ORANI-ESP: A Computable General Equilibrium Model for Agricultural Policy Analysis in Spain.

Part I: Building a CGE Data base for ORANI-ESP

Documento de Trabajo 2009/03

George Philippidis[1]

October 2009

[1] Agencia Aragonesa para la Investigación y el Desarrollo (ARAID), Centro de Investigación y Tecnología Agroalimentaria (CITA) Gobierno de Aragón

CONTENTS

FIGURES

1. Introduction

The aim of the project is the development of a multisector model which enables the modeller the possibility to examine the impacts of agricultural policy reforms across a detailed aggregation of agro-food sectors, whilst examining the implications for the non-food affiliated sectors and the broader Spanish macroeconomy through secondary resource reallocation impacts. In addition, it should be possible to quantitatively assess the distributive impacts of agricultural policy changes on Spanish households stratified by income.

Clearly, the construction and implementation of such a framework requires considerable time and effort to execute. Fortunately, such undertakings have been carried out employing Computable General Equilibrium (CGE) models for a number of countries. More specifically, the well known and respected ORANI framework serves as a vehicle for construction and application of a CGE economy-wide approach. Indeed, the model is designed to be 'relatively' adaptable to the structure of an input-output (IO) table, whilst the microeconomic basis of ORANI can be adapted to incorporate additional pertinent modelling features.

This document constitutes part one of two working papers, which is designed to describe step by step the construction of a CGE database for the Spanish economy. In part two, discussion is reserved for the standard ORANI model and the array of additional modelling features which have been incorporated into the Spanish variant (ORANI-ESP) to better characterise (*inter alia*) agro-food markets.

2. ORANI-G ('generic') standard data format

This study employs a heavily modified version of the CGE model template of ORANI-G[2] developed by the Centre of Policy Studies (CoPS) at Monash University in Australia (Horridge, 2003). It is descended from the ORANI GE model of the Australian economy which has been used extensively for policy analysis in Australia for nearly two decades. ORANI-G is a version of ORANI designed to serve as a basis from which to construct new models based on pre-prepared CGE datasets. Adaptations exist for China, Thailand, South Africa, Korea, Ireland, Pakistan, Brazil, the Philippines, Japan, Vietnam, Indonesia, Venezuela, Taiwan and Denmark.

The structure of the data necessary for the elaboration of a standard country specific version of ORANI-G is presented in Figure 1. In this standard template, the model is split into a series of accounts as follows:

1. Domestic production divided by I industries
2. Investors divided by I industries
3. A single representative household

[2] 'G' stands for 'generic'.

4. A single aggregate foreign purchaser of exports
5. Government demands
6. Changes in stocks.

		Absorption Matrix					
		1	2	3	4	5	6
		Producers	Investors	Household	Export	Government	Change in Inventories
	Size	I	I	1	1	1	1
Basic Flows	CxS	1BAS	2BAS	3BAS	4BAS	5BAS	6BAS
Margins	CxSxM	1MAR	2MAR	3MAR	4MAR	5MAR	n/a
Taxes	CxS	1TAX	2TAX	3TAX	4TAX	5TAX	n/a
Labour	O	V1LAB					
Capital	1	V1CAP					
Land	1	V1LND					
Production Tax	1	V1PTX					
Other Costs	1	V1OCT					

C = Number of Commodities
I = Number of Industries

S = 2: Domestic,Imported,
O = Number of Occupation Types

M = Number of Commodities used as Margins

	Joint Production Matrix
Size	I
C	MAKE

	Import Duty
Size	1
C	V0TAR

Figure 1. The ORANI-G Flows Database

The entries in each column show the structure of the purchases made by the agents identified in the column heading. Each of the ‘C’ commodity rows identified in the model can be obtained locally or imported from overseas. The source-specific commodities are used by industries as inputs to current production and capital formation; are consumed by households and governments; are exported; or are added to or subtracted from inventories. Only domestically produced goods appear in the export column. M of the domestically produced goods are used as margins services (wholesale and retail trade, and transport) which are required to transfer commodities from their sources to their users. Commodity taxes are payable on the purchases. As well as intermediate inputs, current production requires inputs of three categories of primary factors: labour (divided into 'O' occupations), fixed capital, and agricultural land. Production taxes include output taxes or subsidies that are not user-specific. The 'other costs' category covers various miscellaneous costs on firms. Each cell in the illustrative absorption matrix in Figure 1 contains the name of the corresponding data matrix. For example, 2MAR is a 4-dimensional array showing the cost of 'M' margins services on the flows of 'C' goods, both domestically produced and imported (EU and non-EU), to 'I' investors.

In principle, each industry is capable of producing any of the 'C' commodity types. The MAKE matrix at the bottom of Figure 1 shows the value of output of each commodity produced by each industry. By convention, the values in each column 'j', must be equal to the total costs in each industry in the absorption matrix. Equally, the MAKE matrix row totals for each commodity 'c' must be equal to the total values of domestic commodities plus the direct and indirect usage of (domestic) margin commodities. Finally, tariffs on imports are assumed to be levied at rates which vary by commodity but not by user. The revenue obtained is represented by the tariff vector V0TAR.

3. IO Data Tables

It is this template upon which the elaboration of the model is based. The principle source of data which is employed is an input-output (IO) table for the Spanish economy. An IO table is a set of accounts which depicts the production of goods and services from their origins (i.e., the components of industry costs necessary to produce such products) to their end usage (either as intermediate inputs, final demands or investment demands). Technically, this form of the IO Table is referred to as a **Use Table**, a simple example of which is presented in Figure 2. The format of these tables follows closely those of the IO accounts for Spain. **Note that in the Spanish IO Table, there are 118 commodities and 75 industries**. Whilst the representation employed here is much smaller, the principle structure is the same.

At the outset, the input output table presents flows of data in different prices, whether they are 'basic', producer' or 'purchaser' prices. Industry **basic prices** are 'factory gate' prices which are representative of the costs of production on value added (i.e., primary factors) and intermediate input costs (output of industry 'i' used as an input in the production of industry 'j'), as well as direct taxes on production. The **producer price** includes net indirect taxes on product usage (final or intermediate), whilst **purchaser's prices** are inclusive of margin costs (whether retail or transportation) necessary to deliver the product to its final destination point.

Total USE table	Intermediate demands			Final demands					
	Agric	Manu	Servs	Priv	Govt	Invest	Stocks	Export	Total
Agric	7	2	1	5	0	1	-2	3	**17**
Manu	2	14	9	46	21	8	-3	28	**125**
Servs	1	15	9	62	18	2	0	0	**107**
Margin	2	9	18	26	12	3	0	5	**75**
Indirect Tax	-2	7	0	12	8	3	0	-2	**26**
Op Surplus	4	34	31	-	-	-	-	-	**69**
Lab	5	42	19	-	-	-	-	-	**66**
Prod Tax	-2	5	7	-	-	-	-	-	**10**
Total	**17**	**128**	**94**	**151**	**59**	**17**	**-5**	**34**	**495**

Domestic USE table	Intermediate demands			Final demands					
	Agric	Manu	Servs	Priv	Govt	Invest	Stocks	Export	Total
Agric	6	2	1	3	0	1	-2	3	**14**
Manu	1	11	4	38	18	6	-3	28	**103**
Servs	1	8	5	32	9	1	0	0	**56**
Margin	2	8	18	20	10	3	0	5	**66**
Indirect Tax	-2	6	0	8	5	2	0	-2	**17**
Op Surplus	4	34	31	-	-	-	-	-	**69**
Lab	5	42	19	-	-	-	-	-	**66**
Prod Tax	-2	5	7	-	-	-	-	-	**10**
Total	**15**	**116**	**85**	**101**	**42**	**13**	**-5**	**34**	**401**

Import USE table	Intermediate demands			Final demands					
	Agric	Manu	Servs	Priv	Govt	Invest	Stocks	Export	Total
Agric	1	0	0	2	0	0	0	0	**3**
Manu	1	3	5	8	3	2	0	0	**22**
Servs	0	7	4	30	9	1	0	0	**51**
Margin	0	1	0	6	2	0	0	0	**9**
Indirect Tax	0	1	0	4	3	1	0	0	**9**
Op Surplus	0	0	0	-	-	-	-	-	**0**
Lab	0	0	0	-	-	-	-	-	**0**
Prod Tax	0	0	0	-	-	-	-	-	**0**
Total	**2**	**12**	**9**	**50**	**17**	**4**	**0**	**0**	**94**

MAKE MATRIX	Agric	Manu	Servs	Total
Agric	13	1	0	**14**
Manu	3	100	0	**103**
Servs	1	2	53	**56**
Margin	0	25	41	**66**
Total	**17**	**128**	**94**	

Figure 2: 'Typical IO Absorption (USE) and supply (MAKE) IO Tables

In Figure 2, USE tables are split into **total, domestic** and **aggregate imports,** whilst values are presented in basic prices, since a **net indirect tax row** has been disaggregated. Net indirect taxes (subsidies) are payment to (receipt from) government per unit of some good or service in intermediate or final demands. These are mainly constituted by value added taxes, and specific commodity taxes on alcohol, fuel and beverages. Note that in the IO tables, the convention is that 'basic' import flows are valued at **'cost insurance freight**

values' (cif), whilst import tariffs are captured within the indirect taxes matrix.[3] In the ORANI data template, the basic value of imports equals the cif value PLUS the import tariff, which implies a degree of data massage. [4] In the case of **net indirect subsidies**, apart from subsidies on fuel, R&D and education, these mainly include subsidies per unit of agricultural products employed (i.e., production aids on products employed as inputs (i.e., olives), seeds, headage (cattle), area payments), whilst export restitutions are captured within the export account column. Indeed, it is important to note that IO and ORANI basic prices are pre-export subsidy, whilst purchaser's prices in ORANI and the IO Tables are **free on board (fob)** prices.

The rows denote the supply of **commodities** 'c', whilst the columns depict the sources of demands or uses by **industries** or **final demands** for each of the commodities. Thus, the row totals are total supplies (at unit cost) and the column totals are total demands (at unit cost). In the example presented here, there are four commodities, 'agriculture', manufacturing', 'services' and 'margin' commodities, whilst there are three industries, 'agriculture', manufacturing', 'services'. Thus, the matrix is **NOT square** (i.e., commodities ≠ industries). This is similar in structure to the IO Table for Spain, which presents 118 commodities by 75 industries. In addition, additional costs are divided between **value added** and **production taxes**. Value added is divided between gross **labour costs** (salaries including contributions, overtime, benefits) and **gross operating surplus.**[5] Gross operating surplus includes the gross returns on **capital** (i.e., including depreciation) and **land** (in agricultural sectors only) as well as **gross profits** (including bad debts and charitable contributions) prior to income taxes and dividends to shareholders. **Production taxes or subsidies** constitute an additional cost or benefit from engaging in production which are not payable per unit of good or service. In the context of agriculture, subsidies would include payments such as set-aside, LFAs, young farmers' aids, irrigation aids, agro-environmental aids etc.[6]

For obvious reasons, no Spanish exports or domestic stock purchases appear in the imports USE matrix, whilst it is assumed that primary factors are not mobile internationally (i.e., no imports of primary factors). Moreover, the 'margins' commodity includes 'direct' (i.e., direct purchases either as intermediate or final demand) and 'indirect' usage (usage as a margin commodity).

In the ORANI model, the accounting convention applies that total USE demands (i.e., costs) must be equal to total 'domestic' supplies. In the IO tables, this condition is

[3] This implies that purchaser's values are inclusive of import tariffs.
[4] It is therefore necessary to calculate the tariff values from the import taxes and add them to the basic value flows in the model, whilst simultaneously subtracting from the indirect tax matrices. This data reconciliation procedure is discussed in section 9.
[5] Technically this is defined as Value added – Labour costs – other production taxes/subsidies. Operating surplus is also net of capital costs.
[6] In the ORANI-ESP model, the representation of agricultural support is changed compared with the IO Tables. This is discussed later.

expressed by the total costs of domestic industries in the total usage table (17, 128 and 94 units respectively) and the total supplies of commodities in the domestic USE table (14, 103, 56, 66). These row and column totals must be equal to those in the **MAKE matrix**.

The MAKE matrix expresses the relationship between the domestic production of each commodity 'i' by each industry 'j' in basic prices. Note that since the matrix is not square and multi-product production is possible, each 'i' row total is not equal to each 'j' column total. If no multi-product industries existed, the off diagonals in the MAKE matrix would be zero. In this example (as in the IO Tables for Spain), this is not the case (i.e., positive off diagonal elements). For example, the agricultural industry produces 3 'units' of manufacturing commodities.

In addition to the data presented in Figure 2, the Spanish IO Tables present the total USE table in purchaser's prices, whilst total indirect margin usage by rows and total indirect tax totals by rows and columns are available. Each of these sources of data form a useful basis for the construction of the margin matrices (VxMAR) and indirect taxation matrices (VxTAX) shown in Figure 1.

4. Additional comments on the IO Accounts

In addition to the information and definitions provided here, this section provides some further definitions and clarifications of the IO data. It is important to define the difference between '**market' and 'non-market' goods and services**. In the IO format, market production covers production at economically significant prices or otherwise disposed of on the market (i.e. receipts exceeding production costs). Non-market production covers production where products are supplied free or at prices that are not economically significant. It covers also production for own final demands (i.e., subsistence farming, households in owner occupied dwellings producing their own services such as cleaning and maintenance (i.e., dwelling services)).[7]

Non-profit organisations are expenditures by 'not-for-profit' entities mainly financed via government budgets and households. **Government expenditure** consists of both central and local government expenditures on market and non market goods. Gross fixed capital formation is the value of acquisitions less disposals of new or existing fixed assets. Fixed assets consist of both tangible fixed assets (dwellings, other buildings and structures, other structures, transport equipment, other machinery and equipment, livestock for breeding etc., vineyards, orchards etc.) and intangible fixed assets (mineral exploration including oil and gas, computer software, entertainment, literary or artistic originals, etc.).

Changes in inventories are the value of entries into inventories less the value of withdrawals and the value of any recurrent losses of goods held in inventories. Work-in-

[7] As opposed to rent which constitutes the consumption of dwelling services.

progress is included in this category, as well as work-in-progress on cultivated assets (single-use plants or livestock, and young fish, for later slaughtering). Building of oil platform modules and building of ships are however not recorded as changes in inventories, but as gross fixed capital formation while the construction project is in progress (at accruals value).

Private household expenditures are those incurred by 'resident' households on goods or services. This links to the notion of what constitutes 'residents' and 'non-residents'. The first are **purchases by non-residents within Spain** and the second are **purchasers made by residents outside of Spain**. **The former** is made up of **foreign tourism demand** and appears as a single negative entry in the private household account column and a simultaneous addition in the export column. This implies a sale of 'goods and services' to territories outside of Spain - the majority of these expenditures are on hotels, campsites, restaurants and the like. **The latter** is **tourism by Spaniards abroad**. Thus, the sum of these figures constitutes net foreign tourism. The **adjustment row between CIF and FOB** values is simply a correction factor on trade (netting out the international margin between regions) such that the matrices balance. Since ORANI has nothing to say about international margins, these are simply ignored in the ORANI database.

5. Main data construction tasks for ORANI-ESP

A key advantage of the ORANI-G model is that it conveniently lends itself to modification. In the context of this model, ORANI-ESP has extended the standard ORANI structure to include a non-profit user account, a tourism account and a multiple household account. Moreover, the disaggregation of production costs now includes the contribution of the land factor in agricultural sectors, whilst the re-representation of agricultural support in ORANI-ESP model requires the insertion of land and capital subsidies into the benchmark database. Figure 3 shows the structure of the ORANI-ESP database.

Examining Figure 3, the structure of the ORANI-ESP accounts is as follows:

1. Domestic production divided by I industries
2. Investors divided by I industries
3. Eight representative households divided by income groups
4. Exports to EU and non-EU destinations
5. Government demands
6. Changes in stocks.
7. Tourism demand divided by foreign and domestic categories
8. Non profit final demands.

