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The Role of Innovation and Policy Design in Energy and Environment for a Sustainable Growth in Europe (TCH-GEM-E3)

Final Report on the GEM-E3 database update and the development of a depletable resources module.

RESEARCH PROJECT ENG2-CT-1999-00002

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1. SUMMARY.

GEM-E3 is an applied general equilibrium model, for the European Union member states, that provides details on the macro-economy and its interaction with the environment and the energy system. Within the *TCH-GEM-E3* project the model' s database had to be updated so as to take into account all recent structural changes in EU economies.

Constructing a consistent database for an economy-wide multi regional and multi sectoral model is a difficult task since a great number of separate accounts (which in most cases come from different sources) must balance in the accounting framework. This report documents the methods adopted to set up the database of the *GEM-E3* model. It should be noted that the database of the model mainly consists of **S**ocial **A**ccounting **M**atrices (**SAM**) estimated at the base year of the model. The most recent year for which available and complete data could be obtained was 1995 (in the preceding version of the model the base year was 1985).

The deliverables of this effort were: a social accounting matrix for each member state (excl. Luxemburg) and corresponding investment, consumption and trade matrices. The main consideration during data collection and reconciliation was their compatibility with the ESA 95[1] methodology.

2. DATA REQUIREMENTS.

For the base year (1995) of the European version of the *GEM-E3* model, data was required on the following categories:

a) Final demand.

b) Intermediate consumption.

c) Government revenues.

d) Bilateral trade matrices.

[1] European System of Accounts 1995.

e) Investment matrices.

f) Consumption matrices.

g) Transfer payments among institutional agents.

h) Interest rates.

i) Inflation rates.

j) Employment.

These data had to be adjusted in order to be consistent with the model nomenclature. Specifically the model distinguishes the following products/sectors:

Table 1 GEM-E3 Sectors/Products

No	Sector Name
1	Agriculture
2	Coal
3	Oil
4	Natural Gas
5	Electricity
6	Ferrous & Non-Ferrous Metals
7	Chemical Products
8	Other Energy-Intensive Industries
9	Electrical Goods
10	Transport Equipment
11	Other Equipment Goods Industries
12	Consumer Goods Industries
13	Building and Construction
14	Telecommunication Services
15	Transports
16	Services Of Credit And Insurance
17	Other Market Services
18	Non-Market Services

The classification of individual consumption by purpose (COICOP) covers the following categories (ND stands for non durable good and D for durable good):

Table 2 GEM-E3 consumption by purpose categories.

No	Purpose Name	Status
1	Food, Beverages and Tobacco	ND
2	Clothing and Footwear	ND
3	Housing and Water	ND
4	Fuels and Power	ND
5	Housing Furniture and Operation	ND
6	Heating and Cooking Appliances	D
7	Medical Care and Health Expenses	ND
8	Transport Equipment	D
9	Operation of Transport Equipment	ND
10	Purchased Transport	ND
11	Telecommunication services	ND
12	Recreation, Entertainment, Culture, etc.	ND
13	Other Services	ND

2.1. Data Sources.

Complete data sets for all countries were not always available and data from different sources were obtained. These data were combined in a consistent way in order to arrive at a Social Accounting Matrix for each country, with the disaggregation level required in GEM-E3.

The data sources used for the implementation of this task were: EUROSTAT, New CRONOS Database, The European Central Bank and in certain cases the respective statistical offices of each country. In particular the information that could not be supplied directly by the statistical offices was obtained from the following sources:

- Projected Input Output tables 1995 (Source: EUROSTAT).
- Data on National Accounts – Main Aggregates 1995 (Source: EUROSTAT).

- Bilateral trade matrices, on products. (Source: COMEXT).
- Consumption by purpose and by product. (Source: New CRONOS Database).
- Investment by product and by branch (Source: New CRONOS Database).
- Transfers between institutional agents (Source: New CRONOS Database).
- Capital Transfers (Source: New CRONOS Database).
- Employment (Source: New CRONOS and EUROSTAT National Accounts).
- Interest rates (Source: New CRONOS and European Central Bank).

At this point it should be noted that complete data sets were available for Greece and Denmark. Moreover the statistical offices of Belgium, Germany, United Kingdom and Ireland provided the full sequence of national accounts.

3. THE ESA 95.

3.1. The 1995 European System of Accounts.

The main consideration throughout the data collection was to ensure the data compatibility with ESA 95 methodology. This has been achieved for all main aggregates and partly for the rest of the transactions.

Before proceeding with the analysis of the SAM construction it should be noted that the 1995 ESA distinguishes two main valuation concepts of the flows of goods and services: purchasers' prices and basic prices:

1. The purchasers' price is the amount paid by the purchaser, excluding any deductible VAT, in order to take delivery of a unit of a good or service at the time and place required by the purchaser. The purchasers' price of a good includes any transport charges paid separately by the purchaser to take delivery at the required time and place.

2. The basic price is the price receivable by the producer from the purchaser for a unit of a good or service produced as output minus any tax payable on that unit as a consequence of its production or sale (i.e. taxes on

products), plus any subsidy receivable on that unit as a consequence of its production or sale (i.e. subsidies on products). It excludes any transport charges invoiced separately by the producer. It includes any transport margins charged by the producer on the same invoice, even when they are included as a separate item on the invoice.

The difference between these two basic valuation concepts relates therefore to trade[2] and transport[3] margins on the one hand, and taxes less subsidies on products on the other. If we introduce also the concept of producers' prices (which was the main valuation concept in the former system), the difference between these two valuation concepts can be attributed to the two factors. Thus the producer price is the amount receivable by the producer from the purchaser for a unit of a good or service produced as output minus any VAT, invoiced to the purchaser. It excludes any transport charges invoiced separately by the producer.

4. THE SAM CONSTRUCTION.

4.1. The GEM-E3 SAM.

A SAM is a square matrix of monetary flows that describes all transactions taking place between the economic agents of an economy for a determined year. The number of transactors constitutes the dimension of the square matrix. By convention, columns represent expenditures while rows represent receipts. A schematic representation of the GEM-E3 SAM is shown in Figure 1.

The construction of the SAM (Social Accounting Matrices) is the starting point of the model building work. In the base year (1995), by definition the balance

[2] The ESA 95 defines a trade margin as the difference between the actual or imputed price realized on a good purchased for resale and the price that would have to be paid by the distributor to replace the good at the time it is sold or otherwise disposed of. By convention, holding gains and losses are not included in the trade margin. However, in practice, data sources may not allow to separate out all the holding gains and losses. Trade margins are valued at basic prices.

