The IMAGE CGE Model: Constructing the Base 1993 database

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Abstract

The core database for IMA*GE* is the Irish Input-Output table from 1993, extended to a SAM (Social Accounting Matrix) to allow for the value added in the economy to accrue to one of the institutions in the economy. The model distinguishes 34 industries, the first eight of which relate to farm level production, making it by far the most disaggregated CGE model for Ireland thus far. There are two sources of commodities, namely domestic and overseas. There are nine occupational groups and three household types, namely urban, rural farm, and rural non-farm. This working paper details the construction of the domestic and imported inter-industry flow matrices at both basic and purchasers' prices, the factoral and institutional distribution of income, the final demand column vectors, margin matrices and model parameterisation. Given the model's agricultural focus, data issues relating to the modeling approach used for the Common Agricultural Policy are discussed in a separate section.

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1 Introduction

A natural extension of an Input-Output table is a SAM (Social Accounting Matrix), which allows for the value added in an economy to accrue to one of the institutions (households, government, companies etc.) in the economy. The core database for the IMA*GE* (Irish model of Agriculture, *G*eneral *E*quilibrium) model is a SAM, which is a unified set of production accounts that, for any year, gives the flows between all the various productive activities. The development of this matrix is one of the key elements in the modeling process. The SAM is necessary so as to provide a link between economy-wide incomes and expenditures.

The IMA*GE* model distinguishes 34 industries (the first eight of which relate to farm level production, plus a separate industry for each of forestry and fishing) and 34 corresponding commodities, making it by far the most disaggregated CGE model for Ireland thus far. There are two sources of commodities, namely domestic and overseas. There are nine occupational groups and three household types, namely urban, rural farm, and rural non-farm.

The IMA*GE* model is based on the most recently published Irish Input-Output table from 1993 (CSO, 1996). This has been further disaggregated so as to give a more detailed representation of agriculture forestry and fishing, which is traditionally treated as one sector in published Irish Input-Output tables.[1] A full list of the sectors used is listed in the Appendix 2. Ancillary data sources used to develop the SAM are the Household Budget Survey which is based on 1994-1995 data and which incorporates household types also included in the National Farm Survey.

This working paper begins with an overview of the components of the IMA*GE* model database followed by a discussion of the steps behind the construction of the base data set. Section 2 concentrates on the domestic and imported inter-industry flow matrices at both basic and purchasers' prices. Section 3 discusses the factoral distribution of income, while section 4 gives the alternative institutional distribution. Section 5 details the construction of the final demand column vectors, while Section

6 discusses the construction of each of the margin matrices. Given the model's agricultural focus, data issues relating to the modeling approach used for the Common Agricultural Policy are discussed in a separate Section 7 to other taxes and subsidies. Each of the model's parameters is discussed in section 8, while section 9 concludes. A second working paper entitled *"The IMAGE CGE Model: Understanding the Model Structure, Code and Solution Methods"* (O'Toole and Matthews, 2002) details the model code.

Finally, use is made throughout this working paper of a number of key statistical sources, which, for the sake of brevity, are referenced with acronyms followed by the appropriate table number where appropriate. For example, NIE12 refers to Table 12 in the National Income and Expenditure accounts for 1998. A full list of the acronyms with the relevant publications is listed below.

Table 1: Acronyms Used

Acronym	*Full Name*
CIEAS	Compendium of Irish Economic and Agricultural Statistics, DAF (1997a).
NIE	National Income and Expenditure, CSO (1998a).
A1-A2	National Input Output Accounts 1993, CSO (1998b).
Agro_IO	Agricultural Input-Output Table, O'Connor and Matthews (2000)
SA	Statistical Appendix, CSO various years.
RFTS	Road Freight Transport Survey, CSO (1994a).
REV	Statistical Report of the Revenue Commissioners (1993).
ASI	Annual Services Inquiry, CSO (1994b).
LFS	Labour Force Survey, CSO (1993b).
HBS	Household Budget Survey 1994/95, CSO (1997b)
DSESFC	Demographic, Social and Economic Situation of the Farming Community in 1991, CSO (1994c).

[1] See O'Connor and Matthews, 2000 for full details.

Figure 1

A Simplified Representation of a Social Accounting Matrix

Expenditures

Receipts

				Institutional Accounts				Total Receipts
		N	O + 2	1	H	1	1	
		Production Activities	Factors of Production	Government	Other Institutions	Rest of World	Investment	
N	Production Activities	1BAS(dom)		5BAS	3BAS / PO44	4BAS	2BAS, 6BAS	Gross Demand
O + 2	Factors of Production	1CAP, 1LAB, 1LND						Factor Income
1	Government	0TAR, 1TAX		5TAX	VHTG, 3TAX	4TAX	2TAX	Income to Government
H	Other Institutions		VLTH, VCTH, V1OH	VGTH				Income to Institutions
1	Rest of World	1BAS(imp)						Total Foreign Exch. Out
1	Investment							Aggregate Savings
	Total Expenditures	Gross Output	Expenditures by Factors	Expenditure by Government	Expend. by Institutions	Total Foreign Exch'ge Inflows	Aggregate Investment	

2 The Input Output Database

Figure 1 is a schematic representation of the model's Input-Output database. Each column represents a source of domestic demand. So, reading along the row beginning with 'Production Activities' we can see that each industry supplies 1BAS(dom) by way of intermediate inputs, 2BAS and 6BAS to other industries as a capital input, consumed by one of the household types (3BAS/P044), used by the government in providing public goods (5BAS) or exported (4BAS). Further, the 1LAB, 1CAP and 1LND matrices show the use of each of the factors of production in the production of each industry. A fourth matrix PERS (not shown) shows the number of workers in each industry and corresponds to the O*N 1LAB matrix.

There is further information needed that is not illustrated here. Firstly, there is the incomes matrix which maps the income household types receive for the provision of labour, capital and land, while also receiving transfers from the government (VGTH). To calculate disposable income, the amount of income tax paid by each household is also calculated. There are two more matrices, namely the Make matrix (C*N) and the MPC (C*2) matrix. The former relates the production of commodity to industry. For example, electricity would largely be produced by the Electricity, Gas and Water industry, though others might produce (and use) small quantities of electricity as a by-product. In the model it is assumed that there is a one-to-one correspondence between industries and commodities. Based on this assumption, the Make matrix consists of the aggregate output for industry/commodity *g* on the diagonal element m_{gg} and zero for all off diagonal elements m_{ij}, i not equal to j. The latter MPC matrix refers to the marginal propensities of consumption for each of the household types concerned.

Input-output tables for the Irish economy have been produced since 1956 and published since 1964. They are produced at relatively irregular periods, namely 1956, 1960, 1964, 1969, 1975, 1985 and 1990. 1990 was the last time a full set of tables providing both the domestic and imported flows of intermediate goods at both basic and producers' prices was compiled. The principal input-output database used in the model is an amalgamation of two related sources. The first is the published

41*41 input-output tables from the CSO for 1993 (CSO 1999), which provided tables of *combined* domestic and imported flows at both basic prices and producers' prices. The second is the O'Connor and Matthews (2000) 33*33 domestic input-output table for 1993 at basic prices that disaggregates the agriculture, forestry and fishing sector into ten distinct groupings.

As discussed in O'Toole and Matthews (2001a), in the main industry-by-industry section in the input-output tables, it will suffice to produce four 34 * 34 matrices. These are, namely, a matrix of domestic intermediate flows at basic prices, a matrix of domestic intermediate flows at producers' prices, a matrix of imported intermediate flows at basic prices and a matrix of imported intermediate flows at producers' prices. Figure 2 is a representation of the relationship between various price measures.

Figure 2: The Relationship Between Various Price Measures

Factory Gate Price + Net Indirect Tax + Margin Costs

Basic Price --------
Producers' price ------------------------------
Purchaser Price --

In sections 2.1 and 2.2 we give a short description of the main features of the Input-Output data available for Ireland, and describe the adjustments required to ensure that they are appropriate in relation to the structure described in this section. In section 2.3 we discuss the steps taken to reconcile the two tables to form a consistent dataset.