		Absorption Matrix							
		1	2	3	4	5	6	7	8
		Producer	Invest	Private	Export	Govt	Stocks	Tourism	NGO
	Size	I	I	H	X	1	1	T	1
Basic (dom)	Cx1	**1BAS**	**2BAS**	**3BAS**	**4BAS**	**5BAS**	**6BAS**	**7BAS**	**8BAS**
Basic (imports)	Cx2	**1BAS**	**2BAS**	**3BAS**	**4BAS**	**5BAS**	**6BAS**	**8BAS**	**8BAS**
Margins	Cx3xM	**1MAR**	**2MAR**	**3MAR**	**4MAR**	**5MAR**		**7MAR**	**8MAR**
Taxes	Cx3	**1TAX**	**2TAX**	**3TAX**	**4TAX**	**5TAX**		**7TAX**	**8TAX**
Labour	O	**1LAB**							
Capital	1	**1CAP**							
Land	1	**1LND**							
Other costs	1	**1OCT**							
Prod Tax	1	**1PTX**							
Land Tax	1	**LNDTX**							
Capital Tax	1	**CAPTX**							

C = Number of Commodities (146); I = Number of Industries (112); O = Number of occupation types (10); M = number of commodities used as margins (1 composite commodity); H = Number of household types (8); X = Number of export destinations (2: EU and NONEU); 3 = domestic region PLUS foreign imports (EU and NONEU).

	Make Matrix	
Size	I	
C	**MAKE**	Total
	Total	

	Import Tariffs	
Size	2	
C	**V0TAR**	Total
	Total	

Figure 3: The Modified ORANI-ESP data matrices

In addition, labour is subdivided between 10 different occupations, imports are divided into EU and non-EU import routes and the composition of industry costs also includes land and capital subsidies (useful for modelling agricultural support). Moreover, compared with the Spanish IO commodity by industry aggregation of 118 x 75, ORANI-ESP includes a more detailed disaggregation of commodities and industries of 146x112. The new commodities and sectors relate to the disaggregation of primary agriculture, food processing and biofuels sectors. Due to the many man-hours required in the construction of an IO database, it is typically the case that the release of a new IO table is often delayed. At the inception of this project (2004), the most detailed IO accounts (at basic and purchaser's prices) available for Spain were benchmarked to 2000, whilst at the current time, the most recent available IO Table is for 2005. Given the importance of having an up to date dataset for the model, **a key aim of the project became the design and implementation of a flexible program to allow periodical updates of the ORANI-ESP database**. In this way, the model maintains its relevance without the need to start database construction from first principles.[8]

The standard IO data base provided by the **Instituto Nacional de Estadistica (INE)** for Spain is disaggregated to 118 commodities and 75 industries. In addition, final demands include private households, non profit, government, exports, investment and stock purchases. The available IO tables includes a USE matrix (as discussed in section 3 above) for total (domestic plus import); domestic and import usage in basic prices. In addition, a USE table for total activity in purchaser's prices is provided, as well as a MAKE matrix in basic prices. The MAKE matrix also provides useful information on total indirect margin for each of the seven margin commodities, as well as the allocation of this aggregate total across the remaining commodity rows. In addition, the MAKE also gives information on indirect taxation usage by commodity (row), whilst import row totals are disaggregated by EU and non-EU origin. Furthermore, the USE tables provide information on exports by EU and non EU destinations (at basic and purchaser's prices) as well as indirect tax totals by column.

With numerous changes to the structure of the model, a number of arduous data transformation steps are required employing various additional secondary data sources and judgement to elaborate a full ORANI-ESP database. Indeed, the path followed is the opposite of econometric estimation, since with econometrics the modeller uses many observations to estimate single elasticities, or response parameters. In the case of CGE data building, one is often attempting to derive observations from secondary data support and 'reasonable' assumptions since there is a lack of available detailed data. As noted previously, at the inception of this project, the most detailed IO database available was for the year 2000 which included USE matrices at purchaser's and basic prices. The main steps are discussed in the following sections.

6. Creation of tax and margin matrices

Given the availability of IO intermediate and final demands at purchaser's and basic prices, subtracting one matrix from the other gives us an indirect tax PLUS margin (TM) sub matrix of cells with dimensions 118x82 (75 industries; private household; non profit;

[8] The update procedure is discussed in section 17.

government; Investment, stocks, exports EU, export non-EU). By convention, in the purchaser's price matrix, the indirect usage of margins commodities and indirect taxes on a cell by cell basis are allocated across the other rows, whilst the margins commodity rows only include direct usage of margins. In the basic prices matrix, indirect taxes are summed separately in each column, whilst direct and indirect margins are all included within the margins rows. Thus, **in the non margin commodity rows**, where the TM cells are positive, it reveals there is probably a margin and a tax/subsidy present (if positive, the margin is bigger than the subsidy). If the TM entry is negative, then there is a subsidy present for that cell.

In the **seven margin commodity rows** (65-68, 71, 73 & 75) which are a mixture of commercial and trade margins, if the TM entry is equal to the negative of the basic value (i.e., USEP(r,co) – USEB(r,co) = -USEB(r,co)), it implies that the purchaser's value is zero. In other words, it means that the margin commodity is ONLY used indirectly, and therefore in the purchaser's price matrix it is entirely distributed across the other rows. Alternatively, it is possible that there is some direct margin usage (i.e., nonzero USEP values), which implies that the entire margin commodity is not used indirectly. Comparing the total basic value row totals with the total indirect margin usage in the MAKE matrix, we see that row 66 is ALL indirect margin usage. Moreover, the MAKE shows us that in rows 66 and 67, there are no indirect taxes in **rows 66 and 67**, so ALL of the TM matrix entries in these rows across all columns are equal to the indirect margin usage.

In margin row **68**, there is a small tax present, so 'nearly' all of the TM entry is margin. That is, the TM entries are very good indicators of the indirect margin usage by each industry. Comparing the USEB entries with the TM entries for this row, many entries are the same, whilst those which are different are due to the commodity tax which is levied. In addition, some USEB matrix values are zero implying that the industry (i.e., column) does not use that margin either directly or indirectly. Thus, the sum of remaining industry uses of row 68 indirect margin usage is subtracted from the indirect margin usage row total (in MAKE matrix) and shared out between those industries where the above exceptions do not apply, (user columns), employing basic usage shares (USEB).

In margin rows **69, 71, 73 and 75**, there are commodity taxes present. In some cases, the USEB values are zero, so no usage of the margin, either directly or indirectly. Thus, the indirect margin usage is zero for that industry. Alternatively, the column or industry indirect tax total is zero, so all the TM column entry is an indirect margin. Finally, the TM value may be zero in which case, no indirect margin usage. In the remaining industries where: 1) the USEB values are non zero (i.e., the industry purchases the margin commodity in some form); 2) TM values are non zero (i.e., there is a indirect margin usage); and 3) tax values by each column are non zero (i.e., some tax appears in the TM composite entry for that industry), the remaining indirect margin left after subtracting the 'known' TM entries from the MAKE matrix total, are assigned across all remaining industries employing USEB shares.

At this stage, we have all 82 users' indirect margin usage for the 7 margin commodities, which tells us the total margin usage for each of the 82 users. These will serve as useful targets for the RAS (see later) procedure. However, **we do not yet know the allocation of these indirect margins for all r,co cells across non margin rows**. Some industries, we do know the margin usage per "r,co" entry since there is either no indirect margin usage of that commodity by that industry (i.e., zero entries), no commodity tax in that industry, or the TM cell entry is zero. These cases can be calculated directly. In the remaining cases, the residual margin total for each column is assigned across the row elements employing USEB column shares. Simply using basic value use shares by row may overstate (or understate) margin row totals and thereby bias tax column (industry) totals. Thus, what is done is to assign each industry column a weighting value which is multiplied by the row shares. The program is run multiple times until weightings which are reasonably close enough to the residual target tax column totals are found.[9] In the case of the final household demands column, we divide commodities into VAT groups (4%, 7% and 16% of basic values reflecting 2000 rates) and apply these rates of taxes by row, which are subtracted from the "r,co" TM entries in this column.[10] In the exports EU column, there are no commodity taxes, so the "r,co" entries are all margins. In the export ROW column (column 82), there are some subsidy values. Checking column 82, indirect tax total with Fondo Español de Garantía Agraria (FEGA) (MARM, 2009c) data on export subsidies for 2000, the totals are very similar. In addition, we know the exact tax allocation for each relevant "r,co" entry in this column and therefore the residual margin is simple to calculate. Note that the indirect margin usage in the margins rows is, by convention, a zero entry.

Thus, employing weighted USEB shares we derive a preliminary MARGIN(r,co) matrix, which, when subtracted from the TM(r,co) matrix gives us a TAXATION(r,co) matrix. Since this model focuses on the agro-food sectors, greater detail is required to refine the treatment of agricultural net indirect taxes in the model. Thus, using information from the Anuario de Estadisticas from MAPA for 2000, we attain information on product subsidies for agricultural activities. Thus, the entries in TAXATION(r,co) are adjusted in line with this information. This representation of domestic agricultural support is changed in the final model version (see later).

[9] In the standard IO data, we know for sure what the indirect tax column totals are, whilst margin totals by columns are NOT known. Thus, we have to use the known indirect tax totals as a guide in determining the margin value in each row (commodity) entry for each column (industry).

[10] In the Aragón IO Table, the vast majority of commodity taxes are VAT, so it is a reasonable assumption to make for the case of Spain.

To ensure that margin and indirect tax margins obey the row and column restrictions we have from the IO Tables and have calculated,[11] a **Row and Sum (RAS)** procedure is carried out to balance the two matrices. RAS is a mathematical scaling algorithm within the family of entropy optimization methods (McDougall, 1999, pp19), which is designed to multiply row and column data in order to meet target objectives. The RAS may be appropriately used to eliminate small inconsistencies that have arisen during data manipulation, or that may be traced to the use of data from several, mutually inconsistent, sources. RAS does not implement any economic intuition and for that reason the data implemented should not be very far away from the target columns/rows.

The RAS technique should converge with relatively few iterations. Long series of RAS iterations usually imply that the technique is being misused (i.e., you are changing the data a lot from the initial matrix to meet the targets). This suggests that the matrix you began with is not particularly well set up. In the software program, multipliers are provided to indicate to the modeller the degree to which the rows and column were scaled from the original data. Clearly, the larger are these values, the more 'violence' has been done to the dataset and accordingly, the less dependable are the results of the procedure.

RAS will fail to converge if 1) target row totals are not equal to the sum of the target column totals; 2) Some of the target row and column totals are vastly different from the row and column totals of the original matrix; 3) Some of the elements of the original matrix are negative. Further discussion of these issues is provided in Horridge (2001) (pp16).

An example of the RAS procedure is provided here. Thus assume the matrix A, with row 'R' and column 'C' totals as follows:

$$A[0]=\begin{bmatrix}20 & 40 & 80\\ 20 & 20 & 40\\ 20 & 20 & 0\end{bmatrix} \qquad R[0]=\begin{bmatrix}140\\ 80\\ 40\end{bmatrix} \qquad C[0]=\begin{bmatrix}60\\ 80\\ 120\end{bmatrix}$$

Assume that the row and column targets 'T' for this particular matrix are as follows:

$$R[T]=\begin{bmatrix}150\\ 70\\ 50\end{bmatrix} \qquad C[T]=\begin{bmatrix}70\\ 70\\ 130\end{bmatrix}$$

Thus, employing RAS, the **row scaling** becomes:

[11] That is, the indirect margin usage column totals are calculated from knowledge of the IO data and applying common sense and assumptions.

$$\begin{pmatrix} R_1(1) \\ R_2(1) \\ R_3(1) \end{pmatrix} = \begin{pmatrix} 150/140 \\ 70/80 \\ 50/40 \end{pmatrix} = A[1] = R(1) \times A(0) = \begin{bmatrix} 15/14 & 0/0 & 0/0 \\ 0/0 & 7/8 & 0/0 \\ 0/0 & 0/0 & 5/4 \end{bmatrix} \times \begin{bmatrix} 20 & 40 & 80 \\ 20 & 20 & 40 \\ 20 & 20 & 0 \end{bmatrix}$$

$$= \begin{bmatrix} 21.43 & 42.86 & 85.71 \\ 17.50 & 17.50 & 35.00 \\ 25.00 & 25.00 & 0.00 \end{bmatrix}$$

This first iteration (k=1) gives column totals as:

$$C[0] = \begin{bmatrix} 63.93 \\ 85.36 \\ 120.71 \end{bmatrix}$$

Thus, in iteration 2 (k=2), **column scaling** occurs:

$$\begin{pmatrix} C_1(2) \\ C_2(2) \\ C_3(2) \end{pmatrix}' = \begin{pmatrix} 70/63.93 \\ 70/85.36 \\ 130/120.71 \end{pmatrix}' = A[2] = C(1) \times A(1)$$

$$= \begin{bmatrix} 21.43 & 42.86 & 85.71 \\ 17.50 & 17.50 & 35.00 \\ 25.00 & 25.00 & 0.00 \end{bmatrix} \times \begin{bmatrix} 70/63.93 & 0/0 & 0/0 \\ 0/0 & 70/85.36 & 0/0 \\ 0/0 & 0/0 & 130/120.71 \end{bmatrix}$$

$$= \begin{bmatrix} 23.46 & 42.86 & 85.71 \\ 19.16 & 17.50 & 35.00 \\ 25.00 & 25.00 & 0.00 \end{bmatrix}$$

Continuing with this alternate row and column scaling procedure, at the 8^{th} iteration (i.e., k=8), the value of the matrix A becomes:

$$A[0] = \begin{bmatrix} 22.923 & 34.537 & 92.540 \\ 18.559 & 13.981 & 37.460 \\ 28.517 & 21.482 & 0.000 \end{bmatrix}$$

where the initial row, R(T), and column, C(T), targets presented above are met.

7. Creation of an investment matrix

In the standard IO Table for Spain, gross domestic fixed capital formation (GDFCF) or investment is located within the single final demand column. For the purposes of the ORANI data framework, it is necessary to subdivide this 118 row column vector into a full 118 commodity by 75 industry matrix. Fortunately, INE provide limited dimension matrices (6 rows by 30 industries) on the allocation of investment across commodities and industries in **purchases prices**. For the purposes of this study, the year 2000 was used. The first task is to map the 6 commodity aggregates to the 118 commodity rows in the IO matrix. Comparing the INE investment matrix and the Spanish IO column vector totals, the purchaser's value numbers are identical. It is found that 85 rows have zero investment totals, whilst the summation of the remaining 33 rows squares perfectly with the 6 rows total. Employing these row totals, it is possible to map the 33 rows into 6 aggregates. The same procedure is carried out for the columns. This time, it is necessary to map 75 industries to 30 aggregates.

To disaggregate the the 6x30 matrix to 118x75, intermediate purchaser price shares from the IO 118x75 intermediate matrix are employed. Thus, we are assuming that larger intermediate commodity usage by industries carries a greater investment weight. Thus, aggregate investment matrix column 1 (agriculture) concords with two IO industry columns ('agriculture' and 'forestry'). The combined purchaser's intermediate usage of these two IO columns across each of the 118 rows is summed together. This procedure is repeated for the 30 aggregate column groupings. This gives an IO purchaser's price usage matrix of 118x30. Subsequently, from this matrix use shares for the 118 commodities in each of the 6 commodity row groups are calculated.

