	-3,42	-3,46	-3,75	-2,83	-4,57	-5,60	-10,61	-10,61	-3,59
	Foreign IMP	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-0,05	-3,59	

We use the OCPPC ICGE model to estimate the long-run impacts of the project on both national and regional variables. A distinguish feature of short run versus long run simulations is the treatment of capital stock. Short run simulations are based on the assumption of fixed capital stock. That is, industries capital stocks are held at their pre-shock level, while in the long run policy changes are allowed to affect capital stocks.

In the OCPPC ICGE model, the general functional form used for the margin demand equations is presented below:

$$XMARG(i,s,q,r) = AMARG(i,s,q,r) * [\eta(i,s,q,r) * X(i,s,q,r)^{\theta(i,s,q,r)}]$$

where *XMARG(i,s,q,r)* is the margin *r* on the flow of commodity *i*, produced in region *r* and consumed in region *q*; *AMARG(i,s,q,r)* is a technology variable related to commodity-specific origin-destination flows; $\eta(i,s,q,r)$ is the margin rate on specific basic flows; *X(i,s,q)* is the flow of commodity *i*, produced in region *r* and consumed in region *q*; and $\theta(i,s,q,r)$ is a parameter reflecting scale economies to (bulk) transportation. In the calibration of the model, $\theta(i,s,q,r)$ is set to one, for every flow.

In the database of the model, information on transport rates is available. With that in hand, changes in transport rates can be estimated and incorporated in the OCPPC ICGE model, as follows. Rearranging the margin demand equation, we have

$$\frac{XMARG(i,s,q,r)}{X(i,s,q,r)^{\theta(i,s,q,r)}} = AMARG(i,s,q,r) * \eta(i,s,q,r)$$

with $\theta(i,s,q,r) = 1$ implying that the left-hand-side becomes the specific transport rate. A percentage change in the transport rate can then be mapped into the technology variable, *AMARG(i,s,q,r)*. Thus, in percentage-change form, *amarg(i,s,q,r)* becomes the relevant linkage variable

$$xm\arg(i,s,q,r) - x(i,s,q,r) = am\arg(i,s,q,r)$$

Q31. Find in the file OCPPC_ICGE.TAB the occurrence of the variable **amarg_i**. In which equations does it appear? What role does it play?

The details of the shock sizes are contained in the file TRANSP.SHF.

9.3. Implementing the shocks and running the simulation

Start up RunGEM with the OCPPC ICGE model. Go to the *Closure* page. As in the previous example, use the *Load closure* button to select the **long run** closure file (LONGRUN.cls). Notice that the variable **amarg_i** is exogenous:

Then go to the *Shocks* page and delete any existing shocks by clicking **Clear Shocks List**. Then specify the shocks as follows: click on **Load File of Shocks** and select the previously prepared shock file **TRANSP.SHF**.
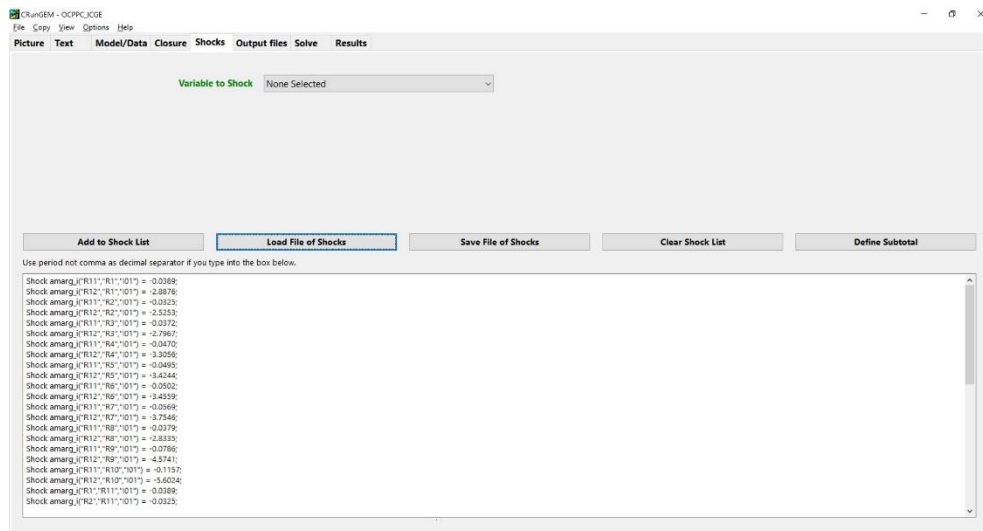
The shock list underneath should now contain:

Shock amarg_i("R11","R1","I01") = -0.0389;
Shock amarg_i("R12","R1","I01") = -2.8876;
Shock amarg_i("R11","R2","I01") = -0.0325;
Shock amarg_i("R12","R2","I01") = -2.5253;
Shock amarg_i("R11","R3","I01") = -0.0372;
Shock amarg_i("R12","R3","I01") = -2.7967;
Shock amarg_i("R11","R4","I01") = -0.0470;
Shock amarg_i("R12","R4","I01") = -3.3056;
Shock amarg_i("R11","R5","I01") = -0.0495;
Shock amarg_i("R12","R5","I01") = -3.4244;
Shock amarg_i("R11","R6","I01") = -0.0502;
Shock amarg_i("R12","R6","I01") = -3.4559;
Shock amarg_i("R11","R7","I01") = -0.0569;
Shock amarg_i("R12","R7","I01") = -3.7546;
Shock amarg_i("R11","R8","I01") = -0.0379;

Shock amarg_i("R12","R8","I01") = -2.8335;
Shock amarg_i("R11","R9","I01") = -0.0786;
Shock amarg_i("R12","R9","I01") = -4.5741;
Shock amarg_i("R11","R10","I01") = -0.1157;
Shock amarg_i("R12","R10","I01") = -5.6024;
Shock amarg_i("R1","R11","I01") = -0.0389;
Shock amarg_i("R2","R11","I01") = -0.0325;
Shock amarg_i("R3","R11","I01") = -0.0372;
Shock amarg_i("R4","R11","I01") = -0.0470;
Shock amarg_i("R5","R11","I01") = -0.0495;
Shock amarg_i("R6","R11","I01") = -0.0502;
Shock amarg_i("R7","R11","I01") = -0.0569;
Shock amarg_i("R8","R11","I01") = -0.0379;
Shock amarg_i("R9","R11","I01") = -0.0786;
Shock amarg_i("R10","R11","I01") = -0.1157;
Shock amarg_i("R11","R11","I01") = -4.2094;
Shock amarg_i("R12","R11","I01") = -10.6058;
Shock amarg_i("Foreign","R11","I01") = -0.0522;
Shock amarg_i("R1","R12","I01") = -2.8876;
Shock amarg_i("R2","R12","I01") = -2.5253;
Shock amarg_i("R3","R12","I01") = -2.7967;
Shock amarg_i("R4","R12","I01") = -3.3056;
Shock amarg_i("R5","R12","I01") = -3.4244;
Shock amarg_i("R6","R12","I01") = -3.4559;
Shock amarg_i("R7","R12","I01") = -3.7546;
Shock amarg_i("R8","R12","I01") = -2.8335;
Shock amarg_i("R9","R12","I01") = -4.5741;
Shock amarg_i("R10","R12","I01") = -5.6024;
Shock amarg_i("R11","R12","I01") = -10.6058;
Shock amarg_i("R12","R12","I01") = -10.6058;
Shock amarg_i("Foreign","R12","I01") = -3.5903;
Shock a4marg_i("R11","I01") = -0.0522;
Shock a4marg_i("R12","I01") = -3.5903;

Q32. Can you tell why we shock **a4marg_i** as well?

When you have finished with the shocks, go to the Output Files page. There, click on the line there that begins **Solution file =**. In the file dialog; type in the name **transplr.SL4**. Then click Save.

Now go to the *Solve* page:

- First, select the solution method to use. To do this, click on the *Change* button to the right of the **Solution method** label. In the *Method* part select **Euler** and then make sure that you have **3 solutions** and **1, 2, 4 steps**. [Select these if they do not become selected after you click on "Euler"]. Check also the radio button **Automatic Accuracy**. Then click **OK**.