2.1 1993 published IO accounts of Ireland

The published 1993 tables are less detailed than usual and consist of only two tables, namely a 41 branch transaction table at basic prices for domestic and imported flows combined, and a 41 branch transaction table at producers' prices for domestic and imported flows combined. All imports in the first table are valued at c.i.f. prices. The difference between the two valuations is the net taxes on products (taxes on products less production subsidies) for domestic production and net taxes linked to imports (taxes less subsidies) for imported goods. Hence, for basic prices, taxes (and subsidies) are distributed along the indirect taxes row and shown as a cost to the branch purchasing the good (which of course includes final demands). The alternative is the producers' prices valuation, where there is no distribution of indirect taxes or subsidies as separate rows. All indirect taxes are added into the valuation of total supply.

The approach taken was to sum the 41*41 table to 23 sectors matching those used in the O'Connor and Matthews (2000) tables, and then to disaggregate the agriculture/forestry/fishing sector into the 10 industries as classified by O'Connor and Matthews as well as separating out 'farm animal feed' from the 'other food' industry. These aggregated tables are referred to by the following names for the sake of brevity. Agro_IO is shown in full in Appendix 2.

A1: Published CSO table, aggregated to 33 sectors, at basic prices.
A2: Published CSO table, aggregated to 33 sectors, at producers' prices.
Agro_IO: O'Connor and Matthews (2000) table at basic prices.

3.2.2 1993 IO accounts for Ireland (Agro_IO)

The 1993 O'Connor and Matthews (2000) set of input-output accounts (from here on referred to as Agro_IO) were produced with the express purpose of developing more detail in relation to agricultural production. In all previous tables, agriculture forestry and fishing were amalgamated into one sector, while in this table, there are four livestock sectors (dairy, cattle, sheep & wool and pigs, poultry & horses four crop sectors (wheat, barley & oats, fruit & vegetables, root & green and other crops) , one sector for fishing and one sector for forestry. A *farm animal feed* sector was also incorporated, a sector which usually appeared in '*other foods*', amalgamated with other activities, such as sugar refining, flour milling etc.. Another important feature to note in relation to agriculture is that all flows are treated on a net basis, so flows between farms are not considered.

The gain of ten sectors (10 + 1 –1) in terms of agriculture was at the price of the loss of a number of sectors. The Appendix shows the list of 18 sectors in the 41 that were amalgamated, along with their new group name. The flows that do not relate to agriculture (or forestry or fishing) in the 1993 tables are in fact based on 1990 input-output flows, and were updated to 1993 using the RAS procedure (Bacharach, 1970). The original table is shown in Appendix 2, and relates to domestic flows, with all imports aggregated into one row. One large advantage of this set of tables over the CSO figures is that the table has already been extended to form a rudimentary SAM. Hence there is already an institutional breakdown of income.

3.2.3 Reconciling the two sets of IO accounts

The process of reconciling the two sets of IO accounts (or more specifically the Agro_IO table and the Basic Prices table in CSO, namely A1) is a necessarily messy affair, with numerous steps. What follows is a discussion of the main steps that were followed in reconciling the data. We generally adhered to the following rules:

- In general, where a disagreement in relation to data arose, the Agro_IO figures were taken as correct.
- Secondly, where uncertainty exists as to the correct treatment of an import flow, the figure is put in the diagonal. This has the implication that the import composition of inputs is in effect assumed to be the same as the domestic composition of inputs.

Creating the imports matrix (basic prices): We calculate the import matrix by subtracting Agro_IO from A1 to give matrix (A1-Agro_IO). The main problems to overcome were to provide estimates of imports used by farms, industry wide imports of farm level produce, the division of '*other foods*' to create a separate '*farm animal feed*' sector, making sure that the import figures made sense and finally making sure the column totals for imports equal the Agro_IO import totals.

Firstly, Agro_IO provided the 33*8 matrix of estimates for import use of 8 of the agricultural sectors, and these estimates are incorporated here. The next step is to estimate the 8*23 matrix of industry wide imports of farm level produce. We have some guidance in that we know the column totals for these imports for each of the 23 industries in question, and can immediately identify 15 as being zero. The remaining industries are shown below in table 2 along with the amounts involved, and how they were eventually allocated.

Table 2:

Allocation of Imports of Farm Produce

Industry	*Imports of Farm Gate Produce IR£ m*	*Industry Attributed to*	*Comparable 1990 Import IR£ m*
Chemical	1.56	1.56 to Other Crops	1.96
Meat processing	42.24	3.6[1] to Cattle, 0.7[2] to Sheep 17.9[3] to Pigs & Poultry	9.31
Milk Processing	1.02	1.02 to Dairy	1.08
Farm Animal feed Other Food	114.34	Pro rata based on the proportions used of domestic agri-output.	150.02
Beverage & Tobacco	14.66	14.66 to Wheat, Barley & Oats	11.42[4]
Textiles	28.75	28.75 to Sheep & Wool	27.84[5]
Other Market Services	11.86	2 to Cattle	1.66

1 Based on CIEAS 83
2 Based on CIEAS 88
3 Based on CIEAS 92 and 103 respectively
4 In 1990 this consisted entirely of beverages
5 In 1990 this consisted almost entirely of textiles/clothing

In disaggregating farm animal feed and other foods from the single IO figures, two stages must be completed – namely a disaggregation of the other foods row and a disaggregation of the other foods column. The former is quite straight forward if we assume (not unreasonably) that - generally - non-agricultural industries have no use for imported inputs of farm animal feed. Firstly we know how much each sector imported of merchandise goods, and how much was invisible imports, so the latter can immediately be allocated to the 'Other Market Services' sector. In terms of merchandise goods, the methodology is somewhat subjective. If SA167 is to be believed, 248.1m of *farm animal feed* (the commodity) was imported in 1993. However it is impossible to both reach this target and keep imports for the industry *farm animal feed* at its Agro_IO target of 147.94. Eventually we allocated the maximum possible amount of imports of *farm animal feed* to the *farm animal feed* sector of 116.68. The remainder of the diagonal term is assumed to be imports of the commodity 'other foods' by the industry 'other foods'. The import by *farm animal feed* and *other foods* of other industries output is calculated on a pro-rata basis with domestic inputs.

Along with these problems of filling in missing data, it is necessary to apply some care in ensuring that the imports produced directly from the A2-A1 operation make sense. Firstly, we assume that any cell worth equal less than 0.1 is zero. However the predicted imported figures by industry do not all match up with Agro_IO row of import totals. By assuming zero imports of credit and insurance, the problem automatically disappears. This would seem to indicate an error in the compilation of one of the tables. Unfortunately, historical input-output tables for Irish imports only cover merchandise imports, not service imports, so we have little guidance for the source of the error.

Finally, even after all these alterations have been made, there remain a few negative entries for imports. All but one is small enough (<2m) to discard. The large one (over 18m) is the amount of imports of the meat processing industry used in the meat processing industry itself. We assume that this reflects differences in estimates of the value of domestically processed meat that is used within the industry, and has nothing to do with imports. Therefore, we set this to zero.

It was decided at this stage to add an additional sector, namely *dwellings*. The Irish IO tables take no separate account of the existence of dwellings. Why might this omission be a loss?

- The availability and price of dwellings has a large impact on the flexibility of the labour force to migrate internally and externally.
- The construction of dwellings has a very particular input structure.
- A separate Dwellings sector would allow a transmission mechanism whereby high economic growth could influence the price of farmland.
- The price of housing is an important feature of the evolution of Irish economic performance over the 1993 – 1998 period.

Crucially, an increase in household income, an increase in the number of households or a dramatic change in the price of land currently has no direct impact on the demand for houses. So how is house building currently incorporated into the model? In terms of output it is treated as part of gross fixed capital formation and in terms of cost it is accounted for in the repayment of mortgages.

We can solve many of these problems by incorporating a Dwelling sector. To avoid 'unsettling' the balanced matrices that have already been calculated, we make this as simple as possible. Our Dwellings sector has the following features:

- It only uses the commodity 'Construction' in intermediate production.
- It only uses land as a factor of production.
- Households are assumed to be the only source of demand for housing. While government, and indeed businesses, can in reality also demand dwellings, these demands are not included in the model.