Thus, for example, in aggregate industry 'agriculture' (column 1 of 30), for the row 'agricultural goods' (aggregate row 1 of 6), aggregate industry usage of IO agricultural product rows is 91% arable crops and 9% livestock products. Similarly, aggregate 'fish' industry usage (column 2 of 30) of the row agricultural goods (aggregate row 1 of 6) is 79% arable crops and 21% livestock products. In the energy aggregate column (column 3 of 30), for the row agricultural goods (aggregate row 1 of 6), the aggregate industry usage of agricultural products is 0% arable crops and 0% livestock products. Once we know the individual IO row shares within the 6 aggregate rows across the 30 industries, **we can subdivide the INE investment matrix from 6x30 to 118x30.**[12] The subdivision of the industries from 30 to 75 follows the procedure suggested by the ORANI modellers in Monash.[13] Thus, estimates of capital factor use[14] by industry are employed as share weights. Thus, within each of the 30 industry aggregates, **primary capital shares are used to subdivide the 30 industry columns into 75**.[15]

Having attained a 118x75 investment matrix at purchaser's prices, the next task is to **create margin and tax matrices**, thereby deriving a basic values investment matrix. Once again, we are obliged to turn to the intermediate input matrix to help determine the tax and

[12] It should be noted again that 85 of the 118 rows have zero investment values.
[13] The principal researcher visited the Centre of Policy Studies in Monash (Melbourne, Australia) in July 2006.
[14] This is discussed in section 11.
[15] It was necessary to change slightly to eliminate 'negative' gross investment flows (from large depreciation estimates) since the ORANI structure does not allow negative value flows (except in stocks). Consequently, the Investment matrix was RASsed before proceeding to the next step.

margin matrices in the investment accounts. Thus, in an initial step, the investment column vectors taken from the margins and indirect taxes matrices, calculated from section 6 based on the underlying IO Spanish data are employed. In each row cell of the investment column vector, an indirect tax rate and a margin rate is calculated. It is then assumed that the rate of indirect tax and margin on all column users of a given commodity (row) is uniform. In this way, a 118x75 investment matrix of margins and indirect taxes are derived. Subtracting these from the purchaser's price investment matrix yields an equivalent basic prices investment matrix. Since the total of the investment column vector in the underlying IO data adds up to the INE 6x30 investment matrix, there is no need to employ RAS techniques.

In section 8, we will see how this matrix is subdivided between domestic and import usage, whilst the treatment of import tariffs on non-EU imported investment goods must also be accounted for.

8. Disaggregation of basic values, margins and taxes into Domestic, EU and non-EU routes

In the Spanish IO data, data are provided on imports (in basic prices) for all 118 commodities and by both EU and non-EU routes. For the purposes of agricultural policy analysis, it is important to separate these routes out in the ORANI-ESP model to allow the user to examine in more detail the impact of abolition (or liberalisation) of import tariffs.

To help with the calculations, it should be noted that the USE matrix for imports in basic prices is also available. However, there is no equivalent matrix at purchaser's prices, whilst there is also no USE matrix split between EU and non-EU routes. Thus, for imports, the main challenge is to determine the indirect taxes and margins matrices, and then split these between EU and non EU uses. Some further help is provided with the indirect tax matrices since domestic and imported indirect tax totals are available by column.

Firstly, indirect margin usage rows (65-68, 71, 73 & 75) across all 82 users calculated in section 6 above, are subdivided employing domestic/imported basic value use shares for the corresponding rows (65-68, 71, 73 & 75) in the domestic and imported basic values matrices in the IO Spanish accounts. Later on, **these are used as column targets for the derived domestic and imported margins matrices**. Why do we do this? There is only information on total (i.e., domestic plus imported) indirect margin usage by users in the MAKE matrix, whilst no corresponding information on indirect margin usage by domestic and imported sources is available. Thus, we are obliged to employ basic value usage[16] of

[16] Remember, in the basic prices matrices, the margin row entries for all columns reflect direct and indirect margin usage.

margin rows (65-68, 71, 73 & 75) as a proxy for indirect margin usage on domestic and imported purchases.

To derive DOMMARGIN(r,co), the indirect margin totals in MARGIN(r,co) are allocated across **non margin** rows using domestic basic value use shares by cell. Additional data massage is undertaken to ensure that **the total margin in each "r,co" cell of MARGIN(r,co) is not exceeded by the domestic margin total by corresponding cell, DOMMARGIN(r,co)**, and that the **total domestic indirect margin usage by column does not exceed the domestic indirect margin targets calculated above.** Once the domestic margin cell values are known, the import values are merely calculated by subtraction of MARGIN(r,co) minus DOMMARGIN(r,co) to give IMPMARGIN(r,co).

In addition, the domestic basic value use matrix is modified. More specifically, the sum of domestic and imported indirect margin usage across each of the 7 margin commodity rows is subtracted from the domestic basic use margin commodity rows, such that these row entries in the domestic matrix now only reflect **direct margin** usage. If the sums above have been done correctly, the total domestic and imported indirect usage of each margin commodity, should not exceed the basic values of these margin commodities in the domestic basic value use matrix.

Thus, at this point, we have **domestic and imported 'margin' matrices**, **domestic 'basic use' values net of indirect margin usage** and **imported 'basic use' values prior to inclusion of import tariffs**.

The next task is to subdivide the total indirect taxation matrix, TAXATION(r,co) into domestic indirect taxation, TAXATIOND(r,co), and a provisional imported indirect taxation matrix **prior to removal of import tariffs**, TAXATIONMP(r,co). As an initial step, domestic indirect taxes in each cell are split out by the modified domestic use matrix (net of indirect taxes) as a share of total basic usage. In the case of specific agricultural and food products, one must be careful, since the split of the indirect net tax (i.e., subsidy) may not reflect the domestic/import use share. For example, examining trade data from the **Ministerio de Industria, Comercio y Tourismo (2009) (DATACOMEX)**, we see that Spain does not import grapes for wine production, so the entire subsidy from the aggregate row 'arable' to the industry 'i_bevs' should be in the domestic matrix. Similarly, on 'arable' subsidies to 'agriculture' (i.e., on cereals, oilseeds, proteins, fruit and vegetables, rice etc), the proportion of these products which are domestically produced according to DATACOMEX is 0.9255. If the domestic usage share in the IO Spanish Table is larger, then employ the domestic usage share. If this is not the case, then use the domestic share of 0.9255. This rule is applied across a number of agro-food rows and columns. In the case of the export columns, all taxes are assigned to the domestic matrix.. Further data massage is necessary such that the domestic taxation values meet the domestic indirect column targets in the IO Spanish data. The indirect taxation matrices for imports are calculated as the residual (i.e., TAXATION(r,co) minus TAXATIOND(r,co)).

The next task is the division of the import matrices (basic values prior to import tariff addition, indirect taxation prior to import tariff subtraction, margins on imports) between EU and ROW routes. Once again, no data is available for this level of disaggregation, so assumptions must be employed. Thus, in the IO Table, the level of imports by commodity from the EU and non-EU sources is provided. This commodity split is applied uniformly by commodity rows to the basic values, taxation and margin matrices to give **EU and ROW basic values, taxation and margin matrices**. In the case of the non EU matrices, the **tariff matrix** (see section 9 below) **is added to the basic value matrix and subtracted from the indirect taxation value matrix**.

To conclude this part of the data construction, the same treatment has to be applied to the investment matrices calculated in section 7 above. First we have to split basic value, margin and taxation investment matrices into domestic and imported components. Thus, the domestic[17]/imported basic use shares in each row cell of the investment (GDFCF) column of the IO table, are used to split out the rows in the 118x75 investment matrix net of indirect margin usage. This gives a domestic investment matrix net of indirect margin usage, and an import investment matrix net of indirect margin usage.

Unlike the case of basic value investment matrix division above, there is no corresponding GDFCF column of domestic and imported margins data in the standard IO table. Thus, for consistently with previous calculations, the domestic investment margins matrix is divided employing the domestic row shares in the GDFCF column of the domestic and import margins matrix we calculated above. These domestic row shares are multiplied by the investment margin matrix calculated in section 7. Once the domestic margin matrix is ascertained, the import margin matrix is simply the total investment margin minus the domestic investment margin for each "r,co" cell.

In a 'similar' manner, the split of the investment taxation matrix is along the same lines as the investment margin matrix. One must employ the domestic row shares in the GDFCF column of the domestic and import tax matrix **AND** the import tariffs in the GDFCF column of the tariff matrix calculated in section 9. These are used to split the investment tax matrix derived in section 7. Thus, with each "r,co" cell divided between domestic tax, import tax and import tariff components, we derive three separate investment taxation 118x75 matrices (2 indirect taxation and one import tariffs). With a separate investment tax and import tariff matrix on imports, there is now no need to subtract tariffs on investment goods from non-EU indirect taxes on investment goods.

Next, we need to derive the final basic values, margin and taxation 118x75 investment matrices for domestic, EU and non-EU usage. The domestic investment basic,

[17] This is the domestic intermediate use before adding import tariffs.

margin and taxation 118x75 matrices are already derived above. The import basic values investment matrix is divided into EU and non-EU components using the EU and non-EU GDFCF column basic use shares in each "r,co" cell. Similarly, EU and non-EU indirect taxation (margins) investment matrices are derived employing the GDFCF columns in the EU and non-EU taxation (margin) matrix. To the basic values non-EU investment imports matrix, we add the import tariff on investment matrix, which in compliance with ORANI, gives the cif PLUS tariff values.

9. Disaggregation and re-representation of tariffs in the ORANI-ESP 2000 data

There is a fundamental incompatibility between the Spanish IO database and the ORANI framework. As noted in section 3, in the IO Tables, the convention is that 'basic' import flows are valued at 'cost insurance freight values' (cif), whilst import tariffs are captured within the indirect taxes matrix.[18] In the ORANI data template, the basic value of imports equals the **cif value PLUS the import tariff, whilst indirect taxes and tariffs are separated.**. This means that the tariff data must be stripped out of the indirect tax matrices from the initial Spanish IO database, and added to the basic value of 'non-EU' imports calculated in section 8. In addition, for compatibility with ORANI, a column vector of non-EU import tariffs must be created.[19] In this way, the cif import price in ORANI is the basic price minus the tariff. For CGE models where agriculture is not the main focus (i.e. Tourism), a simplifying step would be to assume zero import tariffs. However, given the agricultural focus and the importance of import tariffs as an agricultural policy tool, this is not a viable option.

The search for accurate 'applied' tariff data for 2000 yielded very little progress. For compatibility with the Spanish CGE model, data was required on the *ad valorem* equivalent of numerous tariff regimes (i.e., specific tariffs, ad valorem tariffs, compound tariffs, tariff rate quotas etc.) for a detailed disaggregation of commodities. Such 'elaborated' data cannot be readily found at zero cost from traditional internet sources (WTO, UNCTAD, USDA) since it requires some degree of data aggregation and massage. Instead, it was decided to employ the Global Trade Analysis Project (GTAP) version 6 database (Dimaranan, 2006). GTAP 6 data is a global trade database which is available from the department of agricultural economics at Purdue University at cost. For the purposes of this project, this database was useful since it provided applied *ad valorem* tariff equivalents for 57 commodity groupings for the year 2001. This was considered sufficiently close to the benchmark year of the data (2000).

Thus, employing the GTAP database, Spanish tariff revenues are calculated across the 57 product categories. Examining the data, the total value of these tariffs comes to

[18] This implies that purchaser's values are inclusive of import tariffs.
[19] Due to the single market, there are no tariffs on intra-EU trade.

$1294.7m, which translates (at 2001 exchange rates) to €1156m. According to statistical data from the Banco de España, Spanish tariff revenues in 2000 summed to €1073m. The figures are sufficiently close to further justify the usage of GTAP 6 database. A concordance between the 57 GTAP commodities and the 118 Spanish IO Table commodities is carried out. In many cases (particularly services), *ad valorem* tariffs are zero. This reflects the fact that tariff protection is on tangible trade, whilst invisible flows of services are more the remit of non-tariff barriers, which are not considered in this model.[20] In some cases, it is possible to map the GTAP estimate directly to the relevant Spanish IO commodity (for example, arable, livestock, forestry, fishing, gas, dairy, meat etc.). In other cases, it was necessary to split out the GTAP tariff estimate between relevant IO commodities employing non-EU import shares taken from the Spanish IO Tables. This gives us a column vector of 118x1 import tariff estimates summing to . To ensure that the column target of €1073m is respected, the column vector is scaled proportionately. This vector will be required for direct application into the ORANI database (see Figure 3).[21]

To split the 118x1 import tariff vector into a 118x82 (includes final demand accounts), we employ a 118x82 matrix of basic usage values of non-EU imports NET of transport margins.[22] The row shares in this matrix are employed to assign the import tariff row totals (i.e., each row entry of the import tariff column vector) across the 82 using accounts. Thus we are assuming that the tariff rate is uniform for a given commodity across all users. To conform with the structure of the ORANI database, the 118x75 import tariff matrix is subtracted from the 118x82 indirect taxation matrix calculated in section 6 and added to the 'net of indirect margin basic values' non-EU imports matrix (118x82) calculated in section 8. **In this way, basic values of non-EU imports are valued inclusive of import tariffs, whilst indirect taxes are valued excluding import tariffs**.

10. Subdivision of labour into different occupations.

The subdivision of labour into occupation types is aided by the use of labour force survey data for 2002 from INE describing the total number of persons (in thousands) working across 10 different occupation levels in each of 17 broad industry aggregates. In addition, from the IO Spanish 2000 data, information is available on the total number of persons working in each industry, the total PAID employees working in each industry and total FULL TIME PAID employees by industry. Typically, paid employment is smaller than employment levels, especially in agriculture, where there is a considerable family labour input. A concordance is calculated between the 75 industries in the IO data and the 17 aggregate industry activities. Within each of the 17 aggregate industry groups, industry

[20] Since the focus of the model is more on agriculture and food, rather than services, this extension was not seen as a major priority, although it does constitute a useful extension for future development of the model.
[21] In section 14, we explain how the agricultural and food rows in this vector are further disaggregated, whilst an additional column is added for EU imports (all zero tariff values).
[22] Section 8 explains how these values are derived.

shares are calculated based on the share of total labour employed in each IO industry. These shares are employed to subdivide the 10 occupations by 17 industry matrix into a 10 occupations by 75 industries matrix. This matrix is subsequently scaled such that the column totals are the same as the IO Spanish data head totals by industry (i.e., total employed persons (paid and non paid).

From the scaled 10x75 matrix of total employed labour, we calculate a paid labour 10x75 matrix component using the paid labour share (of total industry labour) from the IO Spanish data for each of the 75 industries. Thus, by assumption, the paid labour share is uniformly applied across all the occupation types (i.e., the rows). The paid labour matrix is then split between full time and part time paid labour. Using the full time share data for each industry, full time employees by occupation for each of the 75 industries are derived. The residual (i.e., total paid minus full time paid labour) is part time labour head matrix.

The next stage is to determine the wage bills by industry. Employing data from INE, it is possible to gain access to average (gross) salaries for the 10 occupation types for both full time and part time labour. Thus, multiplying the number of head in each occupation row (across 75 industries) by the average salary (part time or full time) gives the wage bill by cell. This procedure gives a part time and full time 10x75 matrix of wage bills, which when added together gives the total wage bill for the 10 occupations across 75 industries. Importantly, calculating the total Spanish wage bill from the calculated 10x75 matrix gives a total cost of €306,513m, which compares favourably with the Spanish IO table total of €312,176m. The columns of data in the calculated occupation by industry matrix are scaled such that the wage bill totals by industry correspond to the totals in the Spanish IO Table.

11. Disaggregation of Agricultural Land and remaining value added components

Since the focus of the study is on the agricultural sectors, more effort has been applied in improving the disaggregation of value added costs by components. In the underlying Spanish IO table, information by industry is provided on labour wage bills (gross wage bills), production taxes, and gross operating surplus. It was decided early on to try and derive disaggregated agricultural industry (i.e., column) data on primary factor costs and reconcile these data with the IO agricultural industry aggregate (the disaggregation of intermediate input costs by agricultural activity is discussed in section 14).