- Next notice the ***Verbal description*** label and the edit box to its right. It is good practice to enter a few words summarizing the simulation you are about to carry out. So first select the existing entry with your mouse and then replace it by

  Duplication of the Laayoune-Dakhla corridor

- Now click the ***Solve*** button to start the solution process.

RunGEM runs the TABLO-generated program OCPPC_ICGE.EXE to solve the OCPPC ICGE model.

9.4. Looking at the results

When the solution has been obtained, RunGEM will present you with an accuracy summary and a box telling you how long it took to obtain the solution.

Once it has solved, RunGEM displays an accuracy summary chart showing how many variables are accurate in the levels to 1, 2, 3, 4, 5, or 6 figures. A little face summarizes overall accuracy – hopefully, it is smiling. Accuracy of the updated data is summarized in the same way. Click **Help** to learn more, then **OK** to proceed.

Another message now tells how long the solution took. Click **OK** then select ***View | XAC file***. TABmate will show you the Extrapolation Accuracy File where you can see the effect of the solution method and the extrapolation. To be specific, search for **natxigdp** (GDP price index, expenditure side). This row of the XAC file is

```
9.838259E-03   9.833780E-03   9.831554E-03   9.829338E-03 CX 5 L6
```

Here the results are respectively the 1-step (9.838259E-03), the 2-step (9.833780E-03), the 4-step (9.831554E-03) and the extrapolated result (9.829338E-03), with two sub-intervals. The notation CX 5 means that you can be **C**onfident in the e**X**trapolated result (this is the CX) and you can be confident that at least 5 of the figures (that is, at least the 0.0098 part) in the extrapolated result are accurate. The L6 means that at least 6 figures in the corresponding levels result (as distinct from the percent-change result) are accurate.

Close this and go directly to the ***Results*** page.

Look first at the results for **a4marg_i** (tech margins on exports). Check that the relevant components of the variable were indeed shocked.

Then look at the macro results.

Q33. What was the effect on the variables listed below?

Real GDP (*natgdpreal*)

Real Household Consumption (*natcr*)

Activity Level (*natz_tot*)

Employment: Persons (*natemploy*)

Unemployment Rate (% point change) (*del_natunr*)

Nominal Wage Paid by Producers (*natpwage_p*)

GDP Price Index (*natxigdp*)

Consumer Price Index (*natxi3*)

Export Volume (*natexpvol*)

Import Volume (*natimpvol*)

Look over the real GRP results (**yr**).

Q34. Which regions are the main losers and gainers? Can you say anything about the long-run effects of the project on regional inequality?

9.4. Using Subtotals to divide up the effects of the shocks

If your simulation involves several different shocks, GEMPACK offers you a very powerful facility known as "subtotals". This allows you to divide the total change in any endogenous variable between the various shocks.

Try it out using the transportation project described above [if necessary, use **Load file of shocks** on the Shocks page to reload the TRANSP.SHF shock file that you saved, and rerun the simulation]. Divide the total change in three different subsets of shocks that relate to (i) access to foreign markets; (ii) access to foreign suppliers; and (iii) domestic integration. Go to the *Shocks* page and carefully type the following lines underneath the list of shocks:

Subtotal
a4marg_i("R11","I01")
a4marg_i("R12","I01")
 = Access to foreign markets ;

Subtotal
amarg_i("Foreign","R11","I01")
amarg_i("Foreign","R12","I01")
 = Access to foreign suppliers ;