In essence what we are doing is relocating a proportion of GFCF so as to give us flexibility in how we handle it. Therefore any taxes or margins currently imposed on GFCF will be transferred pro-rata to the new sector.

3.3 The Factor Income Rows

3.3.1 Labour Income

The labour costs are gross figures, thereby including any direct income taxes and also employer's contribution to social insurance. The total figure of IR£16,022.53

across all industries in both A1 and Agro_IO can be derived from NIE12 as the remuneration of all employees, excluding foreign employees. The total figure for Agriculture, forestry and fishing of IR£217.09 in A1 is very close to the corresponding total of 219.7 in NIE2, which only lists this figure for four major production classifications. This consists of IR£197.9 of wages to farm employees and to employees of forestry, and IR£21.8 of employer's contribution to social insurance.

In the Agro_IO data set, in terms of employment numbers, we have for each industry total man-hours. Further, LFS23 provides a breakdown of estimated people at work classified by 9 economic sectors, sex and 9 occupation groups. To go from LFS23 to Appendix 2 in the Appendix requires that we first provide an industry-to-industry mapping from the LFS classification to the IO classification. This mapping is shown in Appendix 2. This mapping caused little problems for five sectors. However total employment in the other three industry groups differed significantly (by 10% - 15%) from the level predicted in the Agro_IO figures. In calculating Appendix 2, the employment figures from LFS23 were scaled up to match the Agro_IO figures, and occupation proportions per LFS industry grouping were applied uniformly to each IO industry within that grouping.

We believe that this approach will be satisfactory for most of the industries. However, given our focus on agriculture, it would be preferable to give a closer examination of the 10 primary sectors. Particularly, LFS25 estimates an unemployment rate for farmers of less than 3%, which clearly fails to capture the extent of underemployment in Irish agriculture.

Fortunately, as a check on some of our figures for farming we have DSESFC20 which lists - in terms of the same occupation listing used in LFS25 - the amount of employment by farm type. We will just examine the first three sectors, namely dairy, cattle and sheep, as these sectors most closely correspond to one of the IO sectors. A cursory examination of the DSESFC20 table indicates that this process will be worthwhile – dairying employs a very low number of workers who classify themselves in industries other than agriculture/forestry/fishing, while sheep and cattle producers are much more likely to classify themselves as having some other occupation. Dairy farming tends to require a full time commitment, while cattle and sheep farmers often work on a part-time basis.

We use the RAS technique to adjust the DSESFC20 table to make sure it matches the column and sum totals for the three sectors combined derived from the LFS estimates as discussed above. The results (see Appendix 2) show that in total 500 people classified in occupations other than agriculture/forestry/fishing are in dairy farming, which compares with the original unadjusted estimate of 1,100. To put this in perspective, there are around 35,000 dairy farm workers. Conversely, the number classified in occupations other than agricultural/forestry/fishing in cattle and sheep farming rises from the unadjusted estimate of 2,500 to the RAS estimate of 3,100.

3.1.1 Industry-by-Occupation Wage Bills

Next we must move from an industry-by-occupation matrix of numbers employed to a industry-by-occupation wage bill matrix for each industry by occupation. As well as the 'numbers employed' matrix, we have as a control total the total wage bill for each industry. We have little additional information as to how wage rates should be calculated, so we must assume constant wage relativities as gleaned from the HBS, Volume 1, Table 5, p 67. Based on a state average of 100%, the wages and salaries of the 6 socio-economic groups are shown in table 3 below, which were in turn derived from the 12 socio-economic groups used in the 1991 census. The jobs associated with each socio-economic group are listed in Appendix 4 of Volume 6 of the 1991 census.

Table 3:
Relative Wages and Salaries by Socio-economic Group, based on Household Budget Survey 1994/95

	Number in Workforce	*% of Average State earnings*
Professional, employer or manager	176.4	213%
Salaried & Intermediate non-manual	180.3	134%
Other non-manual worker	122.5	101%
Skilled Manual Worker	191.7	113%
Semi-skilled manual worker	119.6	75%
Agriculture/Farm/fishery	177.9	45%
Unknown	167.9	5%

So, for example, professionals, employers or managers receive over double the state average pay, and almost three times (213% / 75%) semi-skilled manual worker. These relative pay rates were then applied to employment numbers matrix to derive 'labour units' which are assumed to be of the same value within each industry, allowing us to calculate a full occupation*industry matrix of wage bills.

3.1.2 Occupation-by-Household Wages

Our final task is to calculate the (9+1)*3 LINC matrix which maps the wages received by each occupation (plus those on unemployment benefit) to each of the three household groupings. We know the sum total by occupation and can derive the total by household from the HBS data. Next, while exact figures for a rural/urban breakdown are not available, we can approximate by dividing up total (say) urban household income into the different occupations by taking a representative geographic area. So for urban households, the representative area was the sum of Dublin County and County Borough, Cork County and County Borough and Galway County and County Borough[2]. Based on the total occupational structure of these areas, we apply a proportionate breakdown of total urban household income (estimated from HBS). Finally, given control totals for the 9*3 matrix, and estimates of the coefficients derived as described, we use the RAS technique to match the coefficients with the control totals. While ideally this would have been done for the Urban/rural farm/rural non-farm breakdown, in practice it is too difficult to separate rural farm and rural non-farm, so the underlying coefficients were assumed the same, except for agricultural workers who were assumed to be predominantly from farm households.

One of the key features that this approach hopes to capture is the importance of off-farm employment in Irish farm households, and the nature of that employment. Given the approximations that have had to be employed, it is useful to compare the figures returned with a study of rural Wales (Bateman et al 1993) which found that, for principal farmers among farms with off-farm income, almost 40% were classified as professional - technical - administrative - management, with half of these comprising of teachers. Of the remaining 60%, half classified themselves as clerical - sales - services while the other half were classed as construction-production-transport-labourer. A similar structure was found for other members of the household, albeit with a slightly higher weighting in clerical - sales - services. The results of the model calculations for total household off farm employment are shown below. While mismatches in terms of category will explain some of the differences, it is heartening to note that Professional and technical workers are fairly highly represented in the model results as in the Welsh investigation.

Table 4: Total Household Off Farm Employment

Occupation	*Share*
Labourers & Unskilled	3%
Transport & Communication	4%
Clerical Workers	8%
Commerce, Insurance and Finance Workers	15%
Service Workers	13%
Professional and technical workers	22%
Others	7%
Producers, Makers and Repairers	28%

[2] The only manual adjustment was to reclassify 30,000 agricultural workers in Dublin, Galway and

3.1.3 Note on Labour Usage in the Irish Economy

In order to understand many of the simulation results, it is helpful to keep in mind some of the more salient features of the production structure of the economy, not only between particular commodities, but also between different sources of final demand. We do this by fixing industry capital and land, and shocking aggregate employment by 1%. The idea is that, a la the Rybczynski theorm, an increase in the volume of a factor (in this case labour) will increase the output of those industries that use labour and tend to decrease output of other industries. In a general equilibrium context, labour intensity will include the indirect use of labour in the production of a good, i.e. the amount of labour used in intermediate inputs to the good in question.

The results in Table 5 show that, in aggregate, farming industries are the least labour intensive of all the three main sectors, with services the most labour intensive. We can also see that investment demand is very labour intensive, which is not surprising given the importance of the construction industry in investment. Exports and consumption show an equal rise, though consumption in this sense includes public consumption, which is very labour intensive. Therefore, private consumption is the least labour intensive of the final demand categories.

Finally, we remember the Rybczynski theorem which postulates that at constant commodity prices, an increase in the endowment of one factor will increase by a greater proportion the output of the commodity intensive in that factor and will reduce the output of the other commodity.

In the model results, no industry showed a decline in output, with the ratio of price of each capital/land intensive industry to all other industries decreasing sufficiently to compensate for the shift in endowments. Table 6 shows the ranking of each industry by labour intensity, with (1) denoting the least labour intensive, and (34) the most labour intensive. The three least labour intensive are forestry, milk processing and farm level milk production, while the most labour intensive are wood and paper,

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Cork 'city' regions as rural workers.

transport, and non-metallic minerals.