In terms of agricultural land, the Ministerio de Medio Ambiente y Medio Rural y Marino (MARM, 2009a) provides useful statistics on irrigated and non irrigated land prices by agricultural activity in the 'encuesta de Precios de la Tierra'. Moreover, in the 'Anuario de Estadistica Agroalimentaria' (MARM, 2009b), detailed data by agricultural activity on land usage (irrigated and non-irrigated) is also available. By building up a land values by agricultural activity row vector, an estimation of aggregate agricultural land value was arrived at for the year 2000.[23] Since the CGE model requires estimates of imputed rents on land (not land values), we follow the example of Matthews *et al.* (2003) in assuming a 2 per cent rate of return on agricultural land. This is deliberately set low to ensure that the other components of value added are non-negative. Moreover, we justify this assumption from an agricultural policy perspective in that landowners expect future rents and are therefore willing to accept a lower current rate of rental return.

A further approach to disaggregate value added components (except labour wages which are given) was through usage of the 'Red Contable Agraria Nacional' (RECAN, 2002) provided by the Ministerio de Medio Ambiente y Medio Rural y Marino for the year 2000. In this document, it is possible to collect representative farm cost data for various agricultural activities disaggregated between various intermediate input and value added subheadings. Employing this data, detailed cost shares were derived for value added components (including for land) and these where applied to agricultural production totals to determine value added component values. Aggregating over all agricultural activities, aggregate capital rents, land rents were derived. Comparing the estimates of land rents employing the two approaches, **there was a discrepancy in that the RECAN estimate seemed rather large**. Accordingly, it was decided to employ the estimates from the 'Anuario de Estadistica Agroalimentaria' (MARM, 2009b). Thus, land and capital values were subtracted from the gross operating surplus total, with the remainder transferred into ORANI's 'other costs' category (which includes depreciation, other municipal costs).

12. Creating 'Inbound' Tourism accounts

In the Spanish IO private household demand column, there are additional 'balancing' rows at the bottom of the matrix. The first is expenditures by non-residents within the economic territory (i.e., Spain), which accounts for €32,738m. The second item is expenditures by Spaniards outside of the economic territory, totalling €5,561m. Both of these entries are tourism expenditures, where the first is tourism receipts within Spain and the latter is Spanish tourism expenditures abroad. In the IO Table private household column, Spanish tourism abroad (i.e., €5,561m) is an addition of monies, whilst expenditures by parties who are not Spanish within Spain (i.e., €32,738m), is subtracted from the column. This latter figure is added to the exports column, and is therefore treated as foreign demand. Furthermore, examining this row in the exports columns, one observes that €26,734m of foreign tourist expenditures are from EU tourists and €6,004m are from non EU tourists.

In the ORANI model, one has the option of allocating foreign tourism expenditures across export commodity rows, or creating an additional account within the model entitled

[23] No attempt was made to subdivide land into irrigated and non irrigated types. This is a high priority model development for the model's evolution.

tourism. It was decided that the value added to the model from an additional 'separate' tourism account would be preferable. Indeed, given the importance of the tourist industry in Spain, an interesting feature could be the examination of increased tourism expenditures on other sectors (i.e., agriculture). In the case of Spanish expenditures abroad (i.e., **outbound tourism**) no attempt is made to model this in ORANI-ESP, since the model has nothing to say about economic activity outside of the domestic territory. Thus, we do not factor in tourism expenditures to the import demand matrices. Our principle interest is that of **inbound tourism** and its impacts in adjacent Spanish sectors, such as agriculture.

To further help with the disaggregation of tourist expenditures, INE (2009c) also provides a set of **satellite accounts for tourism expenditure** within Spain for the year 2000. These accounts are divided between four categories: foreign tourism expenditures; domestic tourism expenditures; business expenditures on tourism; and public tourism expenditures. The former two categories refer to 'typical' private consumer tourist expenditures on leisure, family visits, study visits, cultural tourism, religious trips, sport (football etc.). Between them, they account for 87% of total tourism expenditures in Spain. Business tourism covers employee expenditures on business trips for meetings and conferences, whilst public expenditure is the same principle, covering workers in the public sector. For the purposes of this analysis, we restrict ourselves to 'individual' tourism expenditures which pertain to the private household column.

The satellite accounts also present expenditures by different types of commodities/services, although as expected, the disaggregation of these expenditures is not as defined as the 118 commodity/service rows in the IO table for Spain. Moreover, comparing total inbound basic foreign tourism expenditure in the satellite accounts (€32,641m) (excluding margins), with the IO accounts (€32,738m), the figures are close, but do not agree. To make the balancing of the IO Table simpler, we use the Spanish IO total, whilst we scale all of the column entries in the relevant satellite account to meet this target.

Thus, it is necessary to apply assumptions on which commodity rows to discard from the tourism accounts (i.e., zero entries). In the case of services, the mappings are one-to-one since the satellite account disaggregation is relatively detailed. Thus, expenditures mainly relate to restaurants, transport and hostelry sectors. In the case of 'goods', the satellite accounts do not separate such expenditures by rows, which makes the task of assigning expenditures across these rows almost impossible. Fortunately, employing data from Blake (2000), who examines tourism in Spain, domestic and foreign inbound tourism expenditure shares are available for agriculture, 'other primary', 'food beverages and tobacco' and 'other manufacturing'. Given these aggregate goods, some judgement is employed in mapping the relevant commodity rows in the IO Table. Aggregate agriculture and food rows are much easier to map, whilst 'other primary' consists of electricity, gas, water and fuel commodities. The most judgement was applied to the case of 'other manufacturing'. It was assumed (not unreasonably), that this only applied to 'finished' manufactured goods. Thus, this group included textile, clothing, leather, ceramic and glass and 'artistic' products. Moreover, expenditures on drugs are also included. The remaining goods rows are assumed to have a zero entry in the tourism accounts.

By introducing tourism accounts, it is necessary to strip out corresponding basic use values from the private household column. Moreover, in the IO Table, basic prices expenditures on (non tradable) transport services in the export columns are also largely 'foreign' tourism related. Thus, **foreign tourist demands on transport services (rows) are stripped out of the EU and non-EU exports columns by use shares**. Since these IO rows do not have taxes or margins, no further operations are required. **Domestic tourist demands on transport** services are stripped out of the 'domestic', EU and non-EU private household accounts according the use shares in each row. **In the case of restaurants, hotels, travel agent services, renting and cultural and recreational services, domestic and foreign tourism expenditures** from the satellite account are stripped out of the domestic private household expenditures account (non domestic private household row values are zero and export account row values are also zero in the underlying IO data).

In the case of tourism demand for 'goods' (as opposed to 'services'), domestic and foreign expenditures are systematically stripped out of the private household accounts. In the case of foreign tourist expenditures, it was found that expenditures for each subcategory of goods exceeded the available row entries in the IO export account. Thus, it is assumed that foreign tourism expenditures on goods are related to the private household account. Domestic and foreign tourism expenditure totals on goods are subdivided into agriculture, 'other primary', 'food beverages and tobacco' and 'other manufacturing', employing the domestic and foreign tourism expenditure shares in Blake (2000). Subsequently, we need to split the total expenditures by detailed IO rows. Thus, in the agriculture aggregate, we have mapped arable, livestock and fish rows from the IO Table. The split of domestic and foreign agricultural expenditure between the three rows is done via private household expenditure shares. The same approach is applied to the splitting of aggregate 'other primary', 'food beverages and tobacco' and 'other manufacturing' expenditures across rows.

Once the domestic and foreign tourism basic values totals by individual row are calculated, these are divided between domestic, EU and non-EU rows by employing private household expenditure shares across the three routes. Thus, domestic and foreign tourist expenditure in the 'arable' row are divided across domestic, EU and non-EU usage assuming the same corresponding shares in the private household. The **margin and taxation matrices** on foreign and domestic tourist demands are simply derived employing calculated basic values expenditure shares. Thus, if 10% of private household consumption for domestically produced arable is now domestic tourism expenditure, then 10% of the margin and tax for that cell now accrues to the domestic tourism account. Thus, we are assuming that the tax and margin rate by commodity row is constant by user (column).

Once the 118x2 matrices for domestic and foreign tourism basic prices, taxation and margins are calculated, the basic expenditure values in the private household and export columns (transport rows only) must be reduced by corresponding sums such that the database remains balanced..

13. Disaggregating the private household account by income sub-groups.

Once the disaggregation of tourism expenditures from the private household account is complete, it is then possible to turn our attention toward the disaggregation of private household expenditures by income sub-groups. Intuitively, such an extension constitutes a useful policy appraisal mechanism when evaluating the distributive impacts of the CAP. More specifically, given the principal of Engel's Law, poorer households spend relatively more on food products, whilst the income elasticity of demand for food is inelastic – that is, as family income rises, food expenditure rises less than proportionately. Thus, poorer households have a higher income elasticity of demand and larger food expenditure shares for food than wealthier households. In short, food policy changes will have less of an impact on wealthier consumers.

Once again, additional secondary data is required to make a useful estimate of private household expenditures by sub-groups. Once again, household survey data for the year 2000 from INE (2009) are available from 'La Encuesta Continua de Presupuestos Familiares'. More specifically, total expenditures by each of 8 income sub-groups are available, whilst in each of the 8 households, expenditure shares across 10 different groups of goods and services are available. Employing these two sources of data, it is a straightforward exercise to calculate an 8x10 matrix of total expenditures by household and subcategory of goods/services. Interestingly, comparing the total expenditure is this matrix (€259,648m), the values are close to the net of tourism demands private household expenditures (€253,263m).

The next task is to find a mapping between the 10 subcategories of goods/services and the 118 commodity rows in the IO data. To check the quality of the mapping, the total of expenditures (over domestic and imported purchases) in each mapped category of IO rows is compared with the corresponding total in *La Encuesta Continua de Presupuestos Familiares*. If the two are sufficiently close, it implies that the mapping is more accurate. For reconciliation purposes, we employ the mapped totals from the IO rows rather than those calculated from *La Encuesta Continua de Presupuestos Familiares*. These category totals are assigned to the 8 households by category budget shares. For example, if poor 'household 1' expenditure on food and drinks is 5% of the total in this category, then 5% of domestic, EU and non-EU private household expenditures are allocated to 'household one'. Subsequently, the allocation of each category of expenditures into the IO rows is based on the expenditure shares. Thus, if domestic arable purchases constitute 3% of private household domestic 'food and beverages expenditure', then this share is applied uniformly to all 8 household's domestic purchases of 'arable'.

This tedious process provides a 118 commodity by 3 routes (domestic, EU imports, non-EU imports) by 8 household matrix of basic prices expenditures, which when aggregated should be equal to the private household aggregate (118x3x1). The tax and margin matrices for each of the households are split out employing basic expenditure shares. Thus, again, we are assuming that the rate of margin and tax is constant for each commodity/service across all households.

14. Disaggregation of agro-food related commodities (rows) and activities (columns).

In the standard IO accounts for Spain, agricultural commodities are divided into arable crops, livestock and agricultural services (i.e., preparation of fields, crop maintenance and treatments, harvesting, animal husbandry etc.). Meanwhile, agricultural activity is aggregated into one single column. In terms of food and drink commodities, more detail is provided (meat products, dairy products, oils and fats, animal feeds, other foods, alcoholic drinks, non alcoholic drinks), whilst food and drink industry activity is slightly more aggregated (meat products, dairy products, other foods, drinks). For useful agro-food policy analysis, a further disaggregation of agro-food commodities and activities are required. Indeed, an inherent strength of the CGE modelling approach are the upstream-downstream relations between primary agriculture and food processing industries.

14.1 Creation of a 118x28 agricultural intermediate sub-matrix

In the case of the agricultural sectors, the subdivisions of the sectors follow the classifications employed in the Eurostat agricultural accounts database. The 28 primary agricultural elements are listed in Figure 4, whilst a more detailed subcategory listing of activities is given on the right hand side of the table. These are based on the NACE Rev.2 statistical classification of economic activities in the European Community.

The process begins by **sub-dividing aggregate agricultural activity into 28 representative activities**. The subdivision of intermediate input usage is facilitated through the usage of the 'Red Contable Agraria Nacional' (RECAN) published by the Ministerio de Agricultura, Pesca y Alimentación (formally MAPA, now MARM). The RECAN data provides a breakdown of intermediate input and value added costs for a number of 'representative' farm activities. RECAN data are useful, since the range of disaggregated 'representative' activities concords well with the 28 activity disaggregation. In some cases, the RECAN classification of industries (e.g., all cereals except rice) is broader than the Eurostat classification (wheat, barley etc). Thus, we assume the same cost composition for all cereals sectors.

Aggregate	Detailed description
Wheat	Hard wheat and durum wheat
Barley	Barley
Maize	Grain maize
Rice	Rice
Other cereals	Rye and meslin, oats, millets, sorghum, other cereals n.e.c.
Potatoes	Potatoes and sweet potatoes
Sugar	Sugar beet and cane.
Oilseeds	Soya beans, groundnuts, castor beans, linseed, mustard seed, niger seed, rapeseed, safflower seed, sesame seed, sunflower seed, other oilseeds n.e.c.
Textile crops	Cotton, jute, kenaf and other textile fibre crops, flax and hemp, sisal, abaca, ramie and other vegetable fibres.
Other ind. crops	hops, peppers, other industrial crops
Feed crops	Cereals, leguminous, root and tuber feed crops, other feed crops.
Grapes wine	Grapes for wine production
Olives for oil	Olives for crushing
Vegetables	Artichokes, asparagus, cabbages, cauliflower and broccoli, lettuce and chicory spinach, other leafy or stem vegetables, cucumbers, gherkins, aubergines (eggplants), tomatoes, watermelons, cantaloupes, other melons and fruit bearing vegetables, carrots, turnips, garlic, onions, leeks, and other leeks, other root, bulb or tuberous vegetable (excl. Sugar beet and potatoes)
Flowers	Growing of flowers and ornamental plants, production of cut flowers and flower buds, growing of flower seeds.
Table olives	Olives for direct consumption.
Dry fruit	Almonds, cashew nuts, chestnuts, hazelnuts, pistachios, walnuts, other nuts.
Grapes	Grapes for direct consumption.
Other fruit	Apples, apricots, cherries and tree and bush berries, peaches and nectarines, pears and quinces, plums and sloes, other pome and stone fruits
Citrus fruit	Grapefruits, lemons, oranges, tangerines, mandarins, clementine, other citrus fruits n.e.c.
Tropical fruit	Avocados, bananas, dates, figs, mangoes, papayas, pineapples, other tropical fruits.
Other crops	Protein crops (beans, broad beans, lentils, lupines, chick peas, cow peas, pigeon peas), coffee, tea, maté, cocoa, other beverage crops, pepper, chillies, nutmeg, ,ace and cardamons, anise, badian, fennel, cinnamon, ginger, vanilla, other spices and aromatic crops
Cattle	Raising and breeding of cattle, production of bovine semen.
Pigs	Raising and breeding of pigs
Sheep & goats	Raising and breeding of sheep & goats, production of raw wool, production of raw sheep/goat milk.
Poultry & eggs	Raising and breeding of chickens, turkeys, ducks, geese and guinea fowls, production of eggs from poultry
Raw milk	Production and raising of dairy cattle, raw milk production
Other animals	Raising and breeding of horses, asses, mules, hinnies (not including race horses), other birds (except poultry), insects (e.g., bees), worms and silk worms, snails, rabbits and other fur animals, production of skins, pets (i.e., cats, dogs, hamsters etc).

Figure 4: A description of the 28 primary agricultural activities in ORANI-ESP

Thus, basic values of production for 2000 from Eurostat are split between value added and intermediate usage row composites employing the splits in the RECAN database. With the 28 agricultural activity intermediate cost totals, we split these values between the 13 intermediate input cost categories in RECAN employing the intermediate cost shares in each corresponding RECAN agricultural activity column. **This gives us an intermediate matrix of 13 rows by 28 agricultural activities**.