[3] The ESA 95 defines transport margins as the transport costs for transportation of products paid separately by the purchaser and included in the use of products at purchasers' prices but not in the basic price of a manufacturers output or in the trade margins of wholesalers or retail traders.

of flows in the SAM is satisfied in both constant and current currency (ECU 1995).

Figure 1: GEM-E3 SAM according to ESA 95 methodology.

<table>
<tr><td></td><td>Industries</td><td>Labour</td><td>Capital</td><td colspan="2">Consumption</td><td>Firms</td><td colspan="3">Investment.</td><td>Ch. in Stocks</td><td>Exports (F.O.B)</td><td>Total</td></tr>
<tr><td></td><td>1……...18</td><td></td><td></td><td>Household</td><td>Government.</td><td></td><td>H.</td><td>G.</td><td>F.</td><td></td><td></td><td></td></tr>
<tr><td>Products
1
.
.
18</td><td>Intermediate consumption at producer’s prices.</td><td>-</td><td>-</td><td colspan="2">Demand of household and government. consumption. (incl. NPIHS)</td><td>-</td><td colspan="3">Demand for investment goods</td><td></td><td>Demand for exports</td><td>Total demand for goods</td></tr>
<tr><td>Wages and Salaries</td><td rowspan="3">Primary factors’ income.</td><td colspan="2" rowspan="3">-</td><td colspan="2" rowspan="3">-</td><td rowspan="3"></td><td colspan="3" rowspan="3">-</td><td rowspan="3">-</td><td rowspan="3">Income transfers from foreign.</td><td rowspan="3">Total factor revenues</td></tr>
<tr><td>Social Security Contribution</td></tr>
<tr><td>Operating Surplus</td></tr>
<tr><td>Households</td><td>-</td><td colspan="2" rowspan="2">Factor payments to agents according ownership.</td><td colspan="2" rowspan="9">Domestic income transfers between agents.</td><td rowspan="9"></td><td colspan="3" rowspan="9">-</td><td rowspan="9">-</td><td rowspan="9">Income transfers from/to abroad.</td><td rowspan="9">Total income of agents.</td></tr>
<tr><td>Firms</td><td>-</td></tr>
<tr><td rowspan="7">Government</td><td>Gov. Firms</td><td rowspan="7" colspan="2">-</td></tr>
<tr><td>Gov. Foreign</td></tr>
<tr><td>Direct Tax</td></tr>
<tr><td>Subsidy</td></tr>
<tr><td>VAT</td></tr>
<tr><td>Duty</td></tr>
<tr><td>Social Security</td></tr>
<tr><td>Indirect Tax</td><td colspan="2"></td></tr>
<tr><td>G. Transfers</td><td>-</td><td colspan="2" rowspan="3"></td><td colspan="2" rowspan="3"></td><td rowspan="3"></td><td colspan="3" rowspan="3">-</td><td rowspan="3">-</td><td rowspan="3"></td><td rowspan="3"></td></tr>
<tr><td>Imports</td><td></td></tr>
<tr><td>Savings</td><td>-</td></tr>
<tr><td>Total</td><td>Total supply of goods</td><td colspan="2">Total payments of factors</td><td colspan="3">Total spending of agents</td><td colspan="6"></td></tr>
</table>

The balance is conceived as the equality between the sum by row and the sum by column. In addition, a SAM ensures the fulfillment of the Walras law in the base year, since by construction the algebraic sum of surplus or deficits of agents is equal to zero. The GEM-E3 SAM represents flows between production sectors, production factors and economic agents. The production sectors produce an equal number of distinct goods (or services), as in an Input-Output table.

Production factors include, in the SAM, only primary factors, namely labor and capital. The economic agents, namely households, firms, government and the foreign sector, are owners of primary factors, so they receive income from labor and capital rewarding.

In addition, there exist transactions between the agents, in the form of taxes, subsidies and transfers. The agents distribute their income between consumption and investment, and form final domestic demand. The foreign sector also makes transactions separately with each sector. These transactions represent imports (as a row) and exports (as a column) of goods and services. The difference between income and spending (on consumption and investment) by an economic agent determines his surplus or deficit.

Combining the Input-Output data, adapted to market prices and to the national product concept (instead of the domestic product concept), and the data of the National Accounts by sector allows building the Social Accounting Matrix for each country.

4.2. Treatment of the Separate Accounts.

The allocation of the adapted Input-Output totals to the different sectors, household, government, firms and rest of the world is rather straightforward using National Accounts data, and can be summarized as follows:

- The total labor value added is allocated to the households except for the part going to the Rest of the World
- The capital income is distributed between household, firms and government as in the National Accounts
- The social security contributions are paid by households to the government and to the firms
- Households and firms pay the direct taxes to the government.

In the SAM it is assumed by construction that all subsidies are paid by the government to the branches (firms). In fact a part of the subsidies is paid by the foreign sector. In order to take into account this issue an imputed flow was created in the SAM representing the difference between the subsidies received by the branches and the actual subsidies paid by the government (this difference is attributed to the foreign sector).