Table 5

Calculating Labour/Capital Intensity

Of Final Demands

Real Variable	*Result*
Exogenous Variables	
Labour	1.0%
Capital	0.0%
Land	0.0%
Endogenous Variables	
GDP	0.6%
Farming	0.2%
Manufacturing	0.5%
Services	0.7%
Consumption	0.5%
Investment	1.3%
Exports	0.5%
Imports	0.6%

Table 6: The Ranking Of Industries by Increasing Labour Intensity

Industry	*Ranking*	*Industry*	*Ranking*
I9Forestry	1	I2Cattle	18
I17MilkProds	2	I23RubPlas	19
I1Milk	3	I12ElecGas	20
I6FruitVeg	4	I21Textiles	21
I8OtherCrops	5	I30Credit	22
I11PetCoal	6	I24Construct	23
I10Fishing	7	I32Govment	24
I4OtherLive	8	I29Commun	25
I14Chemicals	9	I19OtherFood	26
I7RootGreen	10	I25TradeMarg	27
I3SheepWool	11	I15Metal	28
I5Cereals	12	I34Dwellings	29
I20BevTob	13	I16MeatProds	30
I18AnimFeed	14	I26LodgCater	31
I28Sheepmeat	15	I13NonMet	32
I33Animmeat	16	I27Transport	33
I31OtherSers	17	I22WoodPaper	34

3.3.2 Capital Income

The figures for capital income by industry are provided in Agro_IO. The only change required is to subtract the calculated return to land for agricultural industries.

3.3.3 Land Income

The typical valuation method used in calibrating CGE models is by defining quantity as that amount of the good or service that in the base year is worth £1. The reason for this is obvious in that only the value of a flow is needed, with the price being set automatically at unity. So, for example, we would say that £440m of computer purchases consists of 440 million 'units of computers', each with a value of £1. The obvious alternative would be to actually breakdown a flow into physical quantities, with a matching quantity and price measure. So, we would find from sales data that 120,000 PCs, 500 advanced database centers and one supercomputer were sold. We would then try to find appropriate price data (whether basic, producers' or purchasers') and sum over all values, using the known total valuation of £440 million as a control total. While the advantages of the former method are clear, one possible area where the disadvantages outweigh the advantages is in the valuation of flows that accrue to land. The reasons for this are as follows:

- Firstly, we have no valuation of flows to land as a starting point anyway, so the only real guidance is matched data on land price and quality.
- Secondly, the amount and (roughly) the quality of land available is known, and in terms of quality is more or less fixed.
- Thirdly, many EU subsidies (for example, extensification premia and set-aside payments) relate to physical amounts of land, not to the value of rents that accrue to that land.

Therefore the method that is employed is to calculate the amount of land of each type by use and, using published price data, to try to infer the flows to each type of land in the base year. Firstly, however, we will calculate the quantity of land of various qualities available.

Quantity and Quality of Irish Land

The definition of soil quality adopted in the published data is as identified by Gardiner and Radford (1980):

- Class 1: Wide Use Range, no limitations on Use. (23.4%)
- Class2: Moderately wide use range. (11.7%)
- Class 3: Somewhat limited Use Range. (15%)
- Class 4: Limited Use Range. Permanently unsuited to tillage but suited to a permanent grassland system. (21%)
- Class 5: Very limited uses. Much is suitable for forestry. (25.5%).
- Class 6: Extremely limited use range. This contains soils whose productive potential is virtually zero. (3.1%).

Based on the descriptions of each class given above, we can estimate a rough breakdown of land by potential use. Further, as can be seen in Table 7 below, Class 1, Class 2 and Class 3 can be identified as the areas where tillage farming is possible. The bulk of Class 3 land (920,000 ha) is referred to as 'marginally suitable' land. We can immediately ignore class 6, where not even forestry is commercially viable. Table 7 is derived from the percentages in each land class as listed in Barrett and Trace (1999) multiplied by a total land base of 6,829 thousand hectares.

Table 7:

Hectares of Soil Types In Ireland

	Tillage	*+ Pasture*	*+ Forestry*
Class 1	1,598	1,598	1,598
Class 2	799	799	799
Class 3	1,024	1,024	1,024
Class 4	0	1,502	1,502
Class 5	0	0	1,741
Class 6	0	0	0
Total	3,421	4,923	6,664

For our purposes, this breakdown is too detailed, with a three-sector breakdown being sufficient. In particular, we would like to estimate the available area under the following titles:

Class A: Land suitable for tillage, pasture and forestry
Class B: Land only suitable for pasture and forestry
Class C: Land only suitable for forestry.

The summation of Table 7 into these new classes is shown in Table 8 and can be interpreted as the total potential land base.

Table 8:

Potential Land Use

	Class	*Tillage*	*+ Pasture*	*+ Forestry*
Class A	1, 2 & 3	3,421	3,421	3,421
Class B	4	0	1,434	1,434
Class C	5 & 6	0	0	1,741
Total		3,421	4,855	6,596

The next step is to try and estimate the total actual usage of land by type in 1993. To aid this, we assume that no land of Class A is used for forestry, and that tillage is cultivated only on Class A land. Finally, we assume that one-third of forestry land is of Class B, with the remainder treated as Class C.

Table 9: Actual Land Use

	Tillage	*Pasture*	*Forestry*	*Maximum Availability*
Class A	404	3,017	0	3,421
Class B	0	983	170	1,434
Class C	0	0	341	1,741
Total Ag Use	404	4,000	511	4,915

Finally, given the price of each of the classes of land[3], we can calculate a total price for the entire stock of each class of land. Then, by applying a rate of return of 2%[4] we can calculate the expected flows from land in each of the individual industries.

4 Institutional Distribution Rows

These factor payments are subsequently distributed to the institutions, namely government, households and savings.

4.1 Household Income

Household income incorporates wages and profits distributed to each household as well as transfers to households. It is exclusive of direct taxes.

The household income figure in A1 includes IR£6,208.20m which accrues from government current expenditure. This comprises all the various transfers to households, a detailed list of which can be found in NIE24. The IO figure can be reconciled with the NIE24 total of IR£7,228.71m by subtracting national debt interest payments to non-residents of IR£1,020.55m. Capital grants to households (also in NIE24) will be included in transfer payments. These comprise mainly education and disability grants, and the total for this category as a whole is IR£94.4m which is included in the 'other' section, giving a total in Table 10 below of IR£7,322.9m for 1993.

Care must be taken to model these transfers appropriately. First of all the model distinguishes between social transfers and transfers which relate to the meeting of accumulated liabilities. Within the former, we also distinguish between payments that vary with unemployment/low-pay and those that do not, and between domestic and foreign recipients. We assume that unemployment benefit, unemployment assistance and income related payments all vary with unemployment/low-pay. Some amount of Old Age Payments should also be included, reflecting the fact that the

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[3] Barrett and Trace (1999) provide land prices up to 1997 for the six land classes listed above. These are then converted into Classes A, B and C by an appropriate area weighting.

going wage rate/ level of unemployment can induce workers to take up these various schemes. Rather arbitrarily, we assume that one-quarter of all old age payments vary with unemployment/low-pay.

Table 10:

Breakdown of Government Transfer Payments, 1993[5], £m

	Domestic			*Foreign*
	UE/Pay Related	Other Social	Accumulated Liabilities	
National debt interest:				
paid to residents			1,121.8	
paid to the rest of the world				1,020.5
Unemployment benefit	240.0			
Unemployment Assistance	788.8			
Income Related Payments	613.9			
Old Age Payments	426.85	1280.55		
Transfers to the rest of the world				154.8
Child benefits		425.6		
Health benefits		357.7		
Housing Benefits		202.7		
Education Expenditure		597.4		
Other		92.3		
Total	2069.6	2956.3	1121.8	1175.3

Source: CSO, NIE24

This disaggregation of transfer payments will allow us the possibility to hold social transfer payments exogenous, while allowing UE benefits to vary. It will also allow the possibility to explicitly model the accumulation and repayment of the national debt.