Subtotal
amarg_i("R11","R1","I01")
amarg_i("R12","R1","I01")
amarg_i("R11","R2","I01")
amarg_i("R12","R2","I01")
amarg_i("R11","R3","I01")
amarg_i("R12","R3","I01")
amarg_i("R11","R4","I01")
amarg_i("R12","R4","I01")
amarg_i("R11","R5","I01")
amarg_i("R12","R5","I01")
amarg_i("R11","R6","I01")
amarg_i("R12","R6","I01")
amarg_i("R11","R7","I01")
amarg_i("R12","R7","I01")
amarg_i("R11","R8","I01")
amarg_i("R12","R8","I01")
amarg_i("R11","R9","I01")
amarg_i("R12","R9","I01")
amarg_i("R11","R10","I01")
amarg_i("R12","R10","I01")
amarg_i("R1","R11","I01")
amarg_i("R2","R11","I01")
amarg_i("R3","R11","I01")
amarg_i("R4","R11","I01")
amarg_i("R5","R11","I01")
amarg_i("R6","R11","I01")
amarg_i("R7","R11","I01")
amarg_i("R8","R11","I01")
amarg_i("R9","R11","I01")
amarg_i("R10","R11","I01")
amarg_i("R11","R11","I01")
amarg_i("R12","R11","I01")
amarg_i("R1","R12","I01")
amarg_i("R2","R12","I01")
amarg_i("R3","R12","I01")
amarg_i("R4","R12","I01")
amarg_i("R5","R12","I01")
amarg_i("R6","R12","I01")
amarg_i("R7","R12","I01")
amarg_i("R8","R12","I01")
amarg_i("R9","R12","I01")
amarg_i("R10","R12","I01")
amarg_i("R11","R12","I01")
amarg_i("R12","R12","I01")
 = Domestic integration ;

Then go to the ***Solve*** page and click the ***Solve*** button**.**
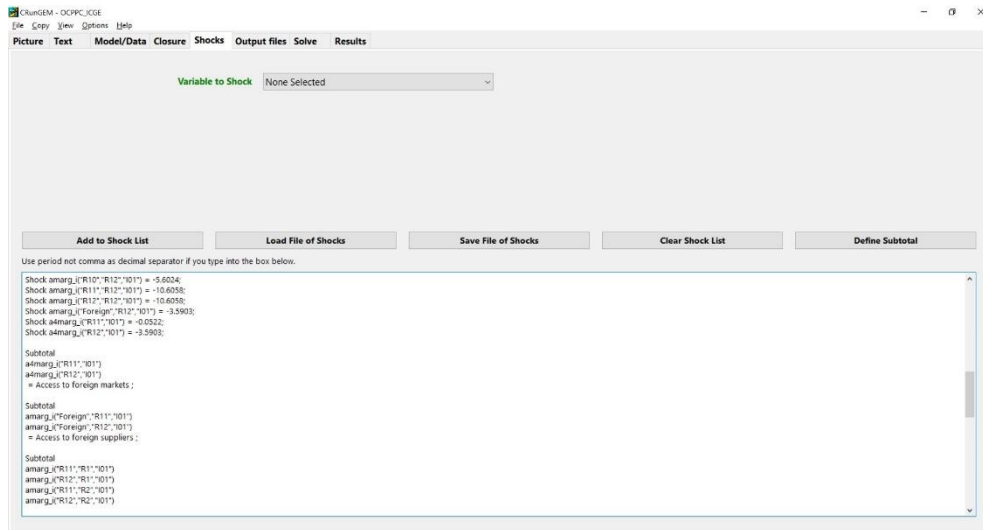
When the solution has been calculated, examine the macro results. You should see 4 columns of numbers. The first column shows the same changes that were calculated before. The next 3 columns show how much of the total change in each variable may be attributed to the exogenous changes in transportation costs on, respectively, tariff reduction on imported (i) flows of international exports; (ii) flows of foreign imports; (iii) trade flows within the country, involving only Moroccan regions. Click on the ***Description*** button above the results to verify this.

The subtotals columns show that the improved access to international markets account for most of the change. Following that, the third column, associated with increased integration with domestic markets, has slightly stronger impacts than improving access to international suppliers.

Q35. Which kind of "improved accessibility" produces the biggest impact on national GDP?

Q36. Look at the real GRP results (**yr**). In relative terms, which region benefits most from the project? And which region benefits least? Can remoteness explain part of the results?

Q37. Why is the improvement of the access from R11 and R12 to foreign imports bad for the other regions? Check that they all present negative impacts associated with cheaper imports for Laayoune and Dakhla.

Go back to the Shocks page and click the Define Subtotal button. This launches a window that can help you compose subtotal statements like the three that you added before. Use the Help button to find out how to use this window, and to find out more about the theory behind subtotals.