The next task is to **further subdivide the 13 intermediate input rows into the 118 commodity rows** detailed in the IO USE tables. Thus, some degree of judgement is required to concord the 13 intermediate input rows of RECAN with the 118 IO rows (of which, 43 rows are zero entries). This task is greatly aided by more detailed decompositions of the 13 RECAN rows between specific inputs, which were found in chapter 30 of the Anuario de Estadistica Agroalimentaria (MARM, 2009b). For example, the RECAN row 'energy' concords with the IO rows petroleum and nuclear fuels, electricity and gas (rows 12, 13 and 14). Thus, the RECAN share of agricultural 'energy' usage in, say, the wheat column, is applied to the domestic and imported IO USE rows (12, 13, 14) in the primary agriculture column to derive a separate wheat entry. **This process is repeated for each of the 28 agricultural activities to yield a 118x28 agricultural intermediate sub matrix in basic values for domestically produced and imported purchases**. To balance these sub-matrices, a RAS procedure was employed.

Once the basic values USE matrices are derived on domestic and imported routes, **primary agricultural column tax and margin matrices are calculated employing basic prices row use shares**. Moreover, the additional columns in the food investment basic, tax and margin sub-matrices employ the same use shares as in the intermediate input equivalents.

14.2 Creation of a 118x11 food intermediate sub-matrix

The subdivision of food activities (i.e., columns) is a little more complicated, since detailed cost data for these sectors is not as readily available as in the case of primary agriculture. On the other hand, the level of industry disaggregation in the IO USE tables is more detailed than that for primary agriculture. Thus, dairy and drinks (including wine) activities are already disaggregated, whilst meat activity is split into 5 sub-sectors, and other food activity is subdivided between oils and fats, sugar processing, processed animal feed and 'other' food categories. A detailed description of the 11 relevant food and drink categories is provided in Figure 5.

A key difficulty here is the **disaggregation of meat into the 5 sub-activities**. There is a complete dearth of information on meat production by detailed line in Spain. It is unlikely that the technology (i.e., input mix) of slaughtering and packing facilities will differ significantly between different meat groups. Moreover, examining the basic prices Spanish

IO USE table, 74% of intermediate inputs to the meat industry are from upstream livestock sectors. Thus, we assume that the use shares of total meat intermediate usage between the 5 meat sectors, is the same division as between the 5 equivalent primary upstream sectors (i.e., cattle for beef; sheep and goats for lamb etc.).[24]

Aggregate	Description
Beef	slaughtering dressing and packing of meat, preparation of burgers etc, fresh meat dishes
Pork	slaughtering dressing and packing of meat, preparation of burgers etc, fresh meat dishes
Sheep and Goat	slaughtering dressing and packing of meat, preparation of burgers etc, fresh meat dishes
Poultry	slaughtering dressing and packing of meat, preparation of burgers etc, fresh meat dishes
Other meat	production of hides and skins, 'rendering' of lard and other edible animal fats of animal origin; production of wool; processing of animal offal; production of feathers and down; slaughtering and preparation of rabbit, horse and other meats of the like
Dairy	Fresh milk, milk based drinks, cream, butter, cheeses, yoghurts, ice cream, sorbet, casein, lactose etc.
Oils & Fats	Vegetable oils, olive oils, soya oils, palm oils, sunflower seed oils, cotton seed oil, rape oil etc..
Sugar Processing	Refining of sugar from cane and beet, manufacture of sugar syrups, molasses, cocoa powders, chocolate and sugar confectionary
Processed animal feed	Prepared feeds for pets, for farm animals, unmixed feeds for farm animals, slaughter waste to produce animal feeds (ISIC Rev. Code 1533 - not the same as other animal products)
Other food processing	Fish products, fruit and vegetable products, milling, bakery products, pastas, rices, soups, sauces, spices, condiments, vacuum packed and canned foods, coffee, tea, baby foods etc..
Drinks industry	Wines, malt liquors (i.e., beers), spirits, soft drinks, juices, bottled water etc.

Figure 5: A description of the 11 food and drink sectors in ORANI-ESP

The other major split occurs in the 'other food' sector, where oils and fats, processed sugar, animal feeds and 'other' food are disaggregated. **For non-food intermediate inputs, use the output value shares of the four industries to apportion the intermediate input usage**. The output values for the four industries in the year 2000 are taken from chapter 31 ('the food industry') of the Anuario de estadistica agroalimentaria (MARM, 2009b). For the agricultural inputs, we are indebted to the help of Dr. Marc Mueller at the Institute of Prospective Technological Studies (IPTS) in Seville. Dr Mueller provided us with access to his Spanish CoCo (completeness and consistency) agricultural database based on the CAPRI modelling system documentation (Britz, (2005)). This database provides a useful support source for estimating the usage of agro-food inputs in

[24] Examining the CoCo database, we see that the division of upstream meat products to the downstream 'meat' industries is very similar to the splits in the ORANI-ESP database.

various agro-food industries. Thus, employing the intermediate input split shares for the 4 industries, the food industry column agri-food inputs are split between uses.

Once the basic values USE matrices are derived on domestic and imported routes, **food column tax and margin matrices are calculated employing basic prices row use shares**. Moreover, the additional columns in the food investment basic, tax and margin sub-matrices employ the same use shares as in the intermediate input equivalents.

14.3 Division of the agro-food commodity rows.

The division of the agro-food rows across all users (i.e., intermediate, investment, final private and public demands, stocks and exports) in the domestic and imported use tables. Starting with the intermediate demands, the usage of the arable commodity by the 22 crop sectors, is converted into a diagonal agricultural sub-matrix (i.e., off-diagonals are zero). Similarly, livestock commodity usage by the 6 livestock industries is also converted into a diagonal agricultural sub-matrix. Usage of livestock commodities by arable industries (i.e., manure) are subdivided based on Eurostat output shares, whilst arable commodities employed by livestock sectors (surplus feeds) are also split employing output shares. Non agricultural usage of arable and livestock commodities is determined by commodity shares of agricultural commodity 'i' in total agricultural output.[25] Moreover, some 'judgement' is also employed to determine which primary agricultural commodity rows are zero and which are non-zero across these non-agro-food columns. For example, the 'wholesale' industry purchases €16.9m (€565.9m) of arable (livestock) products, where it is assumed that all arable (livestock) row entries are non-zero. On the other hand, the 'hotel' industry is assumed not to purchase raw sugar, oilseeds, textile crops, other industrial crops or feed crops, since it is unlikely that such raw products would be directly used.

The usage of meat commodities across all intermediate industries is subdivided employing Eurostat output commodity shares, whilst the meat commodity by meat industry sub matrix is diagonal. Oils and fats, dairy and animal feeds are already disaggregated in the underlying Spanish IO accounts. The processed sugar commodity is stripped out of 'other food processing' commodity row employing Eurostat commodity output shares, whilst all stocks purchases in the 'other food' row are assumed to accumulate to sugar processing.

In the EU and non-EU import intermediate matrices, agricultural and food purchases are subdivided employing DATACOMEX import trade data from the Ministerio de Industria, Comercio y Turismo (2009).[26] For example, the proportion of EU arable imports which are wheat (say 10%) is applied in the wheat EU import row across all columns.

[25] The majority of the non-agro-food industries do not purchase arable or livestock products.

[26] It is not appropriate to employ domestic production shares to apportion import demands.

Private household and tourism demands for arable and livestock goods are subdivided employing Eurostat total domestic output shares. In the case of food products, the Encuesta continua de presupuestos familiares (INE – 2009) for 2000 provides household purchases for different food products. In the EU and non-EU import matrices, the private household and tourism agricultural and food purchases are also subdivided employing DATACOMEX import trade data.

Government and non-profit organisation purchases for all agricultural and food rows are zero in the underlying IO accounts for Spain. Arable and livestock **stock purchases** are subdivided employing Eurostat data under the agricultural supply balance sheets for 2000 and intervention prices for 2000 (to calculate values). Food stocks are all zero in the underlying IO accounts for Spain.

To subdivide the **EU and non-EU exports** rows across all 28 agricultural and 11 food commodities, DATACOMEX trade data from the Ministerio de Industria, Comercio y Turismo (2009) are employed. This data provides detailed export trade flows for each of the 28 agricultural and 11 food commodities. For obvious reasons, these accounts contain zero entries in the import matrices.

In the investment user matrices (V2BAS), the **import** USE Table entries for arable, livestock and food commodity rows are all zero in the Spanish IO database, whilst food rows in the domestic investment matrix are also zero. The division of arable and livestock investment purchases into disaggregate commodites, in the single GDFCF **domestic** use matrix column, is based on Eurostat output shares. The resulting domestic investment totals on each of the 28 primary agricultural commodities is useful when disaggregating the investment matrix. Thus, the arable crops rows in the domestic investment matrix are subdivided by assuming a perfectly diagonal matrix. Thus, investment goods purchases by the wheat industry of an arable related nature are €15.5 million – thus it is assumed that wheat commodity investments into the wheat industry are €15.5m.[27] Similarly, the livestock commodity rows by livestock activity sub-matrices are also diagonal. The remaining row entries (arable row x livestock column; livestock row by arable column) are sub-divided employing the agricultural row values in the single investment (GDFCF) column derived above, as shares.

Given knowledge of the basic values of arable, livestock and food purchases across domestic, EU import and non-EU import matrices, it is possible to calculate tax, margin and tariff (non-EU imports only) employing basic value use shares.

14.4. Assigning agricultural support to individual agro-food commodities and columns

In the IO table, 'net taxes on products' usage of agricultural commodity 'i' in agricultural sector 'j' are payments on the usage of commodities in production (i.e., area

[27] In the absence of other data, this is the most consistent assumption available.

payments, headage payments, production aids). In contrast, 'net taxes on production' refer to subsidies which are received as a registered member of the industry (i.e., young farmers' premiums, LFA premiums etc.). With this convention, and employing detailed support data by crops type for Spain in the year 2000 from the Fondo Español de Garantía Agraria (FEGA) (MARM, 2009c), it was possible to allocate the agricultural aggregate for each commodity across using sectors employing basic value usage shares. The representation of support is improved when updating the model to 2005, where the inclusion of land and capital subsidies wedges into the database allow a better characterisation of land based- and capital based agricultural subsidy payments (which are simultaneously removed from commodity and production tax columns). This procedure is discussed further in section 17 below.

The resulting agricultural basic values, tax and margin matrices are scaled using maximum entropy to accord with the agricultural industry column and row totals in the Spanish IO matrix.

15. Creation of Bio-fuels row and column accounts in ORANI-ESP.

Although the bio combustible sectors are still in their infancy, the importance of bio fuel production in European agriculture is of increasing significance to policy makers. Consequently, a useful appendage to the model framework is an attempt to disaggregate bio fuel production in Spain, with the potential benefit of examining its impact on land usage. The main obstacle here is that available data is scarce. In the Spanish IO Table, there are no biofuels rows or commodities, such that there is no basis upon which to calculate intermediate and value added costs, as well as different uses across intermediate, investment, final demands and stocks accounts. The approach employed follows that in GTAP-E, the energy use variant of the standard GTAP model.

Examining Taheripour et al. (2008), **data is provided from the International Energy Agency (IEA) on bio fuel production across the world between the year 2000 and 2004**. In Spain, 54,000 tones of oil equivalent were produced. Moreover, on page 6 of this paper, the authors estimate that Spain produced $38.98 million of bio ethanol from starchy crops (bioethanol1), $0 of bio ethanol from sugarcane (bioethanol2) and $5.32 million bio diesel from oilseeds. Indeed, further government reports confirm that in Spain, bio fuel production is indeed biased toward bioethanol1 (based principally on barley and wheat), and bio diesel based on recycled vegetable oils, rapeseed and sunflower seed. There was no production of bio ethanol with sugar 2000. Despite these facts, it is decided to include all three biofuels sectors within ORANI-ESP, since sugar based bio ethanol may become more economic in the future, whilst the types of technology cost shares (see below) differ markedly by industry (which rules out aggregating the two bio ethanol sectors together).

As hinted above, Taheripour et al. (2008) also provide cost share estimates in each of the three biofuels industries, broken down into 'feedstock', 'chemicals', 'energy', 'other', 'labour' and 'capital'. Based on a report of the Spanish biofuels market (Ballesteros, 2005), feed stocks is concorded with 'wheat', 'barley', 'maize' and 'alcohol' commodities for bioethanol1. In bio diesel, it is assigned to oilseeds and oils and fats; whilst in bioethanol2, it is assigned to primary sugar. The input 'chemicals' concords with the 'base chemicals' commodity row in the IO accounts, 'energy' input concords with petroleum, gas and electricity, whilst 'other' (which is a very small entry) concords with the remaining rows.

Thus, we have total production values (translated into euros using the 2000 exchange rate) and assuming zero profits, the cost values across six categories for the three industries.[28] Moreover, following Taheripour et al. (2008), we aim to **split out biofuels from existing industries** so as not to upset the internal balances within the ORANI-ESP database. Thus, **'bio diesel' production is subdivided from 'vegetable oils and fats'; 'bioethanol1' is disaggregated from 'other food processing'; and bioethanol2 is split out from the 'chemical' industry**.

From this point of departure, we first need to calculate the domestic, EU import and non-EU import intermediate cost proportions across each of the three biofuels industries. Thus, in the case of bio diesel which is disaggregated from the 'vegetable oils and fats' industry, the proportion of <u>domestic</u> bio diesel feed stocks usage corresponds to the usage of domestic 'wheat', 'barley', 'maize' and 'alcohol' usage in 'vegetable oils and fats' as a share of total usage by the 'vegetable oils and fats' sector of these commodities. This share is multiplied by the feed stocks share in bio diesel, to give <u>domestic</u> feed stocks usage in bio diesel. A similar procedure is applied to 'chemicals', 'energy', 'other' in bio diesel. Moreover, the same procedure for splitting between domestic, EU and non-EU imports is applied to the bioethanol1 and bioethanol2 sectors employing other food and chemical industries as an anchor.

It is assumed that biofuels employ crops as an intermediate input, which implies that they do not demand the land factor directly. Capital and labour costs are calculated as the share of total production values, whilst labour is subdivided between occupations employing the shares of the corresponding industries from which they are stripped out of. Thus, the labour cost shares for bio diesel are the same as those in 'vegetable oils and fats'. Similarly, labour cost shares by occupation for bioethanol1 and bioethanol2 are based on 'other food processing' and 'chemical' industry labour cost shares. Once the three biofuels columns have been calculated, we strip out bio diesel production values from the oils and

[28] In the bioethanol2 sector, the industry has a slightly non zero value in the ORANI-ESP database, despite the fact that production is zero in 2000. This is to allow for updating possibilities in future years.

fats industry column. Grain based ethanol production is taken out of the 'other food processing' column, and sugar based bio ethanol is split out from the chemical industry.

Having subdivided the industry columns, we also require a subdivision of the rows, to incorporate biofuels commodity usage by intermediate and final demand uses. The immediate idea was to split out the three commodities from the corresponding rows in the IO accounts. Thus, bio diesel commodity usage would be split from 'vegetable oils and fats' commodity usage etc. However, in the Spanish IO accounts, there is zero usage of 'vegetable oils and fats', 'other food' and 'chemical' commodities, by the primary agricultural industries.[29] Moreover, the row titled 'refined fuels' includes fuel usage (petrol, nuclear etc.) and is employed by all user accounts. Consequently, this row is judged to be more appropriate for splitting out the three biofuels commodities. The key task is to apportion demand across domestic, EU and non-EU sources. The data in Taheripour et al. (2008) assume very little trade in biofuels, so small positive entries are largely maintained for updating purposes in future versions of the data.

To determine the **intermediate usage** commodity splits of biofuels across domestic usage, EU import and non-EU import usage, the Spanish component of the version 6 GTAP database (benchmarked to 2001) with bio fuel extension created by Taheripour et al. (2008) is employed. Thus, the domestic, EU import, and non-EU import industry usage of the three biofuels PLUS 'other fuel' usage is employed to disaggregate the 'refined fuel' domestic, EU and non-EU import rows in the ORANI-ESP data. The same approach is employed for **private household demand column**.[30] In the **investment usage, public demand** and **NGO demand matrices**, there is no fuel usage, so biofuels usage is also assumed zero, whilst it is assumed that stocks of biofuels are also zero. In terms of the **export accounts**, a close examination of the DATACOMEX database (Ministerio de Industria, Comercio y Tourismo, 2009) revealed no bio fuel trade data. Consequently, we follow the approach in Taheripour et al. (2008) by implementing small non-zero numbers, which allow updating in future years. Implicitly we are assuming negligible export trade of biofuels from Spain in 2000 (i.e., more or less autarky). In the tourism accounts, we assume the same split domestic/EU/non-EU split as in the private household accounts.