[4] This is purposely set quite low to ensure that other factors of production do not record negative value added. It can be justified on the basis that landowners expect future capital gains and are, therefore, willing to accept a lower current rental return.

[5] appendix 2 for a full definition of transfer payments.

3.4.2 Calculating Marginal Propensity to Tax

Income tax in Ireland is charged under four schedules, with Schedule E accounting for the taxation of wages and salaries. The tax is charged for a year of assessment beginning on 6 April, at graduated rates[6]. For individuals, various allowances, deductions and reliefs also graduate income tax. An important feature of the tax code for married couples was that if only one spouse is working, the two spouses' allowances could be combined. This feature was phased out beginning with the 1999 budget as it was felt that non-working spouses (usually women) were discouraged from returning to work because of being charged their husband's marginal rate of tax. The standard rate of tax (payable on the first £7,675 of tax) was 27% in 1993, while the higher rate was 48%. The first £3,600 of income was untaxed. The tax rates were the same in 1993/94 as 1992/93, though the bands and allowances were increased broadly in line with inflation.

Table 11:

Tax Schedule for Personal Income (1993/1994)

Actual Total Income	*Single Person*		*Married Couples who elect for Joint Assessment*			
			One Spouse Working		Both Spouses Working	
	Amount of Tax	Effective Rate	Amount of Tax	Effective Rate	Amount of Tax	Effective Rate
	IR£	%	IR£	%	£	%
5,000	469.53	9.39	0	0	0	0
10,000	1,939.53	19.20	1,332.28	13.32	939.06	9.39
15,000	4,172.97	27.82	2,732.28	18.22	2289.06	15.26
20,000	6,622.97	33.11	4,132.28	20.66	3839.06	19.20
50,000	21,322.97	42.65	18,667.22	37.33	18145.94	36.29
75,000	33,572.97	44.76	30,917.22	41.22	30395.94	40.53

The incorporation of income tax into the model can be done with varying degrees of sophistication. At the simplest level, the effective marginal rate of tax could simply be taken as either the upper or lower legal tax rate, depending on the average industry salary rate. At the other extreme, a full micro-simulation exercise based on the HBS database could be conducted which examined in detail the financial circumstance of each member of the household. This would allow the provision of marginal tax rates for virtually any categorisation – profession, demographic profile, family circumstance etc. This could be done via the ESRI tax-benefit model, SWITCH, details of which can be seen in Callen et al (1998). A compromise is made by the construction of a rough micro-simulation that takes account of the principal taxation rates, allowances, bands and exemptions. This exercise is broken down into two steps. Firstly, the marginal rate of tax for each tax-unit is determined. Secondly, these figures must be re-weighted to ensure that the sample is representative of the population as a whole.

The tax unit usually chosen in such investigations comprises of an adult or married couple together with dependent children, if any. The definition of dependent children is any child under the age of 15 or still in full time education. So a household consisting of a married couple and four children under the age of 15 is one tax unit, while a married couple with three children aged 16, 18 and 19, none of whom are in full time education would be considered to comprise four tax units. The figures presented below were calculated on the basis of the total taxation impact (including PSRI) of an increase in earned income and non-transfer related unearned income of 1%.[7] The reason for calculating these marginal and average rates is that, depending on the purpose of the simulation, we may think that particular opportunities are available only to the head of household. At the lower[8] and higher ends of the scale the difference in marginal rate of taxation is substantial.

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[6] This was changed to a calendar year of assessment in 2002.

[7] This is done by way of a simple tax model that calculates the appropriate allowances and bands applicable for each household based on the information provided for that household of the amount and type of incomes received, and the number and status of household members. So, for example, a one-person household will received the basic allowance plus (possibly) the Schedule E PAYE allowance. Given her total taxable income, we can therefore calculate whether she pays the higher or lower rate. A more complex family may receive pensions, child support, non-PAYE earnings etc. A family may also contain a number of workers paying different marginal rate, resulting in a household marginal taxation rate that is between the 'legal' rates.

[8] The lowest income decile is 1, and the highest income decile is 10.

Table 12:

Simulated Marginal Taxation Rate by Household type Member

Household Income Decile Ranking	*Head of Household*		*Other Household Members*	
	Average	Marginal	Average	Marginal
1	7%	27%	0%	0%
2	9%	26%	0%	0%
3	9%	25%	7%	26%
4	11%	25%	9%	26%
5	14%	27%	11%	27%
6	17%	28%	15%	29%
7	19%	28%	14%	30%
8	22%	38%	17%	31%
9	27%	43%	19%	33%
10	32%	45%	20%	33%

For the purposes of the simulations reported on elsewhere for this model, the only figures required were the average and marginal rates of taxation for each household type independent of which member of the household earns the income. The average figures were 16.3%, 13.3% and 13.2% for urban, farm and rural non-farm respectively, while the marginal figures were 28.2%, 27.0% and 26.9% respectively.

4.3 Government Income

Government income is the sum of direct and indirect taxes. The former can be subdivided into personal and company taxation, the first of which is dealt with in section 4.2. The marginal rate of company taxation is assumed to be equal to the average rate. Indirect taxes are dealt with in section 5.5.

4.4 Company Income

Company income is not calculated directly, but rather can be deduced as the remainder of value added flows when households, government and overseas have taken their share.

5 The Final Demand Accounts

5.1 Household Expenditure

Calculation of the household expenditure figures consisted of two stages. Firstly, the total household expenditure column was calculated and then this was subdivided into the three household types, namely urban, farm and other-rural. A brief description of the steps taken follows.

The first task is to reconcile the Agro_IO (basic prices) and A2 (producers' prices) tables with each other, and with table NIE13 which shows the cost of consumer goods at purchasers' prices. Unfortunately, the aggregation of NIE13 precluded a complete comparison. Here we begin with the Agro_IO figures for domestic consumption (of both domestic and imported products) at basic prices, and compare them with the IO figures at basic prices. If we had a perfect match up of industry classifications, we would expect the difference between the two sets of figures to represent imports at basic prices. There are, not surprisingly, some mismatches.

For farm gate industries 1-10, the subtraction of the two tables leaves 250.7m of imports that must be allocated as farm gate food imports. Most of this can be accounted for by the 245.4m of fruit and vegetable imports which, when intermediate use of 6.73m has been subtracted, leaves 238.37m for household consumption.

One of the main difficulties now is the implied imports of processed meat and processed dairy products, which are –26.68 and 29.23 respectively. Unfortunately, the 1990 SA6.4 figures for Meat and meat preparations figures do not match up – understandably given the different aggregations. Therefore the route chosen was to calculate the rate of increase of meat imports from 1990 to 1993 in SA6.4 (1991, 1994) (-7%) and to apply this increase to the IO meat import figure for 1990.

For all other industries, namely 11–33, there are five industries with very small imports, which are assumed to be zero. Relative to 1990 imports, the movement between the two IO data sets were relatively small, with the exception of Non-metallic metals, which fell by 32% and petrol, and coal, which rose by 12%. A direct comparison with 1990 is not possible for the various services industries. The net effect of these changes is to increase household consumption of imports by 71.51m, which should not affect results significantly.

Given this total of household expenditures, the next step was to subdivide this into the three household types. This was done by categorising each commodity as one of the ten listed in HBS-B - which lists average weekly expenditure classified by household type – and dividing the IO expenditure pro-rata between each of the household types. A full list of this commodity mapping can be found in Appendix 2.

3.5.2 Marginal Household Budget Shares

The method used to calculate the household elasticities was to calculate the appropriate elasticity for each commodity listed in HBS-B and, using the commodity mapping in Appendix 2, to apply these elasticities to the 34 sector IO commodity group. There are two salient features of the figures that are of particular relevance to the model. Firstly, Dublin households allocate £42 a week to housing, while farm households allocate a mere £13. The widely noted empirical regularity that low income households tend to spend more as a percentage of total income on food than high income households is clearly shown, and seems to be independent of household type.