Q38. Can you tell if the improved access of Laayoune (R11) to foreign imports was more

harmful to other regions than the improved access of Dakhla (R12) to goods and services produced abroad? To answer this question, you will need to edit the command to compose subtotals.

10. Customized RunGEM and the complete GEMPACK system

The *Customized RunGEM with OCPPC ICGE* package that you have been using is especially arranged and simplified to suit newcomers to CGE modelling using GEMPACK, in general, and the OCPPC ICGE model, specifically. You might wonder how similar using the full GEMPACK system would be.

One difference is that RunGEM looks after *file management*: it controls the names and locations of the dozen or more files used for each GEMPACK simulation. An advanced GEMPACK user has to assume more of this responsibility.

Another difference is that users of the full GEMPACK system often wish to alter the data and specifications of the model. So they have to:

- use ViewHAR to create and modify the HAR files that contain data;
- edit the TAB file, then run the TABLO program to turn the TAB file into a model-solution program.

This document does not describe the many features of ViewHAR and TABmate that are aimed at these tasks. Also, you must buy a GEMPACK licence to run TABLO, to run larger models, or to modify larger data files. Finally, the full GEMPACK system contains many other programs, not described here.

Nevertheless, if you have worked through this document (and mastered the companion documents that describe the theory of the OCPPC ICGE model) you are well on the way to becoming a competent CGE modeller. You should understand the basic theory which underlies OCPPC ICGE – the same theory is used in every other CGE model. You can read and understand a TAB file – so now you have access to the large number of CGE models that use this notation. The tools that you have been introduced to, such as ViewHAR and TABmate, are the same tools used by other CGE model builders. Even the syntax used in RunGEM's Closure and Shocks pages is identical to the corresponding parts of the Command files (CMF files) required in GEMPACK for carrying out simulations.

The GEMPACK web page, at:

https://www.copsmodels.com/gempack.htm

gives access to a great deal of GEMPACK related information, such as details of the GEMPACK product range and licensing arrangements, but also including much free stuff. For example, you could download the **Demonstration version of GEMPACK** which gives access to the full range of GEMPACK capabilities but is limited to very small models.

Appendix 1: Installing Customized RunGEM

The Customized RunGEM for the OCPPC ICGE model is delivered as a single large EXE file, called CRUNGEMX.EXE, and a folder with the OCPPC ICGE model files. You might have downloaded this EXE file from the Internet (https://www.copsmodels.com/crungem.htm) and saved it in your TEMP folder. CRUNGEMX.EXE is a self-extracting archive which, when you run it, launches a conventional install procedure. Alternatively, you can download CRunGEM from the course area in www.usp.br/nereus.

The install procedure tells you how much free hard disk space you will need. You might have to clean up your hard drive before proceeding. It is best to install into a folder named C:\CRUNGEM. Avoid directory names that contain spaces, commas or Arabic characters or are more than 8 letters long.

The package will typically include other models as well. To have the OCPPC ICGE model running properly, you should copy the OCPPC_ICGE folder into the folder C:\CRUNGEM. If you want to launch the OCPPC ICGE model directly from double-clicking on the Customized RunGEM icon that will appear on your desktop after installation, you should delete all other **folders** in C:\CRUNGEM, except C:\CRUNGEM\OCPPC_ICGE and C:\CRUNGEM\work.

The final step to complete the installation is to copy the \GP folder (also available at the course area in www.usp.br/nereus) directly to the C: drive.

Customized RunGEM assumes that the user has his own copy of the program on his own hard drive. The program cannot be installed on a network drive and used by several people at once.