Having created a set of new rows and columns for biofuels, the **margins and tax matrices** are modified employing *pro-rata* basic prices use shares. For example, in the case of the industry columns, the bio diesel taxes and margins entries are split out from the vegetable oils and fats column taxes and margins, whilst bio diesel row taxes and margins are divided from the 'refined fuels' row taxes and margins. It is not unreasonable to assume that the margin cost on one fuel or another, is more or less the same, whilst when we

---

[29] It would be unrealistic to assume that primary agriculture does not employ biofuels.

[30] This is subsequently split by separate households – see section 13 of this report.

examine the updating of the database to 2005, the tax structure (i.e., energy crop subsidies) of biofuels usage is modified to reflect EU agricultural policy.

16. Splitting the MAKE (or supply) matrix rows and columns.

Reference to Figure 3 shows the role of the MAKE matrix within the ORANI-ESP model. The MAKE matrix shows the source of domestic supply of each given commodity 'c' by each industry 'i'. Thus, this matrix is critical in recording the supply response of the industries to changes in demand driven conditions within the model. Thus, the row totals of the MAKE matrix must be equal to the domestic usage (including margins) of commodities, whilst the column totals in the MAKE must be equal to the industry column totals in the intermediate USE matrix.

In the Spanish IO accounts, the MAKE matrix is not perfectly diagonal, which implies that some commodities are made by more than one industry. Fortunately, the standard ORANI model framework caters for multi-product technology, which implies that no manipulation of the matrix is required for this purpose. However, with the addition of new agro-food and bio-fuels rows and columns to the ORANI-ESP model data accounts, it is necessary to split out the aggregate agro-food rows and columns into corresponding rows/columns in the MAKE matrix.

16.1 Primary Agriculture Splits

Thus, in the MAKE matrix we know the production of arable and livestock products by the agricultural industry. Moreover, examining the ORANI-ESP accounts we also know the production costs of each of the industries. Thus, these **production cost shares are used to subdivide the primary agricultural industry usage of aggregate arable and livestock commodities**. We also assume that of the commodities, wheat is only produced by the wheat sector; cattle is only produced by the cattle sector etc.[31] Employing this assumption we can easily **split out the arable and livestock rows to give ourselves a diagonal (28x28) primary agricultural sub-MAKE matrix**. In the MAKE matrix, the agricultural industry (column) also produces agricultural services (i.e., preparation of fields, crop maintenance and treatments, harvesting, animal husbandry etc.), non residential properties, wholesale, retail, research and development and 'cultural and sport services'. Thus, **the remaining commodity rows produced by agriculture are split into 28 primary agricultural columns by production cost share from the ORANI-ESP data**. To finish the primary agricultural component of the MAKE matrix, the remaining columns (industries) which produce arable and livestock commodities in the original MAKE matrix are 'forestry', 'wholesale', 'retail', 'public administration' and 'non-market activities'. **These columns are split between the 28 agricultural rows employing the domestic**

[31] Not an unrealistic assumption since we are talking about primary goods.

commodity supply shares from the ORANI-ESP data (which is based on the eurostat data for 2000).

16.2 Food Processing Splits

The new **5 meat industry columns are also split out by employing their production cost shares** (gleaned from the ORANI-ESP use matrices). As expected, by far the most important commodity (row) produced is 'meat', which **with the assumption of a diagonal matrix** (i.e., beef is produced by the beef industry; pork is produced by the pork industry etc.) **enables us to split out the five meat rows as well**. The remaining (non meat) commodity rows which are produced by meat industries are split by **production cost share from the ORANI-ESP data**. The five meat commodity rows must also be assigned to other (non-meat) using columns. Thus, the non-meat industry production of the five meat commodities is allocated **employing the domestic commodity supply shares from the ORANI-ESP data** (which is based on the eurostat data for 2000).

In the case of the 'other foods' industry in the standard IO Spanish data, we need to split out 'vegetable oils and fats', 'processed sugar', 'animal feeds' and 'other foods' industries in the MAKE matrix. In addition, **'vegetable oils and fats', and 'animal feeds' rows are already disaggregated** in the standard IO Spanish tables. Thus, in the MAKE matrix, the **production of 'vegetable oils and fats' and 'animal feeds' commodities by the aggregate food industry, is assumed to be all produced by the NEW 'vegetable oils and fats' and 'animal feeds' industries**. The **'other food' row is split between 'processed sugar' and 'other food' columns employing production cost shares** from the ORANI-ESP database. The remaining commodity rows are split between the four industry columns ('vegetable oils and fats', 'processed sugar', 'animal feeds', 'other foods') **by employing production cost shares** from the ORANI-ESP database. Since the 'vegetable oils and fats', and 'animal feeds' rows are already disaggregated in the standard IO Spanish tables, it is only necessary to disaggregate sugar processing commodities from 'other food commodities' across all using industries. Thus, the non-food industry production of sugar and 'other-food' commodities is allocated **employing the domestic commodity supply shares from the ORANI-ESP data** (which is based on the eurostat data for 2000).

16.3 Biofuels Splits

As noted in section 15 of the report, biofuels are split into three industries: bio ethanol from starchy crops (bioethanol1), bio ethanol from sugarcane (bioethanol2) and bio diesel from oilseeds. As before, in the MAKE matrix 'bio diesel' production is subdivided from 'vegetable oils and fats'; 'bioethanol1' is disaggregated from 'other food processing'; and bioethanol2 is split out from the 'chemical' industry. Given knowledge of the total domestic commodity (row) supply of the three biofuels types, it is assumed that in each case, it is all produced by the corresponding bio fuel industry. For example, from the ORANI-ESP database, the total domestic supply of bio diesel in 2000 is €4.86m, whilst the total industry cost is €5.12m. Thus, it is assumed that all bio diesel domestic commodity (row) is produced only by the bio diesel industry (i.e., €4.86m), whilst the bio diesel industry also produces "€5.12m minus €4.86m" of wholesale commodity. This ensures that the MAKE column total is equal to the industry costs column total in the USE matrices. A similar logic is applied to the other two biofuels sectors (i.e., vast majority is produced by corresponding industry, whilst assuming that the two industries also produce the wholesale commodity).

To balance the MAKE matrix, the bio fuel and wholesale production now attributed to bio diesel, bioethanol1 and bioethanol2 industry columns (very small totals) is subtracted from the wholesale production by 'vegetable oils and fats', 'other food processing' and 'chemical' industry respectively. Whilst this leaves these 6 columns balanced in terms of costs, it also leaves total wholesale supply (i.e., row total) short by 5.12+42.72+0.11=47.95. To compensate, the production of wholesale by the 'refined fuels' industry is increased by 47.95. Whilst the wholesale row is once again balanced, the total industry costs of the 'refined fuel' industry are too big. Thus, to compensate reduce the production of the 'refined fuel' commodity by the 'refined fuel' industry by 47.95. Since the three biofuels commodities are stripped out of the 'refined fuel' row, this leaves the matrix 'almost' balanced.[32] To ensure that the MAKE perfectly balances with the original IO matrix totals, a RAS procedure is implemented.. It should be noted that further refinements are made to the biofuels sectors cost shares when updating to 2005 (see section 17).

17. Creating a 2005 ORANI-ESP database

In December 2008, the **Instituto Nacional de Estadística (INE) released an updated set of Spanish IO accounts** (with the same 118 commodity by 75 industry aggregation) **benchmarked to 2005**. Furthermore, 2005 is seen as a useful reference year, since it represents the year prior to the introduction of the single farm payment (SFP) in Spain. To complete this task, one could employ a RAS or maximum entropy procedure. These are purely mathematical procedures which yield a set of 'appropriate' results to satisfy a given problem set, but do not provide any intuition as to why certain outcomes occur. Moreover, such algorithms are more useful for simple two dimensional matrices.

A preferable update approach is the Monash method developed by Horridge (2004), which allows the user to update and balance a CGE database. The program includes all of the detailed accounting conventions (although not the behavioural equations) underlying

[32] Although not quite balanced since the removal of biofuels costs from the 'refine oil' industry slightly exceeds the increase in domestic biofuels supply added to the 'refined fuel' row.

the standard ORANI database such that exogenous changes in specific 'target' variables are simultaneously fed through to the rest of the database. In particular, those data entries where detailed data may not be available (i.e., margins or taxes) are simply updated proportionally to the changes in basic values. Thus, unlike RAS, the Monash program provides some intuition when updating specific flows for which no data exists. Furthermore, when updating CGE databases which typically incorporate 3, 4 or even 5 dimensional arrays, employing RAS, the modeller would require considerable time updating each 2 dimensional array before conducting a check to ensure overall database balance. On the other hand, this program permits a consistent and simultaneous update of the entire database in a single experiment.

A further perceived advantage of this approach is its flexibility. The program can be employed for 'simple' updates merely involving macro variable projections, or it may be applied to highly complex update procedures with a multitude of detailed simultaneous accounting constraints to allow close replication of a more recent IO Table. Thus, without the need to start from the ground up, the user should be able to replicate more recent IO accounts with reasonable accuracy. Consequently, it is envisaged that in future years, the ORANI-ESP model will maintain its 'temporal' relevance **via periodical updates of the model database with updated IO accounts data**.

In comparison with the standard ORANI model, ORANI-ESP incorporates additional 'user' accounts (inbound tourism, multiple households, NGOs), disaggregated trade routes split between EU and non-EU sources and subsidies on land and capital. Consequently, the structure of the update program is modified to allow for update of these additional data items.

17.1 Implementing the aggregate column and row totals - basic prices

Once the update program is prepared, a series of secondary data sources are required for implementing the update shocks to pre-specified target variables. The MAKE matrix from the 2005 Spanish IO accounts is a useful starting point for updating. It **provides target totals in basic prices for domestic commodity supplies and industry costs.** These data are applied directly as target totals to all of the **non agro-food commodities** (rows) and industries (columns).

In the primary agricultural sectors, Eurostat's 2005 economic accounts for agriculture data for Spain in basic prices is employed to **target the domestic sales row (commodity) totals for the 28 primary agricultural sectors** (adjusted slightly to meet the IO accounts totals for 2005). The **meat sector row total for 2005** is divided between the five meat types using the upstream agricultural output shares, whilst the **sugar processing commodity (row) total is separated from the 'other food processing'**

total using data from the MARM (2009b) anuario de estadisticas on processed sugar products for 2005.

For biofuels, a relevant European Commission (2006) fact sheet details the production (in 000't) of bio-diesel and bio ethanol in Spain (*inter alia*) for the years 2004 and 2005. Indeed, the 2004 figure from European Commission (2006) is consistent with the 2004 Spanish data totals presented in Taheripour et al. (2008). This suggests that bio diesel production has grown from 6,480t in 2000 to 73,000t in 2005, whilst the corresponding figures for bio ethanol are 47,520t in 2000 to 243,000t in 2005. Employing data in Neeft et al (2007), these totals are converted to litres totals for 2005, whilst the EU27 price of bio ethanol and bio diesel in 2005 was $1.96 and $2.34 a gallon respectively (Birur et al, 2008). Thus, translating into euros, **we calculate that Spanish bio diesel and bio ethanol output in 2005 was €42.7m and €216.9m** (compared with €5.3m and €39.0m respectively in 2000). These target totals are used for the domestic sales row totals in bio diesel and bioethanol1 (grains based). In bioethanol2 (cane based ethanol production), a 'small' number is implemented to allow for future updating, whilst the sum of these three bio fuel values are subtracted from the row total for 'refined fuel'.

The Spanish IO accounts MAKE matrix also contains data on import sales totals at basic prices for the EU and non-EU regions by commodities, which are applied directly as target row totals in the non agro-food and non-biofuels commodity rows. In the case of imports, detailed HS6 level data for 2005 on **agricultural and food imports from the Ministerio de Industria, Turismo y Consumo (2009) DATACOMEX** database are aggregated and reconciled with the IO Spanish accounts totals for EU and non-EU imports. **In the case of bioethanol1** (cereals based ethanol), imports of unnatured and denatured ethanol (TARIC codes 220710 and 220720) are employed and disaggregated between EU and non-EU routes. In Bamiere et al. (2007), it is noted that, "assessing the EU external trade for bio diesel is difficult", whilst, "there is limited trade in this product per se" (pp15, Barmiere et al, 2007). Consequently, for **bio diesel import trade**, we assume small non-zero numbers, which allow for updating in future databases, whilst the applied tariff rate applied is 6.5% (pp4, Barmiere et al, 2007). For bioethanol2 (sugar based), it is assumed that Spain imports near-zero levels of biofuels (i.e., Autarky) – again, this also allows for further updating if data becomes available in the future.

Industry cost (column) target totals are implemented directly from the 2005 IO Spanish MAKE matrix in the non agro-food and biofuels sectors. In the agro-food sectors, Eurostat commodity data at producers prices for the 28 agricultural activities split the aggregate agricultural sector, whilst data from MARM (2009b) in chapter 34 of the 2005 Anuario de Estadistica Agroalimentaria, are used as output shares to subdivide oils and fats, sugar processing, animal feed and other food processing industries from the 'other food' column total in the 2005 IO accounts. The meat industry column in the IO accounts is divided into 5 sub activities (beef, pork, lamb, poultry, other meat) employing corresponding upstream output shares.

17.2 Intermediate account target values – basic prices

Having determined the row and column totals in basic prices for the Spanish economy, additional detail from the IO accounts is employed to target the individual user accounts (intermediate, investment, private demand, exports, public demand, stocks, tourism, NGOs). Thus, in the IO Spanish accounts, all the individual cell entries are employed to **update domestic intermediate usage of non agro-food commodities**. **In the biofuels sectors**, the bioethanol1 cost share of intermediate cereals usage in Spain is increased to approximately 60% (instead of 39% in the 2000 data) based on a report by the Ministerio de Industria, Turismo y Consumo (2005). The vast majority of bioethanol1 production is from local barley and wheat so it is assumed that 98% is domestic intermediate input usage, with the remaining 2% equally divided between EU and non-EU sources. In the case of bio diesel, it is noted in Bamiere et al. (2007, p23), that "oilseeds account for nearly 80% of the manufacturing cost of the bio diesel". This ratio is respected in the updated 2005 database. Moreover, they comment that, "bio diesel supply (in the EU) relies almost exclusively (95%) on rapeseed oil, the remaining 5% being produced from imported palm or soybean oil". Thus, we split oilseed usage in bio diesel into 95% (domestic), 4.9% (non-EU imported) and 0.1% (EU imported). Given aggregate commodity (row) totals for **primary agriculture and food commodities**, we allow the update program to determine their intermediate usage across industries. Similarly, given knowledge of industry cost totals (and value added target values – see later), we allow the update program to endogenously update intermediate input usage by agro-food industries.

17.3 Investment account target values – basic prices

Information on investment good production in the 2005 Spanish IO accounts is limited to a single column. Consequently, we merely implement the total basic value of gross domestic capital formation in 2005 and allow the model to endogenously choose the relevant cell entries in the investment matrix, respecting the restrictions imposed in the other accounts.

17.4 Private households account – basic prices

Household (HH) survey data for 2005 from INE (2009) are available from 'La Encuesta Continua de Presupuestos Familiares'. More specifically, total expenditures by each of 8 income sub-groups are available, whilst in each of the 8 households, expenditure shares across 10 different groups of goods and services are available (food and drink;

alcohol, tobacco and drugs; clothes, house and energy costs; furniture and home appliances; health; transport; communication; culture and leisure; education; hostelry, other). Employing these two sources of data, it is a straightforward exercise to calculate an 8x10 matrix of total expenditures by household type and aggregate commodity grouping. For each commodity column, the HH expenditure share is calculated.