To calibrate the LES (Linear Expenditure System), three sets of data are required. Firstly, the average budget share of each good per household that is easily calculated from the expenditure data is required. Secondly, the 'Frisch' parameter, or 'money flexibility,' of each household is also required. In the LES, the income elasticity is equal to the ratio of income to supernumerary income, and is referred to here as the Frisch parameter. The larger are subsistence expenditures, the smaller is supernumerary income and thus the larger is the absolute value of income elasticity. Frisch (1959) suggests the following values:

ù = -10	for an extremely poor and apathetic part of the population.
ù = -4	for a slightly better off but still poor part of the population with a fairly pronounced desire to become better off

ù = -2 for the middle income bracket, 'the median part' of the population.

ù = -0.7 for the better-off part of the population

ù = -0.1 for the rich part of the population with ambitions towards 'conspicuous consumption'.

Finally, the expenditure elasticities of each household type for each good must be estimated. The elasticities were calculated for each group by taking a point estimate of the elasticity based on the change in expenditure in moving from one decile to the next, and than averaging these nine point estimates. This implied Frisch parameters of –1.79 for urban households, -1.45 for rural farm households and –1.60 for rural non-farm households.

3.5.3 Gross Fixed Capital Formation

The available IO tables for Ireland give the nominal expenditure on Gross Fixed Capital Formation (GFCF) for each commodity. From these figures, the amount of domestic versus imported GFCF can be derived. However, we need these figures by industry, so that we have (say) the amount of investment by industry *i*, using commodity *j* which is sourced from *s*. Given that the model is static, this capital investment has no direct implications for production in the investing industry, so the figures are not of critical importance.

This 34*34 matrix is formed on the basis of investment flows excluding tax and margin flows. It takes the amount of additions to capital assets in CIP1993, Table 19, in each of the two sectors Plant, machinery, equipment & vehicle and Buildings & other construction work, and applies the proportions of investment by industry implicit in these figures to distribute investment in machinery and construction. Other investment is distributed on the basis of an average of the two. The reason why the total figures from CIP19 exceed those in the IO tables is that CIP19 includes purchases of second hand goods, such as buildings, while IO only considers the formation of new units of capital. Therefore the method implicitly assumes that new (say) buildings are bought in the same proportion as second hand buildings by all industries.

3.5.4 Export Demand

The total exports vector is subdivided into merchandise and invisible exports in Agro_IO. A slight modification was implemented by dividing exports into three destinations, namely UK, EU excluding the UK, and the rest of the world. This was only done for relevant agricultural exports to allow for a correct treatment of agricultural supports. In particular, the sectors that were disaggregated were cattle, sheep & pigs, poultry & horses, dairy exports and total processed meat. The aggregate export figures as taken from the Compendium of Agricultural Statistics were substantially lower in each of the sectors than the corresponding Agro_IO entries. It is not particularly clear why this might be the case.

5.5 Indirect Taxation

This section discusses how taxes were apportioned. First, note from Agro_IO that the sum of the totals for Taxes Linked to Production (ex. VAT), Net Taxes Linked to Imports (ex. VAT) and Vat on Products is IR£4,900.87m, the same as the total for indirect taxes for intermediate and final demand in A1. A large portion of this is accounted for by indirect taxation on household consumption of IR£2,791.20m which includes a significant portion of total custom and excise revenue. Further, the total tax linked to production in A1 of IR£1,396.59 is broken down into the full 33-industry list.

The initial approach taken to try and solve for the various tax matrices was in isolation with the aid of various data sources. Then numerous target values were compared with the result of the estimation procedure to check how reasonable the results were. For example, in the estimate of household expenditure tax, various VAT estimates from the ASI and estimates of household expenditure contained in NIE13 were used. Generally, it proved extremely difficult to come close to some of the targets.

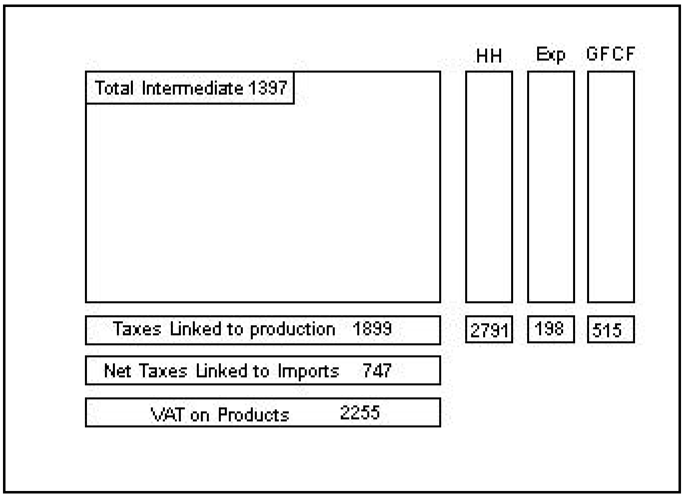
For the most complex table, the taxes on intermediate flows, perhaps the most obvious approach was to get the difference between the flows at basic prices and producers' prices. In practice, however, this resulted in two large problems, namely the existence of numerous negative entries, and row and column sums that seemed to bear very little relation with any total figures provided in the IO tables themselves.

The approach that was finally used was more mechanistic but has the great advantage that it satisfies the appropriate column and row sums. A brief description of the steps is as follows:

- **Step 1:** From figure 1, we firstly note that the column Taxes linked to production, net taxes linked to imports, Vat on products *by industry* and intermediate production will equal the corresponding row sums for all intermediate and final demand by industry.
-

Figure 3:

Representation of 1993 Input-Output Flows



Source: Input-Output Tables, 1993, CSO.

- **Step 2:** A RAS procedure was implemented to arrive at the 33*4 matrix consisting of industry-by-final demand usage. It was based on the column and row sums and used the underlying 'basic' flows as the initial coefficient matrix. So, for example, the answer ensured that taxes paid by sales of (say) dairy were correct, and that the amount of tax paid on exports was correct at 198.

- **Step 3:** Step 2 provides a 33*1 column of intermediate industry tax. We have from Ag-IO the corresponding 1*33 row vector. To reconstruct the 33*33 intermediate tax matrix, we again apply the RAS procedure based on these column and row sums and use basic intermediate flows as our initial coefficient matrix.
- **Step 4:** Finally, where appropriate, these various tax matrices were divided into import/domestic flows on a pro-rata basis.

3.6 Margin Matrices

We will restrict attention for the purposes of margin matrices to two final demand sectors, namely household consumption and exports. Government demand does not contain any margin commodities *per se,* as margin sectors are all catered for in the inter-industry matrix. It is also assumed that changes in inventories do not require margin commodities.

3.6.1 Household Expenditure Margin Matrix

To simplify the construction of the margin matrices, the following assumptions were made. Firstly, the demand for margin services is assumed to be the same regardless whether we are discussing the domestic or imported variety of the product. Secondly, the amount of margin purchased is independent of the household purchasing the good. This second point is to allow the calculation of margin matrices without preempting the choice of household disaggregation. Finally, for the sake of simplicity, retail trade is assumed to be the only margin commodity for household consumption. The main other sector which might be included as a margin commodity would be transport, both internal and overseas. It would be difficult to disentangle personal travel from margin demands for these commodities.

The total of IR£2,249.97 for wholesale trade in matrix A1 consists entirely of retail trade as consumers are assumed not to buy *wholesale and repairs,* which can be seen to have zero household consumption from the IO table.

While data on gross retail trade are available for 1993, they are not provided in the sectoral detail that is required. The next best set of figures comes from Annual Services Inquiry (1991). A table of gross margins from this survey is shown in table 13 below. Note the gross margins figures are expressed as a percentage of 'Purchases of Goods for Direct resale excl VAT' as this corresponds to our figures for total household consumption. So, for example, the margins associated with petrol stations are relatively low (13%). On the other hand, it should also not be surprising that Public Houses margins are the highest at 48%. To understand why this is the case, think of £20 of petrol sold to one individual - the transaction takes place within minutes by self-service in a drive by station. On the other hand the publican, for every £20 of alcohol sold per person, must also provide a few hours' worth of communal area to consume the alcohol that incurs a high cost in terms of staff, rent and fittings.