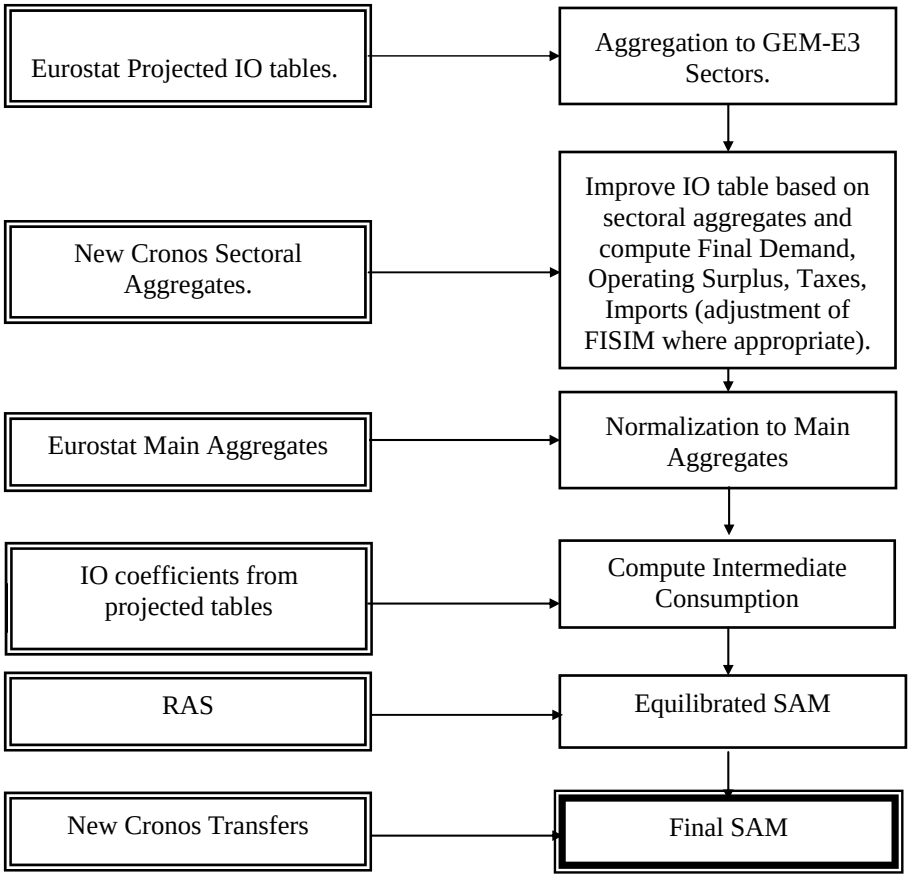
Since government does not receive the sum of the taxes on product paid by the branches (a part goes to the foreign sector) a similar treatment to the one applied on subsidies has been established.

5. CONSTRUCTION OF THE SOCIAL ACCOUNTING MATRICES.

5.1. Main Steps.

The main steps followed during the construction of the GEM E3 data set are depicted in Figure 2.

Figure 2: Main Steps for the GEM E3 data construction.



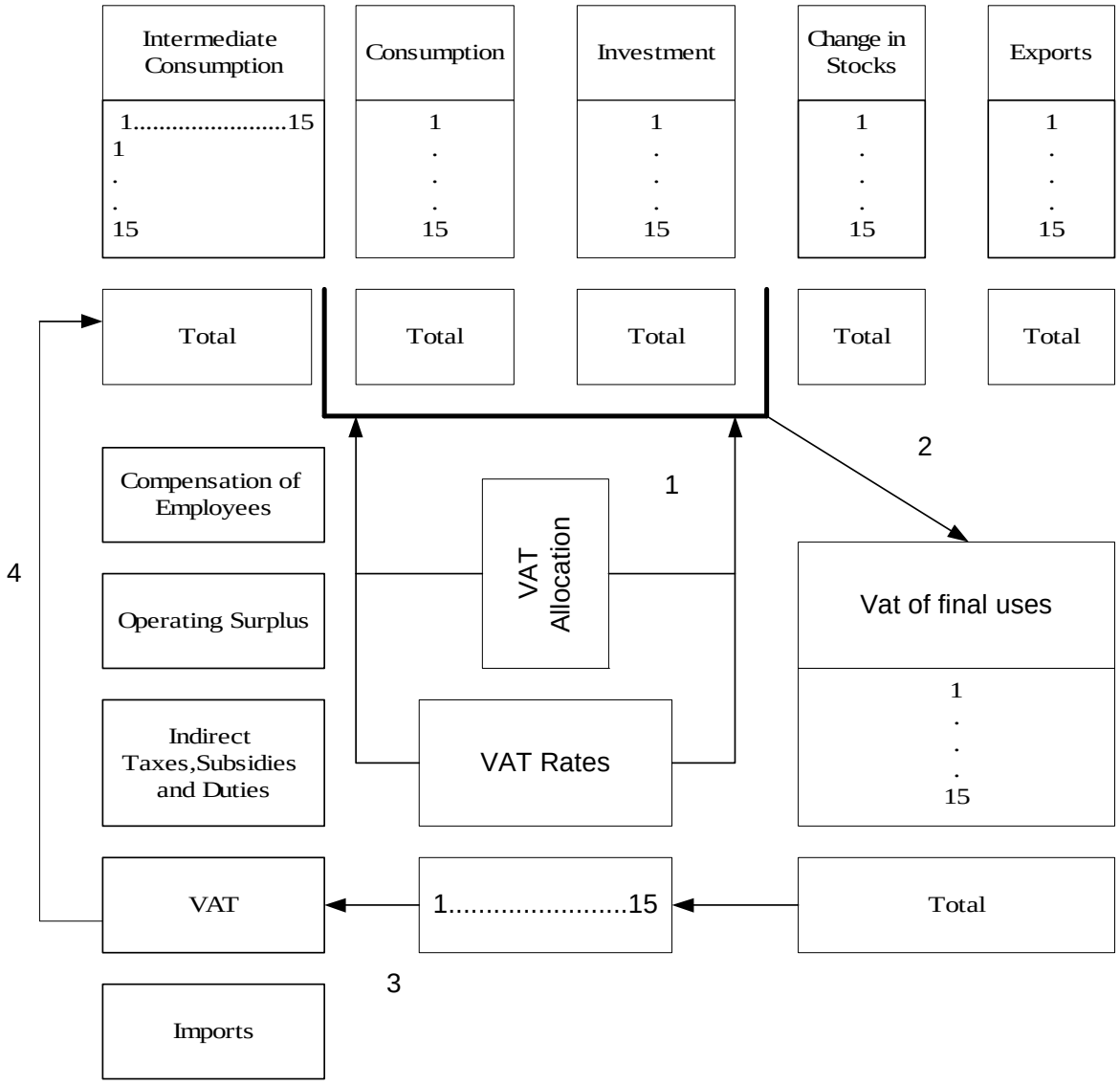
5.2. IO tables at producers' prices including VAT.

For the construction of the Social Accounting Matrices the Projected IO tables had to be aggregated from 25 to 15[4] sectors in order to be compatible

[4] Throughout the SAM Construction the energy sectors are aggregated to one sector. The disaggregation of the energy sectors was made after all SAM's were constructed and balanced.

with GEM E3 data requirements. Since these tables were evaluated at producers' prices excluding VAT, a first step was to allocate the non-deductible VAT to the final uses and intermediate consumption (this action resulted in IO tables expressed at producer prices including VAT).

Figure 3: Allocation of VAT to Eurostats' Input Output Table (Producers' Price).