The next task is the concord the 146 ORANI-ESP commodities (not 118 as in section 13) and the 10 commodity groupings. In the update procedure, this concordance exercise is done with the additional help of the COICOP classification system (found in the Google search engine). Moreover, it is assumed that the initial updated 2005 aggregate household totals for 2005 across domestic, EU and non-EU categories are the correct values for 2005.[33] Thus, having mapped the 146 commodities to 10 aggregate groups (from La Encuesta Continua de Presupuestos Familiares), the totals in each of the 10 mapped groups (summed over domestic, EU and non-EU columns) are calculated. [34] These totals are compared with the original aggregate commodity column totals in the 8HHx10 aggregate commodity matrix. We look to ensure that the both sets of aggregate commodity totals are reasonably close (and therefore the concordance between the 146 commodities and 10 aggregate commodities is relatively accurate).

The expenditure shares for each of the 8 HHs in the initial 8x10 matrix, multiplied by the 10 aggregate commodity groups of ORANI 2005 expenditure totals, are used to recalculate the amount each household spends in each of the 10 categories (i.e., based on ORANI-ESP target data, <u>not</u> INE HH budget survey data). These totals for each of the 8 HHs across the 10 aggregate commodities are split out by the share of each ORANI-ESP commodity. For example, if <u>domestic</u> commodity 'wheat' consumption in the group 'food and drink' is 1% of total domestic commodity food and drink expenditure, then 1% of each HH's domestic commodity 'food and drink' expenditure is 'wheat'. This assumption is applied across EU and non-EU import routes, as well as all aggregate commodity groupings. These values are therefore deployed as the target 2005 basic prices expenditures for the 8HHs.

17.5 Export account target values – basic prices

The export columns in the IO Spanish accounts for 2005 are already split by EU and non-EU usage. Thus, the basic values (i.e., prior to export subsidies) from these accounts are deployed to update **all non agro-food rows**. For **primary agriculture and**

[33] Thus, an initial experiment is run where all the other 2005 target values are implemented and the household adjust endogenously. These aggregate totals are then taken as the target totals for the aggregate household. We cannot target aggregate household consumption using the 2005 Spanish IO Table totals directly since these incorporate domestic tourism purchases.

[34] For example, in aggregate group 1 (food and drink), we have 40 ORANI-ESP commodities by 3 sources (domestic, EU, non-EU). Summing over all commodity rows, we have expenditure totals on food and drink for each of the three routes.

food sectors, detailed HS6 level trade data from the DATACOMEX database are aggregated and reconciled with the IO Spanish accounts totals for EU and non-EU exports. **Biofuels export data** are also incorporated into ORANI-ESP 2005 data. For bio ethanol, export data for natured and denatured ethanol[35] from the Ministerio de Industria, Turismo y Consumo (2009) from the DATACOMEX database, are compared with the supply and demand balance accounts in Ballesteros (2005) for 2005. Both sets of figures are close. We employ the official DATACOMEX data, which divide export trade into EU and non-EU components. In the case of bio diesel exports, the supply and demand balance data are employed from Ballesteros (2005).

17.6 Government demands – basic prices

Government demands for domestic commodities at basic prices are updated directly from the Spanish IO accounts. In the case of import demands, this only applies to three commodities, although the EU/non-EU split is unknown. Thus, given the relevant row total constraints on EU and non-EU imports, we let the update program endogenously update these values to meet target totals.

17.7 Stock accounts – basic prices

The stock accounts are left unaltered except in those cases where negative entries appear in row cells. In these cases, the stocks values are altered to compensate.

17.8 Inbound Tourism accounts – basic prices

In the Spanish 2005 IO accounts, there are no explicit divisions of tourism expenditure by commodities. Updating is facilitated by usage of the **satellite accounts for tourism expenditure** within Spain for the years 2000 and 2005, provided by INE (2009c). Comparing the expenditures <u>at basic prices</u> between both years, domestic inbound tourism has risen by 51% and foreign inbound tourism has risen by 21%. Thus, these percentage rises are applied to the column totals of both types of tourism, whilst the update program determines the allocation over commodities.

17.9 Non profit accounts – basic prices

Non profit organisation domestic demands for commodities at basic prices are updated directly from the 2005 IO Spanish accounts. There are no import demands in this account.

[35] The trade codes for these commodities are taken from Bamiere et al., (2007).

17.10 Value added

For the **non agro-food and biofuels industries**, **explicit 2005 targets for labour and capital** by industry from the Spanish IO accounts are implemented. The labour totals by occupation are determined endogenously within the aggregation program. Effectively, we are assuming that the occupation labour cost share by industry remains the same as in 2000. In addition, the total Spanish labour cost in 2005 is implemented, whilst the total agricultural labour cost is also implemented to ensure that the total labour cost over the **28 primary agricultural industries** (columns) is equal to the 2005 Spanish IO target value. With the implementation of target values for totals costs, total intermediate costs, and production subsidies (see later) for each agro-food industry, and total Spanish labour costs and primary agricultural labour costs, labour and capital costs in the agro-**food and biofuels industries** adjust endogenously within the update program.

The **land factor rent payments**, which is only employed in primary agricultural sectors, is calculated for 2005 employing the same data sources required for the year 2000 data. Thus, employing MARM (2009a) 2005 land prices for irrigated and non irrigated land are available in the 'encuesta de Precios de la Tierra', whilst the 'Anuario de Estadistica Agroalimentaria' (MARM, 2009b), yields detailed data by agricultural crop activity on land usage (irrigated and non irrigated) is also available. As before, these values are aggregated for each industry to yield a land value by agricultural crop activity. As in section 11, land rents are calculated employing a 2 percent rate of return. The target estimates of crop land are implemented directly, whilst livestock land values adjust endogenously given the restrictions on other components of value added.

Production subsidies for the non agro-food industries are also imposed directly using the data from the IO Spanish accounts in 2005. In the agro-food and biofuels sectors, **production subsidies and land/capital based payments** are implemented for 2005 using the relevant FEGA (MARM, 2009c) data. This data splits up agricultural support by type and crop. These data are then assigned to the relevant agro-food and bio fuel sector. Thus, **production subsidies** (i.e., direct aids) are broadly defined as 'production subsidies' (e.g., olive oil payment, wine payment), 'additional marketing and distribution support measures both on domestic and foreign sales' (especially in fruit), 'storage aids', 'other expenditures', 'fraud or overpayments' (negative entry) and 'traceability and quality control costs'. Where necessary, these subsidies are split employing output shares. The resulting production subsidy target values are implemented in the agro-food and biofuels columns. In order to meet total cost targets, labour and capital totals adjust.

Land based subsidy payments are largely made up of agenda 2000 area payments on cereals, oilseeds, protein crops and on dry fruit and potatoes, set aside payments, land payments for leaving fruit and vegetable land fallow. **Capital based payments** include agenda 2000 headage payments on livestock and raw milk production, vineyard restructuring and investment aids. Where necessary these are split employing output cost shares, whilst the target totals in the primary agricultural industries are implemented directly into the land and capital subsidy wedges.

17.11 Tariffs and Commodity Taxes

The treatment of non-EU **import tariff rates** in ORANI-ESP for 2005 is improved compared with the ORANI-ESP 2000 data. Previously, tariff rates were taken from the GTAP database for 2001, employing an aggregation of Spanish trade with EU and non-EU partners. The advantage of the GTAP database is that the tariff rates provide a useful *ad valorem* tariff equivalent of all possible tariff measures (i.e., ad valorem tariffs, mixed tariffs, compound tariffs, tariff rate quotas etc.) employed within an aggregate bilateral tariff route. Unfortunately, the commodity disaggregation in GTAP is not as detailed as in ORANI-ESP, which, for example, implied that the applied tariff rate on 'other cereals' in the GTAP database, was imposed uniformly in each of the 'barley', maize' and 'other cereals' sectors.

For the ORANI-ESP 2005 data, **non-EU import applied tariff data is a calculated trade weighted aggregate of HS6 level data for 2004** attained from the TASTE (Tariff Analytical and Simulation Tool for Economists) software developed by Horridge and Laborde (2008). The TASTE data forms the basis upon which the tariff and import trade component of the GTAP version 7 trade database is calculated. **The advantage for ORANI-ESP, is that at HS6 disaggregation, it is possible to calculate tariff rates for all commodities with much greater accuracy since we are aggregating upwards**. In addition, the TASTE software also provides **bound ad valorem tariff rates** for each of the HS6 trade routes. Trade weighted bound tariff rates have also been calculated for the ORANI-ESP database for all commodities, thereby providing a useful extension when examining the impacts of tariff liberalisation.

In the case of commodity (indirect) taxes, **target totals are imposed on total industry intermediate input taxes**, **total investment account taxes**, and **aggregate exogenous commodity tax target for Spain.** In the intermediate and investment accounts, the individual cell entries adjust endogenously within the confines of the model update program. On the other hand, in the private household and tourism accounts, rates of value added tax (4% for pharmaceuticals; 7% for food and services; 16% for manufactured items) are employed in the majority of commodity rows. In the tobacco, alcohol, fuel and insurance/finance/legal commodity rows, additional taxes are incorporated (based on information from Banco de España (2005)) which satisfy the row tax totals in the Spanish IO accounts. Consequently, commodity taxes in these rows are higher (petroleum - 65%; tobacco - 280%; alcohol 70%; insurance - 25%; legal and accounting services – 200%). **Export subsidy targets** in the relevant agro-food commodity rows are also incorporated explicitly based on FEGA data from MARM (2009c) for 2005.

In the ORANI-ESP 2005 database, many of the **agro-food intermediate commodity subsidies** have been **stripped out and reconstituted as land and capital subsidies**. Those agro-food intermediate commodity subsidies which remain are subsidy payments on energy crops (i.e., oilseeds in bio diesel, cereals in bioethanol1), product processing subsidies, textile crop processing subsidies, seed payments, wine distillation subsidies, subsidies on raw milk usage to the dairy sector, agro-monetary aids, less favoured areas and rural development subsidies (i.e., irrigation aids on water usage, young farmers aids, training, early retirement, agri-environmental measures, other programs). In the update program, these subsidies are assigned as exogenous targets to the relevant intermediate input linkages, or where general programs are concerned, the subsidy is divided according to the primary agricultural output share and assigned as an intermediate input to the corresponding industry (i.e., commodity 'c' = industry 'i'). **Given the reduction in agro-food intermediate subsidies (due to their removal and re-representation as land/capital subsidies), the net commodity tax total in the intermediate industry tax accounts is increased in the update program to compensate**.

17.12 Indirect Margins Usage

Any attempt to separate indirect margins usage once again into domestic, EU and non-EU routes across all accounts would require a rigorous treatment along the same lines as discussed in section 6, when building the ORANI-ESP 2000 data. Since the update program automatically updates margins in proportion to the basic value uses in the accounts, this convenient facility is employed subject to an exogenous target total on indirect margin usage which is taken from the Spanish IO accounts for 2005.

18. Elasticity parameters and Agricultural Policy parameters

18.1 Elasticity parameters for ORANI-ESP

Having created a consistent ORANI-ESP CGE database for the year 2005, the next task is to choose appropriate supply and demand response parameters for the model. In particular, CGE models require elasticities of substitution for each of the levels of the demand and supply nests, estimates of expenditure elasticities for the LES private household demands and export demand elasticities.[36] Unfortunately, a common (and valid) criticism of these models is that there is a dearth of elasticity estimates from the literature on these parameters, which implies that the modeller is forced to borrow estimates from other models or relevant literature sources. **In the future, a rigorous revision of these**

[36] For a full discussion of the ORANI model structure, the reader is encouraged to read part II of this report.

elasticity estimates for the Spanish economy would constitute an important development in the model's future evolution.

In the top part of the production nest, there is an **elasticity of substitution between a composite value added and energy input and a composite intermediate input**. Due to a lack of empirical estimates, most CGE models assume a Leontief treatment, where inputs are employed in proportion and are unresponsive to price changes.[37]

The industry substitution elasiticities between labour, land, other costs and the capital-energy composite input in the **value added nest** are taken from the standard GTAP version 7 database; whilst the **elasticity of substitution between labour occupations within an industry** employs the same elasticity values as the aggregate value added nest (for lack of better information). The **capital-energy sub-nest** substitution elasticities are taken from a bio fuel extension of the GTAP-E model by Birur et al (2008). Examining greenhouse gas emissions, this work extends the standard GTAP to incorporate a module on energy usage (including biofuels), carbon markets and permit trading. At this stage, ORANI-ESP has no carbon market or permit trading scheme, although like GTAP-E, it contains an explicit treatment of energy markets and biofuels.

At the outset, the essential nature of energy in the production structure implies an inelastic demand structure, which is reflected in the substitution estimates in Birur et al. (2008). The estimates in their paper are revisions of the original GTAP-E estimates of Burniaux and Truong (2002) which were found to be too elastic. Birur et al. (2008) employ evidence from Beckman et al. (2008) for their revisions. Thus, the **elasticity of substitution between capital and the energy composite** input is 0.1. The **substitution elasticity between electrical energy, coal energy and the non-electrical-coal energy** composite is **0.1**. The **substitution elasticity between non-electrical or coal energy** sources is **0.25**. Finally, the **elasticity of substitution between biofuels and petroleum** is zero (i.e., complements). The logic here is that in production, biofuels are often blended with gasoline.

In the **intermediate inputs nest, both for industry and investment demands**, the elasticities of substitution are the same as those in the latest GTAP version 7 database for Spain (Narayanan and Walmsley, 2008).[38] Thus, in the **upper nest**, there are elasticities of substitution between domestic and composite imported intermediate inputs, whilst in the **lower nest** (known as the Armington nest) the elasticities of substitution between EU and non-EU imports are double those of the upper nest.[39]

---

[37] In this model, we continue this tradition. Attempts to implement production nest elasticities between intermediate inputs and value added taken from the work of Keeney and Hertel (2005), resulted in exaggerated output changes in the ORANI-ESP model.

[38] Those for Spain are from the group of 'developed' country estimates.

[39] The Armington nest differentiates imports by region of origin employing an elasticity of substitution less than infinity. This prevents total specialisation effects, although it also has implications for the terms of trade.

Further constant elasticities of transformation (CET) govern the **transfer of land between agricultural using industries**. In ORANI-ESP, the three tiered nested structure follows that of OECD's Policy Evaluation Model (OECD, 2003) by assuming that the substitutability of land allocation differs by land types (see Part II for fuller discussion). Using this structure, one may specify an increasing degree of transformation (substitutability) between land types, where the more distinct are the agricultural activities (moving up the tree), the smaller are the transformation elasticities. Thus, in the **top tier of the land nest**, the CET between permanent pastures and composite livestock and cereals/oilseeds land usage[40] is 0.001. **In the second tier**, the CET between livestock, and composite cereals and oilseeds land usage is 0.05. In the **bottom tier** of the nest, the CET between cereals, oilseeds, feed crops, textiles and primary sugar is 1.

Following Keeney and Hertel's (2005) work on GTAP-AGR, additional **CET elasticities control the transference of labour and capital between agricultural and non agricultural uses**. The idea is to capture the observed wage and rent differentials between agricultural and non-agricultural sectors. Thus, in ORANI-ESP a borrowed value of 0.5 is employed. Similarly, given the non-diagonal MAKE matrix, there is the possibility of multi-product industries in ORANI-ESP, which requires a CET **estimate of how responsive one industry switches between the production of two or more outputs**. ORANI-ESP employs the standard ORANI model estimate for Australia, of 0.5.