Table 13:

Retail Trade Gross Margins 1991

	Turnover (ex VAT)	*Purchases of Goods for direct resale (ex VAT)*	*VAT*	*Turnover (incl VAT)*	*Purchases of Goods for direct resale (ex VAT)*	*Gross Margin*	*Gross Margin as a % of (2)*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Grocery	2859	2311	248	3107	2511	558	22%
Grocery with Pub	147	117	22	169	135	30	22%
Pub With Off-License	916	580	181	1097	695	336	48%
Tobacco, sweets and newspapers	285	227	41	326	260	59	23%
Fresh Meat	277	204	2	279	205	73	36%
Other Food, drink & Tobacco	294	234	15	309	246	62	25%
Garages/Filling Stations	2054	1774	389	2443	2110	270	13%
Chemists	304	215	22	326	231	90	39%
Hardware	252	189	47	299	224	66	29%
Electrical Goods	197	145	39	236	174	52	30%
Drapery and Apparel	797	548	96	893	614	260	42%
Footware	107	74	11	118	82	34	42%
Other Non-Food	867	622	140	1007	722	255	35%
Total	9356	7240	1253	10609	8208	2145	26%

Source: SA7.1

Table 14 below gives the allocation of these margins to the total household consumption in 1993. Firstly, no retail margin is present with services industries, food consumed on farm and the sector 'electricity, gas and water'. We can be fairly confident in our allocation of retail margins as the figures display quite a clear pattern. Firstly, food and drink margins represent around 22% of sales except in specialist shops like butchers (36%), pubs (48%) and chemists (39%). Non-food items display higher margins of around 40% with the exception of petrol (13%).

The resultant figures for margin use were then summed to get IR£2,982.6m, well in excess of the target value of 2,249.97m. The figures were then compared with the more aggregated published figures for 1993 that seemed to indicate that the estimate for beverage and tobacco was too high.

Table 14:

Application of Gross Margins to IO Sectors

IO sector	*Sales*[3]	*Margin Sector*	*% of Total Sales*	*Margin use*
Fruit + Vegetab.	352.0	Grocery	22%	77.4
Petrol.+Coal	750.2	Garages/Filling Stations	20%	150.0
Non-Met.Min.	77.4	Other non-food	35%	27.1
Chemicals	370.6	Other non-food	35%	129.7
Metal,Eng.,Veh.	961.7	Hardware, Electrical & Cars[1]	32%	307.8
Meat	600.8	Fresh Meat, Grocery	26%	156.2
Milk Prods.	471.4	Grocery	22%	103.7
Other Food nes	1140.3	Grocery	22%	250.9
Beverag.+Tobac	2117.4	Pub	48%[4]	386.0
Textil.Cloth.Lea.	1057.8	Drapery & Apparel, Footware	42%	444.3
Wood+Paper	618.8	Other non-Food	35%	216.6
Rubb.Plast.,O.M	293.2	Other non-Food	35%	102.6
Total	8811.6		36%	2982.6

1 It is assumed that car sales margins – which are not accounted for in table SA7.1 - are 35%.

2 A weighted average of 15% for petrol and 35% for coal.

3 Taken directly from IO3

4 Not used.

This figure was then replaced by the 1990 figure, with an appropriate allowance for inflation. With this change, the total falls to 2,352.3, very close to the required total.

The figures in Table 14 were then proportioned downwards to satisfy the IO total, and these margins were then applied proportionally to domestic and imported to arrive at household margins for each flow.

3.6.2 Gross Fixed Capital Investment (GFCI) Margin Matrix

For the GFCI Margin Matrix we assume that the amount of margin purchased is independent of which industry is investing. Wholesale/Retail trade, and Marine, air & auxiliary transport are assumed to be the two margin commodities used. Both are zero for imports, so we assume that they only apply to domestic use of GFCI.

In terms of the distribution of Wholesale/Retail trade, the approach followed will closely match the methodology in relation to Household margins, with the exception of course that the relevant comparison is with wholesale trade, not retail trade. These figures (which correspond with those in table 14) are shown in table 15. Note the limited number of sectors. This reflects the fact that GFCI is relatively concentrated – 90% of domestic demand is for construction. The results show that applying the wholesale margins leads to a gross over estimate of margin use (IR£834 compared to our control total of IR£282.1). Therefore, in the last column of table 3.16 our estimates are rescaled to equal IR£282.1.

Given that there is such a difference between our control total and our calculated total wholesale margin use, it is not unreasonable to question the reliability of our results. The reason that they are so 'off' is that most (say) construction materials will not come through traditional wholesalers, but will rather be purchased in bulk directly by the builders. Why retain these figures then? Firstly, because we have little other guidance as to what margins might be. Secondly, because we suspect that the *relative* margins implicit in the ASI figures (see table 15) do tell us something about differences in wholesale margins. The IR£7.4m use of *marine, air & auxiliary transport* in GFCI we assume to be linked solely to construction.

Table 15:
Wholesale Trade Gross Margins 1994

	Turnover (ex VAT)	Purchases of Goods for direct resale (ex VAT)	VAT	Turnover (incl VAT)	Purchases of Goods for direct resale (inc VAT)	Gross Margin	Gross Margin as a % of (5)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Builders' Materials	728	547	142	870	654	199	30%
Hardware and Electrical	528	405	102	630	483	124	26%
Motor & Non-Ag Machinery	1812	1454	347	2159	1732	422	24%
Agricultural machinery	173	145	32	205	172	34	20%
All Other Non-food	3530	2695	529	4059	3099	854	28%
All Business	11596	9147	1679	13275	10471	2583	25%

Source: ASI7

Table 16:

Application of Gross Margins to IO Sectors

Merchandise List	*Domestic* Flows	*Margin* Sector	*Margin % of* Total Sales	*Predicted* Margin use	*Rescaled* Margin Use
Non-Met.Min.(13)	7.2	All Other Non-food	28%	2.0	0.68
Metal,Eng.,Veh.(15)	253.9	Motor, Non-Ag Machinery	24%	60.9	20.54
Textil.Cloth.Lea.(21)	3.3	Clothing, footware	28%	0.9	0.31
Wood+Paper(22)	6.0	All Other Non-food	28%	1.7	0.57
Rubb.Plast.,O.M(23)	11.2	All Other Non-food	28%	3.1	1.05
Construction(24)	2551.1	Builders Materials	30%	765.3	258.06
Total	2832.7			834	281.2

6.3 Exports Margin Matrix

The margin commodities for exports are Wholesale/Retail Trade and Marine, air and auxiliary transport. The other obvious possibility, internal transport, is already incorporated into inter-industry flows, and as such has a zero entry in the merchandise export column. We are given in F1 the use of these two industries in merchandise exports.

The first simplification employed is to assume that Wholesale/Retail Trade margins are a fixed proportion to the value of export. However, this rule of thumb is clearly not satisfactory for transport costs which depend on the product's weight, its perishibility and its fragility. Secondly, the transport figures reflect purchases of Irish transport services by export industries. Therefore we need to assume that Irish (as opposed to overseas) providers of transport services are not dominant in the transport of one product, with a relatively smaller share in other products. Thirdly, the only information we have is from RFTS8, which refers to road freight related to international journeys. We must therefore assume that the costs of intra-national transport are proportional to costs of inter-national transport, with both being determined by the 'bulkiness' of the product. Fourthly, RFTS8 does not distinguish between imports and exports. Therefore we must approximate transport costs based on a sum of imports and exports, and then proportionally allocate costs to exports. This will yield as a by-product the transport costs related to imports, which are discarded. Fifthly, following from the last point, we must assume that the 'bulkiness' of exports from an industry is the same as the 'bulkiness' of that industry's imports. Finally, we have no estimate of 'fragility' or 'perishability', so we must assume that transport costs relate only to weight.

The application of the method is shown in table 17. Each IO sector is matched with one of the five sectors shown below (see Appendix 2 for this mapping). In columns (1) to (3) we have the value of exports, imports and total international trade from the IO table F1, summed into the five sectors. The recorded tonne-km million from RFTS7 are shown in column (4). Dividing value (3) by (4) gives the price of each category by tonne-km million. Ideally, this would be by tonne-million. We must assume therefore that the distance traveled by each commodity is the same. In column (6) we divide the previous column proportionally to separate out exports from total trade. Column (6) is translated into the column of transport margins in F1 based on a proportionate allocation of total transport costs from the IO table. Within sectors (which are aggregated in Table 17), the assumption is made that transport costs are proportional to value.