Appendix 2: List of regions and sectors of the OCPPC ICGE model

R1	Tanger-Tetouan-Al Hoceima
R2	Oriental
R3	Fès-Meknès
R4	Rabat-Salé-Kénitra
R5	Béni Mellal-Khénifra
R6	Grand Casablanca-Settat
R7	Marrakech-Safi
R8	Drâa-Tafilalet
R9	Souss-Massa
R10	Guelmim-Oued Noun
R11	Laayoune-Sakia El Hamra
R12	Dakhla-Oued Eddahab

A00	Agriculture, forestry, hunting, related services
B05	Fishing, aquaculture
C00	Mining industry
D01	Food industry and tobacco
D02	Textile and leather industry
D03	Chemical and para-chemical industry
D04	Mechanical, metallurgical and electrical industry
D05	Other manufacturing, excluding petroleum refining
D06	Oil refining and other energy products
E00	Electricity and water
F45	Construction
G00	Trade
H55	Hotels and restaurants
I01	Transport
I02	Post and telecommunications
J00	Financial activities and insurance
K00	Real estate, renting and services to enterprises
L75	General public administration and social security
MNO	Education, health and social action
OP0	Other non-financial services

Appendix 3: Morocco's road transportation network
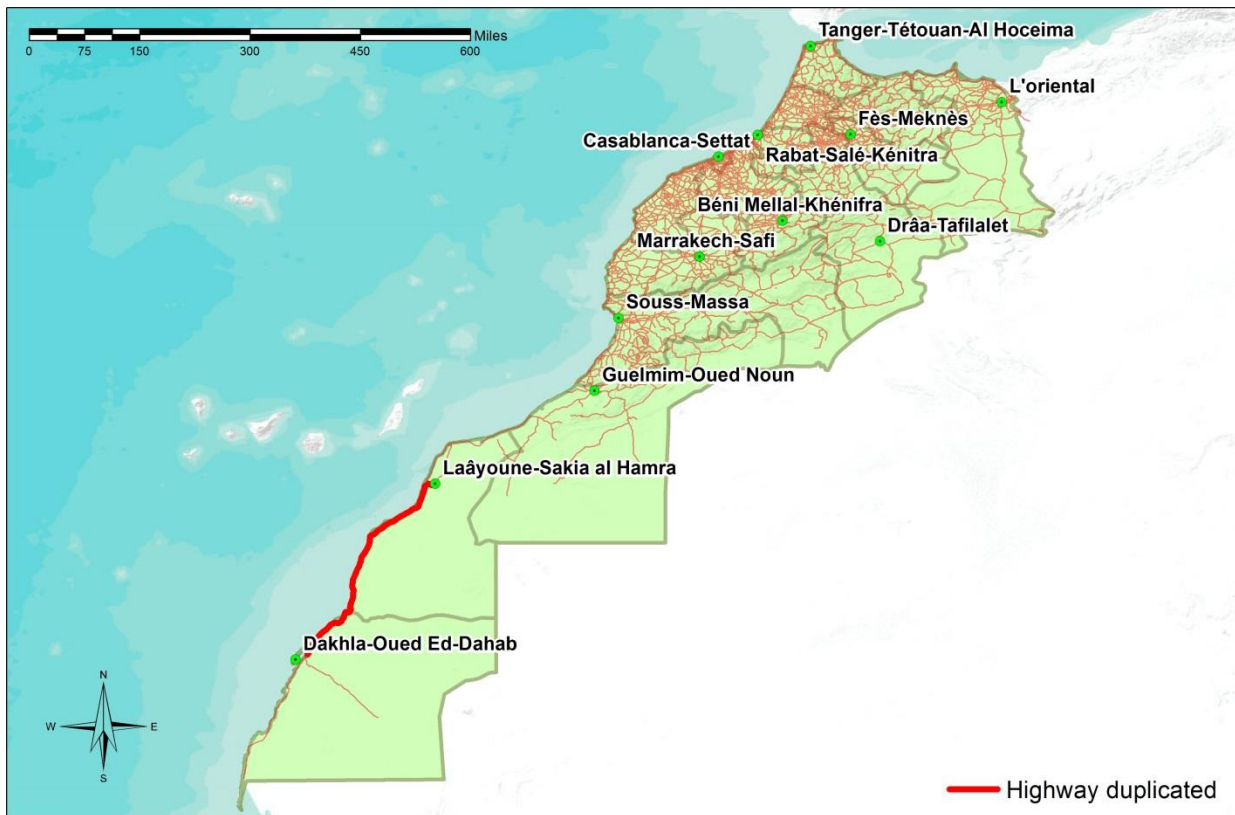
Appendix 4: Answers to questions in the text

Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
Q9
Q10
Q11
Q12
Q13
Q14
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Q38