The allocation was made by applying the VAT rates to each use. Finally in order to equilibrate the sum of the derived amount of VAT with the amount

presented at the corresponding row of the projected IO tables a normalization procedure was adopted. In this way the VAT row in the projected table was replaced by the estimated non-deductible VAT by product on final uses (the procedure is depicted in figure 3).

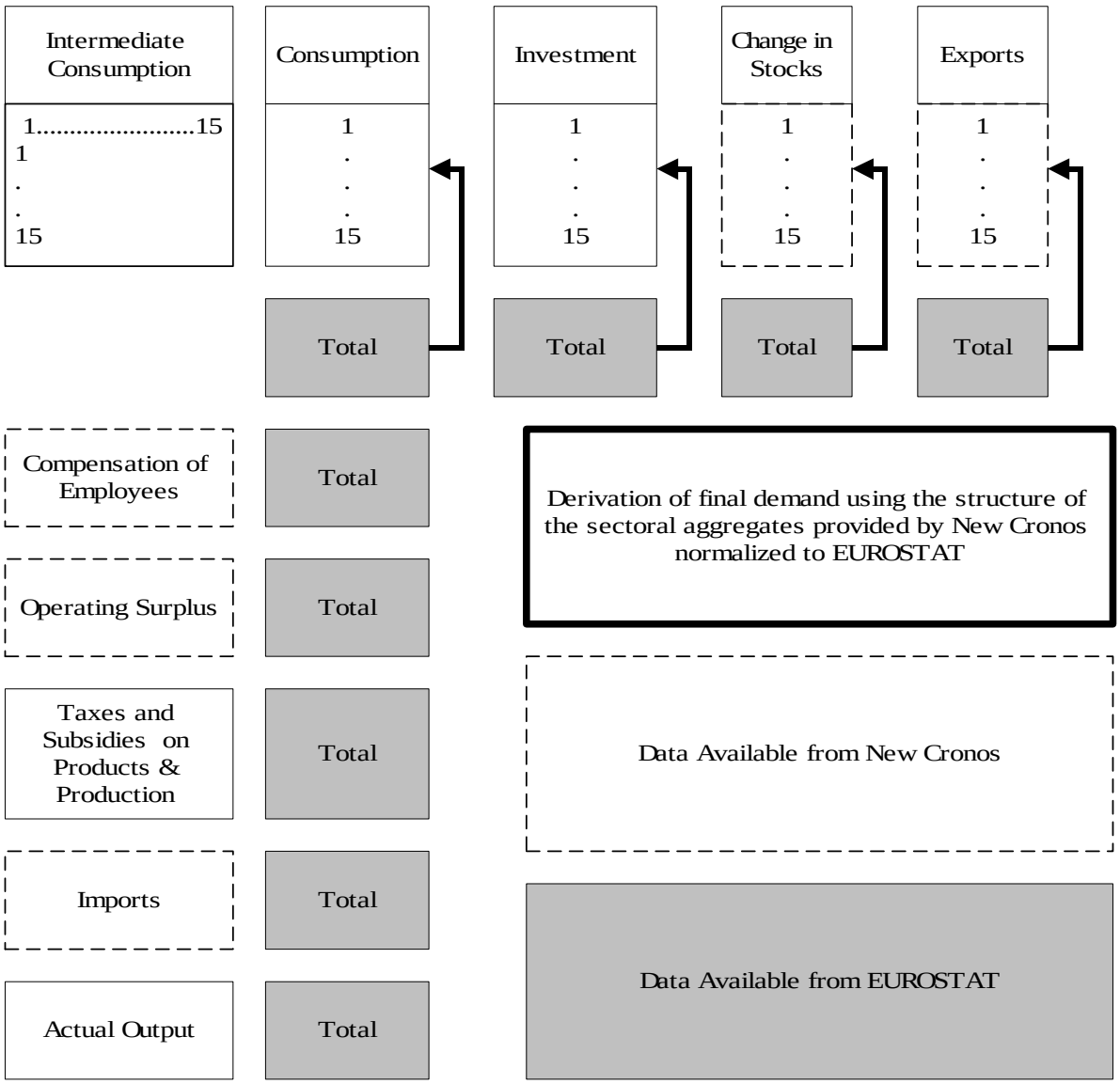
5.3. Final Demand.

For the Final Demand the following official data were available:

- Household Consumption and Total final consumption of NPISH' S[5].
- Total Government Consumption.
- Exports of Goods & Services[6].
- Changes in inventories and acquisition less disposition of valuables.
- Gross fixed capital formation by branch and by good.

[5]Non-Profit Institutions Serving Households.
[6] The discussion on the treatment of exports of goods and services is presented on the chapter dealing with trade.

Figure 4: Computation of the Final Demand.



5.3.1. Household Consumption.

Household final consumption expenditure mainly represents the traditional consumer spending. It includes, however, imputed rent for the provision of owner-occupied housing services, income in kind and consumption of own production.

In GEM – E3 the household sector is consolidated with the non-profit institutions serving households (NPISH)[7] sector. Although these institutions form a distinct sector in the ESA 95 there are not yet detailed figures available that allow a separately identification of that sector.

[7] These include productive units such as charities and universities.

Household consumption is built up from the detailed information received from EUROSTAT 1995 projected tables (25 sectors). In particular the consumption shares for each product were computed and then applied to the main aggregates, as these are published by EUROSTAT. It should be noted that at this stage VAT is allocated to household consumption.

Table 3: Household Consumption by Product for Selected Countries (in million ECU 1995)

GEM-E3 Products	U.K.	Germany	France	Greece
Agriculture	9049	18590	20209	2254
Coal	661	1363	497	0
Oil	12013	29221	17173	1976
Gas	6985	11220	4256	60
Electricity	9847	36117	17686	1162
Ferrous & N. Ferrous metals	5162	230	201	0
Chemical Products	8687	18135	18875	1669
Other energy intensive.	9025	16892	17596	1457
Electric Goods	9000	20126	7528	287
Transport Equipment	25021	72091	23692	898
Other Equipment Goods	986	34554	17366	431
Consumer Goods Industries	98321	171386	94668	16235
Construction	6596	3211	6117	387
Telecommunication Services	14166	18077	9603	980
Transport	18883	40461	16913	1961
Credit & Insurance.	20614	49778	5723	710
Other Market Services	181576	477241	376873	35638
Non Market Services	112324	50745	4556	335
Total	548914	1069439	659533	66441

Source: GEM-E3 Database.