Table 17:

Calculating the Tonnage of Merchandise Exports

	Export	*Import*	*Int'l Trade (Value)*	*Tonne-km million*	*Price per tonne-km*	*Tonne-km (exports)*
	(1)	(2)	(3)	(4)	(5)=(3) / (4)	(6)
Agri-products / Live Animals	436.91	311.37	748.28	69	10.84	40
Foodstuffs / Animal fodder	5064.86	911.76	5976.62	237	25.22	201
Chemicals & Fertilisers	3214.9	736.34	3951.24	39	101.31	32
Other	9021.78	6403.01	15424.79	529	29.16	309
No Transport Cost	0	163.01	163.01	0		0
Total	17738	8525	26264	874	30.05	590

Given the plethora of restrictive assumptions employed in the calculation of column (5), it is reassuring to note that the figures are intuitively appealing. Our interpretation of them is that a tonne of Agri-products/Live Animals is only worth one-tenth (or 10.84/101.31 to be exact) of a tonne of chemicals. Between these two extremes are Foodstuffs/Animal Fodder and Other which comprises the bulk of exports.

6.4 The Common Agricultural Policy

In terms of the total methodology used for the modelling of the Common Agricultural Policy in the model, this working paper is only concerned with the data required for implementing the direct subsidies and price subsidies.

In practice, a minimum price floor was achieved by the CAP via an import levy which prevented non-EU countries selling below the floor price, and export subsidies which ensured that farmers received the artificially higher internal EU price, even when they sold to non-EU markets[9]. The model currently ignores the allocation of import duties, for the simple reason that Ireland is a large net agricultural exporter and agricultural imports from outside the EU are small. Export subsidies are treated

[9] The floor price was also maintained by intervention purchases in Ireland and other EU member states

as a price wedge between the price actually paid by non-EU purchasers and the price that is actually received by farmers. The export subsidy figures are shown in table 18 and are culled from the Compendium of Irish Economic and Agricultural statistics (1997). Therefore the difference between the producers' price and the purchasers' price is equal to margin costs plus indirect taxation (if any) minus subsidy (if any).

Table 18:
Allocation of Subsidies Among Sectors

	Export Subsidies	*Direct Subsidies*
Dairy	92.76	45.98
Beef	335.94	202.91
Sheep	0.00	181.24
Other Livestock	2.19	1.61
Cereals	5.62	0.39
Fruit & Veg	0.00	0.30
Root & Green	0.00	0.27
Other Crops	0.00	0.06

Source: Compendium of Irish Economic and Agricultural Statistics (1997)

Direct payments are dealt with as subsidies to land. For each direct subsidy, the rent paid to the owner of land is greater than the rent that accrues from the farming activity to the extent of the subsidy. The figures provided in the Agro_IO tables do not actually match up with the corresponding figures in the published NIE tables because the Agro_IO table figures relate to flows actually received in the relevant timeframe while the figures given in NIE are calculated on an accruals basis. As mentioned at the beginning of this working paper, we will maintain the principle of assuming Agro_IO is correct for the purposes of consistency. No forestry subsidies are recorded in Agro_IO, so they are ignored.

6.5 The Model Parameters

6.5.1 Elasticities of Substitution Between Primary Factors

There are two sets of substitution elasticities that need to be specified. The first set of elasticities required for the model describes the degree of primary factor mobility between sectors. If the elasticity is close to zero, the allocation of factors across sectors is almost fixed, and therefore the factor is unresponsive to changes in relative returns. On the other hand, if the elasticity is large, then small changes in relative prices induce large changes in factor supply to a sector. The elasticities chosen for both were as calculated by Dimaranan, McDougall and Hertel[10] (1998) for use in the GTAP model. They are shown below in table 19 for the 34 industries in the model.

6.5.2 Armington elasticities

The second are the so-called Armington elasticities, which measure the substitutability between domestic and imported goods. In the model, three such vectors of elasticities are required as there are three import competing uses of commodities – in intermediate production, in the production of investment goods and finally household consumption, and are assumed to be the same for all three sources of final demand. These elasticities are also taken directly from Dimaranan, McDougall and Hertel (1998) and are shown below in table 19. The elasticities of substitution between primary factors are denoted by $ó_{VA}$ where VA stands for Value Added, while $ó_{D}$ denotes the Armington elasticities.

[10] In McDougall, R.A., A. Elbehri, and T.P. Truong (1998). Global Trade Assistance and Protection: The GTAP 4 Data Base, Center for Global Trade Analysis, Purdue University.

Table 19: Substitution Elasticities

Industry	σ_{VA}	σ_{D}		σ_{VA}	σ_{D}
Milk	0.24	2.8	Animal Feed	1.12	2.2
Cattle	0.24	2.8	Other Food	1.12	2.2
Sheep & Wool	0.24	2.8	Bev & Tob	1.12	3.1
Other Livestock	0.24	2.8	Textiles	1.26	4.0
Cereals	0.24	2.2	Wood & Paper	1.26	2.3
Fruit & Veg	0.24	2.2	Rub & Plas	1.26	1.9
Root & Green	0.24	2.2	Construction	1.40	1.9
Other Crops	0.24	2.2	Trade marg	1.68	1.9
Forestry	0.20	2.8	Lodg & Cater	1.26	1.9
Fishing	0.20	2.8	Transport	1.68	1.9
Pet & Coal	0.20	2.8	Sheep Meat	1.12	2.2
Elec & Gas	1.26	2.8	Commun	1.26	1.9
Non-Met	1.26	2.8	Credit	1.26	1.9
Chemicals	1.26	1.9	Other Serv	1.26	1.9
Metal	1.26	3.2	Publ Serv	1.12	1.9
Meat Products	1.12	2.2	Anim Meat	1.12	2.2
Milk Products	1.12	2.2	Dwellings	1.26	1.9

6.5.3 Elasticities of Substitution Within Primary Factors

The next requirement is the specification of pair-wise labour-labour substitution elasticities and pair-wise land-land substitution elasticities. While there are a number of studies that attempt to measure the former, very little evidence exists to estimate the latter. Tinbergen (1975)[11] concludes that the evidence for pair-wise labour-labour substitution elasticities is not inconsistent with a unitary elasticity between different occupations.

For land-land elasticities, the magnitude of substitution elasticities must reflect the fact that the classification adopted in section 3.3. already pools together land of quite differing quality. Class A incorporates land with no limitations on use to land with a 'somewhat limited use range'. Class B includes land that has a limited use range and in the wording is "permanently unsuited to tillage but suited to a permanent grassland system", while class C incorporates land with very limited uses and land with soils whose productive potential is virtually zero. In the model it is assumed that Class C is only used in forestry. Therefore the necessary parameterisation effectively is between Class A and Class B in each industry. On this basis, the following elasticity values were chosen:

Table 20

Pair wise Land-Land Substitution Elasticities

	Elasticity Value
Milk	0.5
Cattle	0.5
Sheep & Wool	0.5
Other Livestock	0.5
Cereals	0.0
Fruit & Veg	0.0
Root & Green	0.0
Other Crops	1.0

6.6 Concluding Remarks

This working paper has explained the data requirements for CGE models of the IMAGE type, and explains the process used to reconcile the (at times conflicting) data from the various input-output sources. It continued by explaining in some detail the methods used to extend the existing data set so as to arrive at a detailed breakdown by occupation type, by household type and by land type. A separate section was devoted to issues behind the allocation of subsidies to ensure an adequate modelling of the Common Agricultural Policy. Finally, the choice of model parameters was explained.

There are numerous ways that the data could be extended. Most notably, import duties are not currently included in the IMA*GE* model. A major development would be the breakdown of households to allow for a more detailed assessment of the

[11] Cited by Dixon et al (1980).

distributional impact of various policies. For example, households could be broken down into income deciles. Other major developments which would require a matching effort in terms of model code would be to develop an environmental database to run alongside the core model, and to allow for the possibility of imperfect competition within the model.