In the private household demand nests, the top nest incorporates an **Linear Expenditure System (LES) function** to apportion expenditures over aggregate (i.e., domestic plus imported) commodities. ORANI-ESP also explicitly models the substitution possibilities between energy demands. **Thus, the top nest divides each household's LES demand into energy and non-energy commodities**. To calibrate the function, estimates of expenditure elasticities are required. Thus, for **agro-food commodities**, expenditure elasticity estimates are borrowed from a study of Italian households by Moro and Sckokai (2000). The advantage of this study is that it estimates expenditure elasticities for households stratified by wealth for a range of different food products (which are concorded with the agro-food commodities in the ORANI-ESP database). Whilst no such studies are available for Spain, Italian consumer preferences are judged to be a useful proxy for Spanish household behaviour.

Thus, 'low income' households in Moro and Sckokai (2000) correspond with household 1 (poorest), 'medium.-low' corresponds with household 3; 'medium.-high' corresponds with household 5; and 'high' corresponds with household 7. Given Engel's Law, poor households exhibit higher income elasticities than wealthier households, reflecting the larger consumption share of 'necessities' in the consumption bundle. For

[40] Potatoes, sugar, textile crops, other industrial crops, feed crops, grapes for wine, olives for oil, vegetables, flowers, table olives, dry fruit, table grapes, other fruit, citrus, tropical, other crops.

many commodities, Engel's Law is observed in the expenditure elasticity estimates (i.e., declining expenditure elasticity for richer households). In those cases where the Law does not hold across all households, a linear extrapolation across households is applied, employing those estimates which adhere to Engel's observation. **For non-agro-food commodities**, income elasticity estimates from version 7 GTAP (Narayanan and Walmsley, 2008) are implemented. Some adjustment is made to these elasticities to ensure that Engel's Aggregation is maintained.[41]

In addition to the expenditure elasticities, estimates of the **FRISCH parameters** (FRISCH, 1959) are required. The FRISCH parameter measures the ratio between total disposable income and supernumerary (luxury good) income. The larger is the absolute value of the parameter the poorer is the household, since more income is allocated to subsistence purchases. Employing data for Australian households,[42] Dixon and Lluch (1977) estimated a FRISCH value of 1.82 for average income households – this is applied to household 4 in the model. Moreover, they empirically showed, based upon a log linear regression analysis, that the Frisch parameter declines by approximately 0.36 per cent for every for every one per cent increase in GNP per capita In the ORANI-ESP data, the midpoint income level is chosen for each household, whilst income changes with respect to each prior household (in the direction of both poorer and wealthier households) are calculated. Given a starting point of 1.82 for household 4, it is possible to calculate the increase/decrease in FRISCH with decreases/increases in household income. Thus, for the 8 households (poorest first), the absolute values of the FRISCH parameters are 2.85; 2.30, 2.01; 1.82; 1.63; 1.50; 1.26 and 1.03.

Energy demands are a CES aggregate of coal, oil, gas, electricity and a 'petroleum and biofuels composite'. Once again, household demands are inelastic such that the elasticity of substitution is 0.1 (taken from Birur et al, 2008, based on estimates in Beckman et al, 2008). In the second energy nest, aggregate (i.e., domestic and imported) biofuels substitute with petrol at the pump, whilst the value of 3.95 is chosen, represents the elasticity employed in Birur et al (2008).[43] In the lower nests, **private household CES substitution elasticities between domestic and import composites; and EU and non-EU imports** are taken from the GTAP model database (Narayanan and Walmsley, 2008). As with the intermediate and investment CES demands, the upper level elasticity estimates are double the lower nest (Armington) values.

In the **tourism accounts, total (i.e., foreign and domestic) tourism expenditure is a Leontief aggregate of commodity expenditure**. **In the second nest**, Leontief is also assumed when allocating total commodity expenditure between domestic and foreign

---

[41] The sum of the budget shares multiplied by the expenditure elasticities is equal to unity.
[42] As a developed economy, this serves as a sufficient proxy for Spanish household behaviour.
[43] In their paper, this substitution elasticity value reflected the value required to increase historical biofuels given the historical increase in petrol prices between 2001 and 2008.

inbound tourism – that is, both these forms of commodity expenditure are complements. Thus, we assume that both increase/decrease in tandem with the general conditions of the tourism industry.[44] **In the third and fourth level nests**, domestic (foreign) tourist demand is allocated between domestic-composite import commodities; and EU/non-EU import demands, respectively. The CES elasticities employed are identical to those in the corresponding private household nests.

The demand function for exports is a decreasing linear function of fob prices. Thus elasticity of demand for exports is assumed to be -5. Moreover, the **supply of exports is a two stage CET nest** where supply is determined between domestic and composite export routes in the upper nest, before being allocated between EU and non-EU export routes. In both cases, following the standard ORANI treatment, the CET elasticities are assumed to have a value of 20.[45] Finally, the land supply parameters are estimated 'in-house' employing a non-linear maximum least squares approach. This is discussed further in part II of the report.

18.2 Agricultural Policy parameters for ORANI-ESP

The **sugar and milk quota mechanisms** are modelled within ORANI-ESP (see part II for details). In terms of data support, estimates are required of the quota fill rates and the size of the quota rent (if the quota is binding). In the case of milk, the rent estimate was taken from Jongeneel and Tonini (2008), which is based on the findings of the AGMEMOD European project.[46] In the report, it is estimated that Spain has a positive milk quota rent estimate, which implies that the quota is binding. Jongeneel and Tonini (2008) estimate that rents constitute 29.5% of the total value of milk production. This estimate is employed in ORANI-ESP, whilst the 'other costs' component of raw milk costs is reduced to compensate. For the sugar sector, EU15 rents data from EC (2005) are employed. The report suggests that Spanish sugar production is relatively uncompetitive in Europe, resulting in zero rents. This implies that the quota is not binding. We assume that only 80% of the allowable sugar quota is filled in Spain.

Information on intervention price changes was taken from OECD (2007) and OECD (2008). Examining the arable sectors **intervention prices are employed in the cereals (except rye), rice and sugar sectors**, although not in oilseeds and protein crop (peas, beans, lupines) production. In terms of livestock activities, **intervention exists for dairy, beef and pig meat**.[47] Cereals intervention prices remain unchanged (they were

[44] It is certainly not plausible to consider foreign and domestic tourism expenditures as substitutes, since one does not crowd-out the other.
[45] The high elasticity implies that the commodity is relatively homogeneous across different export routes.
[46] AGMEMOD is an EU funded project which sets out to construct partial equilibrium agricultural models for each of the 27 members of the EU and select candidate countries.
[47] No intervention has been applied to the pig meat sector since the early 1980s (OECD, 2007, pp107), so in this sector, no intervention purchases are modelled.

reduced in the agenda 2000 reforms), whilst **in rice**, the intervention price was reduced 50% from €298/t to €150/t in the marketing year 2004/5. Thus, **no further reductions in rice intervention are modelled from 2005 onwards**. As part of the 2006 sugar reforms, the 'reference' price for **white sugar is cut 36%**. In the livestock sectors, **beef intervention prices remain unchanged**. In the dairy sector, MTR intervention price reductions (between 2004 to 2007) for skimmed milk powder (SMP) and butter fall from €1952/t and €3052/t respectively in 2004/5, to €1747/t and €2595/t respectively in 2006/7. Examining data from EC (2008), SMP production in Spain is very minor, so the **fall of 15% in butter** (between 2004/5 – 2006/7) **is employed in the dairy sector**.

In the case of the **export subsidy limits within the Uruguay Round**, in the Economic Research Service (ERS) of the United States Department of Agriculture (USDA), data is available on the EU's export subsidy and quantity commitments as a percentage of the agreed Uruguay Round limits. These EU-wide percentages are assumed to apply to Spain and are implemented into the 2005 database.

19. Brief Conclusions

This report presents a detailed account of the necessary steps required to build a CGE database from an array of secondary data sources. Reference to the individual steps discussed in this report will enable the reader to have a greater appreciation of the necessary checks, balances, data searches and man-hours needed in undertaking such an labour intensive task. At the current point in time, this database for 2005 represents a point of departure, in that further data will be required as the ORANI-ESP model evolves to include additional modelling features (e.g., a treatment of irrigated and non irrigated land, concentration ratios for imperfect competition; environmental emissions data; additional investment parameters to support a dynamic treatment of investment and adaptive expectorations etc.).

Whilst the model and accompanying database will continue to evolve, the current incarnation of ORANI-ESP represents the first CGE model designed to help make informed decisions in Spanish agro-food sectors based on changes in EU agricultural policy. With the inclusion of useful trade data (applied and bound rates), biofuels data, household stratification and a healthy disaggregation of primary agricultural and food sectors, the modeller is well placed to examine the quantitative impacts of policy scenarios on sectoral outputs, whilst examining the distributional and welfare impacts in Spain.

20. References:

Banco de España (2009) Estadisticas, http://www.bde.es/estadis/estadis.htm

Blake, A. (2000) The economic effects of tourism in Spain, Christel DeHaan Tourism and Travel Research Institute, Working paper 2000/2, http://www.nottingham.ac.uk/ttri/

Britz, W. (editor) (2005): CAPRI Modelling System Documentation. http://www.ilr1.uni-bonn.de/agpo/rsrch/capri/capri-documentation.pdf, University of Bonn.

Ballesteros, M. (2005) Biofuels market in Spain, Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas, CIEMAT.

Bamiere, L., Bureau, J.C., Guindé, L., Guyomard, H., Jacquet, F. and Treguer, D. (2007) Prospects for EU Bio fuel Production and Trade, TradeAG: European Commission framework VI project, Working Paper 07/12.

Beckman, J., Hertel, T.W. and Tyner, W.E.. (forthcoming) "Validation of the GTAP-E Model", Centre for Global Trade Analysis, Purdue University.

Birur, D.K., Hertel, T.W. and Tyner, W.E. (2008) Impact of Bio fuel Production on World Agricultural Markets: A Computable General Equilibrium Analysis, Department of Agricultural Economics, GTAP Working Paper no. 53, Purdue University, USA.

Burniaux, J. and T. Truong (2002) "GTAP-E: An Energy-Environmental Version of the GTAP Model", GTAP Technical Paper No. 16, Centre for Global Trade Analysis Purdue University, West Lafayette, IN.

Dimaranan, Betina V. (Editor) (2006). *Global Trade, Assistance, and Production: The GTAP 6 Data Base*, Centre for Global Trade Analysis, Purdue University

Dixon, P.B. and Lluch, C. (1977) Durable goods in the extended linear expenditure system, Review of Economic Studies 44, pp 381-384.

European Commission (2005) Reforming the European Union's sugar policy: Update of impact assessment, Brussels.

European Commission (2006) Fact Sheet: Biofuels in the European Union: An Agricultural Perspective, Brussels.

European Commission (2008) Agriculture in the European Union – Statistical and Economic Information 2008 http://ec.europa.eu/agriculture/agrista/2008/table_en/index.htm

Eurostat (2009) Economic Accounts for Agriculture, years 2000 and 2005 http://epp.eurostat.ec.europa.eu/portal/page/portal/agriculture/data/database

Eurostat (2009) Agricultural products – supply balance sheets, years 2000 and 2005 http://epp.eurostat.ec.europa.eu/portal/page?_pageid=0,1136206,0_45570467&_dad=portal&_schema=PORTAL

Frisch, R. (1959) A Complete Scheme for Computing All Direct and Cross Demand Elasticities in a Model with Many Sectors, Econometrica, Vol. 27, No. 2. (Apr., 1959), pp. 177-196.

Horridge, M. (2001) DAGG Guide: A multipurpose freeware software package for manipulating and balancing databases, University of Monash, Melbourne, Australia.

Horridge, M. (2003) *ORANI-G: A Generic Single Country Computable General Equilibrium Model*, Centre of Policy Studies and Impact Project, Monash University, Australia

Horridge, M. (2004) Using levels GEMPACK to update or balance a complex CGE database, Discussion paper, Centre of Policy Studies and Impact Project, Monash University, Australia.

Horridge, M. and Laborde, D. (2008) TASTE: A program to adapt detailed trade and tariff data to GTAP related purposes, Technical document, https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=2666.

Instituto Nacional de Estadística (INE) (2009) http://www.ine.es/ Gobierno de España.

Instituto Nacional de Estadística (INE) (2009b) 'La Encuesta Continua de Presupuestos Familiares' http://www.ine.es/jaxi/menu.do?type=pcaxis&path=%2Ft25/p458&file=inebase&L=0

Instituto Nacional de Estadística (INE) (2009c) Cuenta satélite del turismo de España, Gobierno de España. http://www.ine.es/jaxi/menu.do?type=pcaxis&path=%2Ft35/p011&file=inebase&L=0

Jongeneel, R. and Tonini, A. (2008) The milk quota rent puzzle in the EU: Economic significance, review and policy relevance, 109th EAAE Seminar, Viterbo, Italy, November 20-21st, 2008.

Keeney, R. and Hertel, T.H. (2005) GTAP-AGR: A Framework for Assessing the Implications of Multilateral Changes in Agricultural Policies, GTAP Technical Paper No.24, August 2005, University of Purdue, USA.

MAPA (2002) Red Contable Agraria Nacional, Año 2000, Ministerio de Agricultura, Pesca y Alimentación, Madrid.

MARM (2009a) Ministerio de Medio Ambiente y Medio Rural y Marino, Servicio de estadísticas, http://www.mapa.es/es/estadistica/infoestad.html, Encuesta de Precios de la Tierra (2000 and 2005), Gobierno de España.

MARM (2009b) Ministerio de Medio Ambiente y Medio Rural y Marino, Servicio de estadísticas, http://www.mapa.es/es/estadistica/infoestad.html, Anuario de Estadistica Agroalimentaria (2000 and 2005), Gobierno de España.

MARM (2009c) Ministerio de Medio Ambiente y Medio Rural y Marino, Fondo Español de Garantía Agraria (FEGA), Gobierno de España, http://www.fega.es/PwfGcp/es/el_fega/presupuesto/index.jsp

Matthews, A., O'Toole, R. and Jensen, J. (2003) The IMAGE model: Decision Making Tool for the Food Industry, Department of Economics, Trinity College, Dublin.

McDougall, R. (1999) Entropy and RAS are Friends, GTAP Technical Paper, Purdue University, USA.

Ministerio de Industria, Comercio y Turismo (2005) Plan de Energias Renovables 2005-2010, http://www.mityc.es/desarrollo/seccion/energiarenovable/plan, Gobierno de España.

Ministerio de Industria, Comercio y Turismo (2009) DATACOMEX: Estadísticas del comercio exterior, http://datacomex.comercio.es/index.htm, Gobierno de España.

Narayanan B. G. and Walmsley T. L., Editors (2008). Global Trade, Assistance, and Production: The GTAP 7 Data Base, Centre for Global Trade Analysis, Purdue University.

Neeft, J., van Thuijl, E., Wismeijer, R. and Mabee, W.E. (2007) Bio fuel Implementation Agendas: Spain, IEA Task 39, Report T39-P5, pp1-52.

Moro, D. and Sckokai P. (2000) Heterogeneous preferences in household food consumption in Italy, European Review of Agricultural Economics, vol 27 (3), pp305-323.

OECD (2001) Market Effects of Crop Support Measures, OECD Publications, Paris, France.

OECD (2007) Agricultural Policies in OECD Countries: Monitoring and Evaluation 2007, Secretary general of the Organisation for Economic Co-operation and Development, Brussels.

OECD (2008) Agricultural Policies in OECD Countries: At A Glance 2008, Secretary general of the Organisation for Economic Co-operation and Development, Brussels.

RECAN (2002) Red Contable Agraria Nacional, Ministerio de Medio Ambiente y Medio Rural y Marino (anteriormente Ministerio de Agricultura, Pesca y Alimentación).

Taheripour, F., Birur, D.K., Hertel, T.W: and Tyner, W. (2008) Introducing Liquid Biofuels into the GTAP database, GTAP Research Memo No. 11.

United States Department of Agriculture (2009) Economic Research Service WTO export subsidy notifications database, Federal Government of the USA.
http://www.ers.usda.gov/db/Wto/ExportSubsidy_database