5.3.1.1. The Consumption Matrix.

There are two approaches in analyzing the components of household consumption. The first is a commodity breakdown into types of good and service. The second approach is a *purpose* classification and for this an internationally agreed standard, the Classification of Individual Consumption by Purpose (COICOP) is used. COICOP groups together consumption according to the purpose of its use.

In GEM-E3 a mechanism that combines these two approaches is needed, this is the consumption matrix. The consumption matrix translates the demand per consumer category into deliveries by branch. An example of the consumption matrix of Greece is given in Table 4:

Table 4: Consumption Matrix of Greece (in m. ECU 1995).

Purpose[8]. / Product	Food, Beverages and Tobacco	Housing and Water	Fuels and Power	Housing Furniture and Operation	Heating and Cooking Appliances	Medical Care and Health Expenses	Transport Equipment	Operation of Transport Equipment	Purchased Transport	Telec. services	Recreation, Ent, Culture, etc.	Other Services	Housing and Water	Total
Agriculture	2194	0	0	60	0	0	0	0	0	0	0	0	0	*2254*
Coal	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Oil	0	0	0	627	0	0	0	0	1349	0	0	0	0	*1976*
Natural Gas	0	0	0	60	0	0	0	0	0	0	0	0	0	*60*
Electricity	0	0	211	952	0	0	0	0	0	0	0	0	0	*1162*
Ferrous & Non-Ferrous Metals	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Chemical Products	0	0	42	0	379	0	376	0	0	0	0	192	680	*1669*
Other Energy-Intensive Industries	0	0	0	0	585	35	0	0	0	0	0	577	259	*1457*
Electrical Goods	0	0	3	0	10	78	0	0	0	0	0	196	0	*287*
Transport Equipment	0	0	0	0	0	0	3	877	0	0	0	18	0	*898*
Other Equipment Goods Industries	0	0	0	0	2	301	34	0	0	0	0	94	0	*431*
Consumer Goods Industries	9657	4499	44	0	1488	0	0	0	40	0	0	166	341	*16235*
Building and Construction	0	0	387	0	0	0	0	0	0	0	0	0	0	*387*
Telecommunication Services	0	0	0	0	0	0	0	0	0	0	980	0	0	*980*
Transports	0	0	0	0	0	0	0	0	0	1847	0	0	114	*1961*
Services Of Credit And Insurance	0	0	0	0	0	0	0	0	189	0	0	0	521	*710*
Other Market Services	0	0	9976	0	351	196	3645	0	1145	100	0	3075	17150	*35638*
Non-Market Services	0	0	0	0	0	0	0	0	0	0	0	0	335	*335*
Total	*11851*	*4499*	*10663*	*1699*	*2816*	*610*	*4057*	*877*	*2723*	*1947*	*980*	*4318*	*19401*	*66441*

Source: GEM-E3 Database.

New Cronos database had sufficient information regarding consumption by purpose but since there was lack of information on the transformation

[8] Description of Consumption Categories is given in Table 2.

matrices the matrices of Greece and United Kingdom were used after certain modifications. These modifications were partially based on information obtained from the energy balances of each country. The matrices were then balanced through a RAS procedure.

In particular for the countries where no such matrix exists, the matrix was computed using the following procedure:

1. The consumption per consumer category is taken from the National-Accounts and the New Cronos Database.
2. Given VAT rates for the different consumer categories, the total per category without VAT is computed.
3. The total deliveries are taken from the projected Input-Output tables and appropriate assumptions were made to allocate the total per categories to the delivery branch.
4. Apply a RAS procedure to equilibrate the matrix.

5.3.2. Government Consumption.

Government final consumption expenditure covers spending, other than on capital goods, by both central and local government. The share of government consumption to total consumption as well as the shares for each product was obtained from the IO projected tables. Then these shares were applied to EUROSTAT' s main aggregates, to receive government consumption by product as published in the national accounts.

5.3.3. Gross Capital Formation.

The Gross capital formation consists of:

- Gross fixed capital formation, which relates principally to investment in tangible fixed assets. It also includes investment in intangible fixed assets, improvements to land and also the costs associated with the transfer of assets
- Changes in inventories, which depicts the change in goods held by producers prior to further processing or sale[9].
- Acquisitions less disposals of valuables[10].

[9] Inventories also includes work-in-progress.

From the New Cronos database it was feasible to extract information regarding to gross fixed capital formation by branch, changes in inventories and acquisitions less disposals of valuables. In addition information on investments by product was available through the main aggregates of EUROSTAT. Combining this information with the investment structure derived from the projected tables the final investment by product transaction could be obtained.

The distinction of investments between the institutional sectors (Households, Firm, Government) was made by incorporating the information realized from the investment matrices as well as from the respective structure of Greece and United Kingdom.

5.3.3.1. Investment Matrix.

The investment matrix translates the demand of investment goods by the branches into deliveries by branches. The matrix, which has been constructed to portray the investment transactions between sectors of the United Kingdom Economy, is showed in Table 5.

Table 5 : United Kingdom Investment Matrix.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total
Agriculture	498	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**498**
Coal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Oil	0	0	1179	131	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1310**
Natural Gas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Ferrous & Non-Ferrous Metals	50	54	1029	122	463	43	78	239	67	469	75	112	519	116	263	607	530	511	**5346**
Chemical Products	0	0	0	0	0	0	12	0	0	0	0	0	4	0	0	0	0	0	**16**
Other Energy-Intensive Industries	0	0	0	0	0	0	0	227	0	0	0	0	381	0	0	0	5	0	**613**
Electrical Goods	26	13	56	226	1581	239	770	441	997	512	401	312	52	4475	659	3461	1849	3104	**19174**
Transport Equipment	388	60	158	112	80	123	119	102	56	26	109	142	399	351	2989	4403	987	324	**10928**
Other Equipment Goods Industries	706	186	339	219	836	714	795	1296	632	939	1307	1491	899	212	776	1747	3058	1598	**17751**
Consumer	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**

[10] Valuables are goods which are not used in the production process, and which are generally held as a store of value. The presentation in the accounts, bringing together acquisitions less disposals of valuables within gross capital formation, is new.

Goods Industries																			
Building and Construction	795	125	2286	702	1594	188	392	329	503	275	545	565	29710	466	2886	4218	4771	9760	**60111**
Telecommunication Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	165	**165**
Transports	21	1	661	73	0	4	2	6	2	14	4	5	8	13	10	53	69	33	**979**
Services Of Credit And Insurance	151	48	727	104	104	138	256	549	229	159	404	567	4304	215	256	1965	661	1282	**12119**
Other Market Services	263	56	233	116	552	222	346	452	343	372	390	423	372	926	555	1450	1184	1035	**9289**
Non-Market Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	483	0	1617	**2099**
Total	**2897**	**542**	**6669**	**1805**	**5209**	**1670**	**2771**	**3642**	**2830**	**2766**	**3234**	**3617**	**36648**	**6774**	**8394**	**18388**	**13114**	**19429**	**140398**

Source: GEM-E3 Database.

This example depicts that the deliveries were basically made by the branch of other energy intensive industries (number 08), the branch of Electrical Goods (number 09), the " Transport Equipment" branch (number 10), the " Other Equipment Goods Industries" branch (number 11), the " Building & Construction" (number 13) among industrial sectors and to a lesser extent the branch which represents the market related services (number 17).

Investment matrices were available only for Greece and UK. For the computation of the rest of the matrices the information available was the investment by branch and by product. Since there was insufficient information on the transformation matrix a RAS procedure was adopted. The initial tables for the RAS procedure were based on the Greek and UK investment matrix modified appropriately in order to serve the specific investment structure of each country.

5.4. Intermediate Consumption.

Intermediate consumption is defined as the value of products, other than fixed assets, which are transformed or used up as inputs to a process of further production. Having computed the Final Demand by product a version of a Leontief model can by adopted in order to derive the Intermediate Consumption matrix.

In particular from the projected tables (as modified during the previous stages) the following coefficients were calculated: $A_{ij} = \frac{Q_{ij}}{Q_j}$, where A_{ij} is the

intermediate demand coefficient. Then by applying the formula $Q = (I - A)^{-1} \cdot Y$, to the corresponding final demand Y as estimated above, actual output Q was estimated. Once the actual output was obtained the total (by branch) intermediate consumption could be computed $IC_{i,j} = A_{i,j} \cdot Q_j$.

5.5. Value Added.

Gross Value Added in GEM-E3 is net of all taxes[11] (at factor cost) but includes FISIM[12]. Which means that value added at this form represents the amount remaining for distribution to the primary factors and equals the total value of factor incomes generated by production.

5.5.1. Gross Operating Surplus.

In GEM-E3 FISIM is included in the operating surplus. Operating surplus/mixed income was computed by subtracting from gross value added at factor cost (incl. FISIM) the compensation of employees. The appropriate information was obtained form the New Cronos sectoral aggregates.

Moreover since the operating surplus generated by FISIM is included in the surplus of both the financial intermediation sector and of the purchasing sectors it is possible to find a negative operating surplus in the SAM. Thus by including FISIM, negativity is offset (the financial services adjustment) so as to give the correct operating surplus for the economy as a whole.

5.5.2. Compensation of Employees.

Compensation of employees is divided into:

1. Wages and salaries.
2. Employers' contributions.

Both transactions were available at a sectoral level through the New Cronos Database. These were aggregated to GEM-E3 sectors and normalized to EUROSTAT main aggregates.

[11] Taxes less subsidies on products and taxes less subsidies on production are not applied in value added.
[12] Financial Intermediation Services Indirectly Measured: services charged for by a differential interest rate rather than by explicit charges.

5.6. Taxes.

The GEM-E3 model covers all types of taxes. These are represented in the following categories: i) Indirect Taxes, ii) Value Added Taxes[13], iii) Subsidies and iv) Duties. Information on taxes on products and production as well as on subsidies on products and production was available from New Cronos database. Since in most cases the total value of each tax category didn' t coincide with the figures presented at the national accounts all were normalized to the latter.

5.7. Trade.

5.7.1. Imports and Exports of Goods & Services.

Exports in GEM-E3 are valued at f.o.b (free on board) prices while for imports a different convention is applied. This is the ' cost-insurance-freight' (c.i.f.) price – that of a good delivered at the frontier of the *importing* country before payment of any duties or taxes on imports.

The Comext data have been used to compute a bilateral trade matrix for the GEM-E3 branches for 1995.

Different problems have been encountered:

1. Quality of the data: Exports as given in Comext in certain cases are very different from those reported in the NEW CRONOS database.
2. The Comext data only concern trade of goods and there are no other sources for the disaggregation by country of the external trade in services of a particular country. On the other hand the NEWCRONOS database contains aggregate data on service trade. The allocation of services trade by country was obtained by judgmental assumptions.

5.8. Transfer Payments to Institutional Agents.

In order to build the table " transfers between sectors" two sets of tables were used:

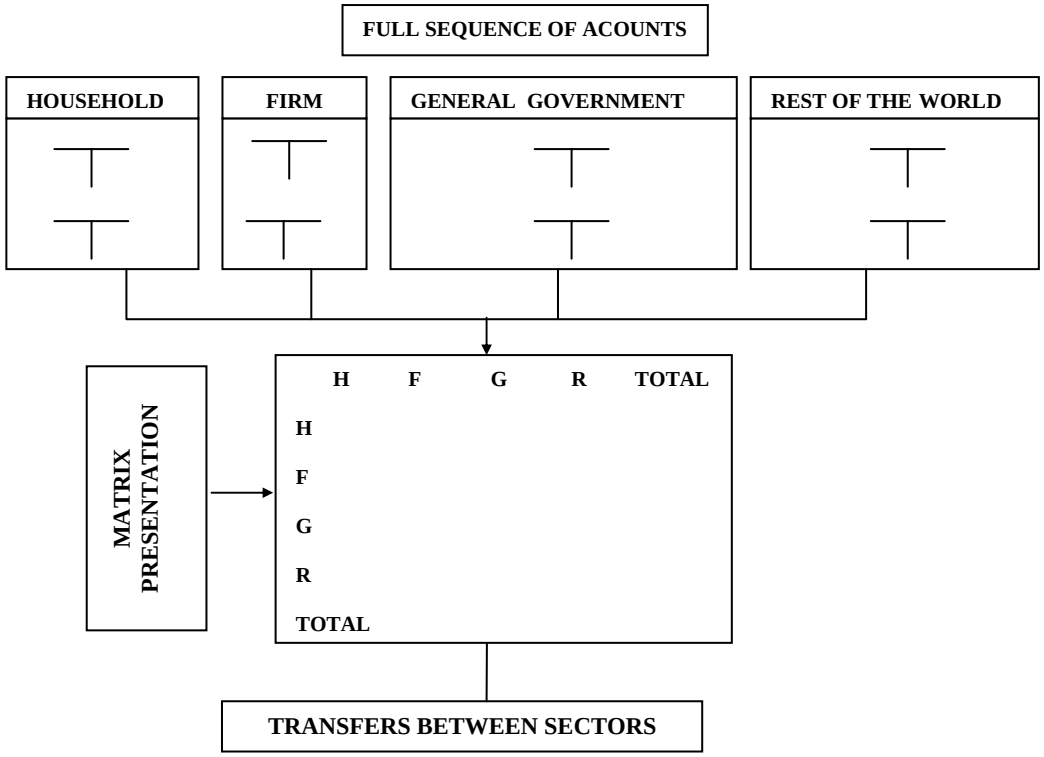
I) The tables for the full sequence of Accounts of each institutional sector (Households, Firms, General Government, Rest of the World, total

[13] The computation of the value added tax has already been described in paragraph 5.2.

Economy). These tables were not available in the same format for each country. The full set of tables according to ESA 95 methodology was available only for Greece, the United Kingdom, Belgium, Germany and Denmark. The full sequence of accounts of General Government and of Total Economy according to ESA 95 methodology was available for all the countries (New CRONOS Database). For France, Spain, the Netherlands and Italy the full sequence of Accounts of all sectors was also available but it followed the ESA 79 methodology (New CRONOS Database).

II) A matrix presentation of the most important transactions of the system. A matrix presentation permits each transaction to be represented by a single entry and the nature of transaction to be inferred from its position. Each transaction between two institutional sectors is represented with a column and a row pair. The convention followed is that resources are shown in the rows and uses are shown in the columns. For instance, taxes on income are payable by the Households and received by the government.

Figure 5: Transfer Payment Computation Methodology.



Nevertheless some problems exist with the treatment of some transactions such as the Property Income, or the " Other current transfers" . As it is depicted in Figure 6, in the corresponding matrices there are some entries which represent a kind of income received by Government and is payable from all other sectors (for example penalties, rents from public mines etc.). But in the Government section of the SAM there is no specific row to introduce such a transaction. Such transactions have been placed in the row with heading " General transfers" .

Figure 6: Matrix presentation of Institutional Sector Accounts (Denmark)

Allocation of primary income of Households

Uses	**Resources**
Property Income 81547	Property Income 74018

Allocation of primary income of Firms

Uses	**Resources**
Property Income 236575	Property Income 245002

Allocation of primary income of Government

Uses	**Resources**
Property Income 64692	Property Income 37979

Current Accounts with the Rest of the World.

Uses	**Resources**
Property Income 108456	Property Income 134271

Property Income

	H	F	G	W	Resources
H	33483	40534	0	0	**74018**
F	48064	183438	8874	4627	**245002**
G	0	5027	32952	0	**37979**
W	0	7575	22867	103829	**134271**
Uses	**81547**	**236575**	**64692**	**108456**	

Interest

	H	F	G	W	Resources
H	32406				**32406**
F	48064	169492	8874		**226430**
G			32952		**32952**
W	0		22867	99388	**122255**
Uses	**80470**	**169492**	**64692**	**99388**	

5.9. RAS.

All data were aggregated and reconciliated according to GEM-E3 nomenclature and ESA 95 methodology. However the resulted SAMs were not balanced. This was partly due to different data sources used and partly to the assumptions that had to be made in the absence of specific data. Thus in order to equilibrate the matrices a variant of the RAS method was developed and applied to all matrices. Through this variant it was feasible to keep relatively unchanged the coefficients related to transactions coming from reliable sources.

Moreover the matrices had to be modified (transposition of rows and columns where necessary) so as to take under consideration the negative signs in rows (subsidies) and columns (change in stocks).

6. THE GREEK SAM.

Since for the construction of the Greek SAM all data sets needed were complete and available through the Greek Statistical Office a more thorough presentation of the construction of the Greek SAM is required.

For the construction of the Greek SAM both main sets of data were available:

1. The institutional sector accounts.
2. The input-output table.

Very often, these two sets of data are incompatible with each other and a lot of adaptations are needed, in order to derive from them a SAM in general equilibrium.

The Greek national account system is based on the international recommendations given by the System of National Accounts 1993 (SNA 1993) and the European System of Accounts (ESA 1995).

Methodologically the SAM is approached as a table consisting of four divisions. These represent:

- The Intermediate Consumption.
- The Final Demand.
- The Revenues from Sectors.

- The Transfers between Sectors.

For the compilation of the first three tables the supply and use methodology was applied. For the derivation of the fourth table the rules concerning the compilation of institutional sector accounts have been followed.

6.1. Supply and Use tables for the Greek Economy

In the new European System of Accounts supply and use tables play an important role as one of the main integration frameworks. The Supply and Use tables framework consist of four types of tables:

1. The make matrix.
2. The balances of resources and uses.
3. The matrix of intermediate Uses.
4. The production accounts by branch.

6.1.1. The make matrix

The make matrix table shows at a detailed level the resource of goods and services produced by resident units in the economic territory. The table has a " commodity by industry structure" . Each column of the table presents the commodity structure of total industry output and each row presents the industry share of total commodity output. So the main diagonal identifies the principal production activities of the branches and the secondary production is allocated outside of the main diagonal. The dimensions of Greek make matrix are " 447 products X 125 Branches" . Using the GEM-E3 classification the make matrix for year 1995 was aggregated to a table of dimension 18X18.

6.1.2. The balances of resources and uses

The resources and uses balances are in fact a representation of the basic identity between the supply and demand for each one of the 447 products considered by the Greek system of national accounts. On the side of balance of resources and uses the various data of the supply-side of a product appear, namely domestic production and imports. On the other side of the balance the various kinds of uses of the product concerned such as the categories of final demand appear (private and government consumption, gross fixed capital formation, changes in stocks and

exports). Provided that supplies and uses of a product are estimated consistently, the total supply of a product must be equal to its total uses. The system used for the valuation of the flows complicates the framework to a great extent: supply is normally valued at basic prices while uses are evaluated at purchaser prices. The bridge between the valuations of both sides is achieved using the data for taxes, subsidies and trade margins, which are also presented in the balance of each one of the 447 products. Using the GEM-E3 classification the 18 aggregated balances for the year 1995 were derived.

6.1.3. The matrix of intermediate uses

The use matrix table shows the utilization of commodities in the production process of the industries. The table has a " commodity by industry" structure and in the case of Greece consists of 447 rows and 123 columns. Each column in it presents the commodity structure of intermediate expenditures of each industry. Using the GEM-E3 classification the use matrix for the year 1995 was aggregated to a table of dimension 18X18. This matrix is evaluated in purchaser prices. In order to derive this matrix two adaptations were made:

- First, the amount of FISIM was allocated in the row, which refers to banks. The allocation has been made assuming that the amount of FISIM that corresponds to each branch is proportional to its operating surplus.
- Second from each entry of the use matrix the corresponding trade margins were eliminated and the total amount of trade margins for each industry was allocated in the row of " Other market services" .

6.1.4. The production accounts by industry (branch).

Production accounts have been drawn up for each one of the 123 industries of the classification used in the national accounts. They present data about the domestic actual production by branch at basic prices as well as the total intermediate uses of the branch at purchaser prices. The production account can be used to obtain one of the most important balancing items in the system – value added. Also they present the components of value added, namely compensations of employees and operating surplus. Using the GEM-

E3 classification 18 aggregated production accounts were derived for the year 1995.

6.2. Symmetric input-output tables

A symmetric input-output table is a product-by-product or industry-by-industry matrix describing the domestic production processes and the transactions in products of the national economy in great detail. A symmetric input-output table rearranges both supply and intermediate uses in a single table. The IO tables received from Eurostat for most countries are not symmetric input-output tables. They are rather combined supply and uses tables. That is the reason for the presence of " Transfers" rows in the received projected IO tables. There is one major conceptual difference between a symmetric input-output table and a combined supply and use table: in the supply and use table the statistics relate products to industries, while in a symmetric input-output table the statistics relate the transactions of flows from product to product or from industries to industries.

Most statistical information that can be obtained from producer units indicates what types of products they have produced/sold and, usually in less detail, what type of products they have sold/used. The format of the supply and use tables is designed to fit in with this type of statistical information (i.e. industry by product). By contrast, information of a product-by-product nature as required by the symmetric input output table is not often available. So the product-by-product input-output table can be compiled by converting the supply and use tables. This involves a change in format i.e. from two asymmetric tables to one symmetric table.

The conversion can be divided in three steps.

a) Allocation of secondary products in the make matrix to the industries of which they are the principal products.

b) Rearrangement of the columns of the use matrix from inputs into industries to inputs into homogeneous branches.

c) Aggregation of the detailed products of the new use table to the homogeneous branches shown in the columns.

Step b) is more complicated, as the basic data on inputs relate to industries and not to each individual product produced in each industry. The kind of

conversion to be made here entails the transfer of inputs associated with secondary outputs from the industry in which that secondary output has been produced to the industry they principally belong. In making this transfer two different approaches might be taken:

1. By means of supplementary statistical and technical information.
2. By means of assumptions.

The assumptions used to transfer outputs and associated inputs hinge on two types of technology assumptions:

a) Industry technology, assuming that all products in a product group produced in a branch are produced with the same input structure.

b) Product technology, assuming that all products in a product group have the same input structure, whichever industry produces them.

For the construction of the Greek symmetric IO tables the industry technology assumption was adopted. The result is the symmetric matrix of intermediate consumption, which consists of the upper left division of Greek SAM for GEM-E3.

Using the industry technology assumption the operating surplus and compensations of employees by industry was converted to operating surplus and compensation of employees by product. Combining the so derived data with the data taken from supply and use balances (taxes, subsidies, imports etc.) the table " Revenues from Sectors" was constructed.

6.3. Investment matrix, Consumption Matrix and Final demand table.

The Greek national Account System provide in annual basis three types of tables:

a) The matrix of final consumption of households and Non Profit Institutions. The table has a " commodity by purpose (or function) structure.

b) The investment matrix by branch. The table of investment matrix has a " commodity by Industry" structure.

c) The matrix of investments by institutional sector. The table of investment matrix has a " commodity by institutional sector " structure.

Applying the corresponding GEM-E3 classifications to the aforementioned tables the following tables were obtained:

a) The investment matrix.

b) The consumption matrix by function.

c) Combining the information of investment by institutional sector with the information from the supply and use balances " final demand table" was constructed.

6.4. The Institutional sector Accounts- Transfers Between Sectors.

In order to build the table " transfers between sectors" two sets of tables were used:

a) The overall economic table of year 1995 for Greece which presents a full sequence of accounts of all institutional sectors.

b) A matrix presentation of the most important transactions of the system.

A matrix presentation permits each transaction to be represented by a single entry and the nature of transaction to be inferred from its position. Each transaction between two institutional sectors is represented with a column and a row pair. The convention is followed that resources are shown in the rows and uses are shown in the columns. For instance, taxes on income are payable by the Households and received by the government.

Some problems exist with the treatment of some transactions such as the " Property Income" or the " Other current transfers" . In particular there are some entries, which represent a kind of income, received by Government and is payable from all other sectors (for example penalties, rents from public mines etc.) but in the Government section of the SAM there is not a relevant row to put such a transaction. Transactions of that type are placed in the row with heading " Government firms" . This treatment does not affect the equilibrium of the SAM but of course will affect the calibration of the model.

7. DEPLETABLE RESOURCES MODULE IN GEM-E3.

7.1. Summary.

The GEM E3 model distinguishes four energy sectors, namely coal, oil, gas and electricity. The supply behaviour of these sectors is modelled identically to any other industrial sector. This approach is defective in the sense that certain crucial features, such as resource depletion, are not taken into consideration. Within the context of TCH GEM E3 project NTUA undertook to examine ways of improving the realism of the supply behavior of these sectors by developing an energy supply sub module inside GEM E3.

Initially a full depletable resource specification was designed and tested. However problems with data and the specific characteristics of the European energy market has *** that the results obtained fell short of expectations. Consequently a reduced form module has been implemented allowing for interaction between international prices and domestic supply/demand.

Thus this chapter is divided in two parts: the first part provides the methodology of incorporating a depletable resources mechanism into GEM-E3 and the difficulties that led to the abandonment of such an approach. The second part describes the mechanism finally implemented in the model, which enhances the model' s capability in assessing effects of oil and gas price variations.

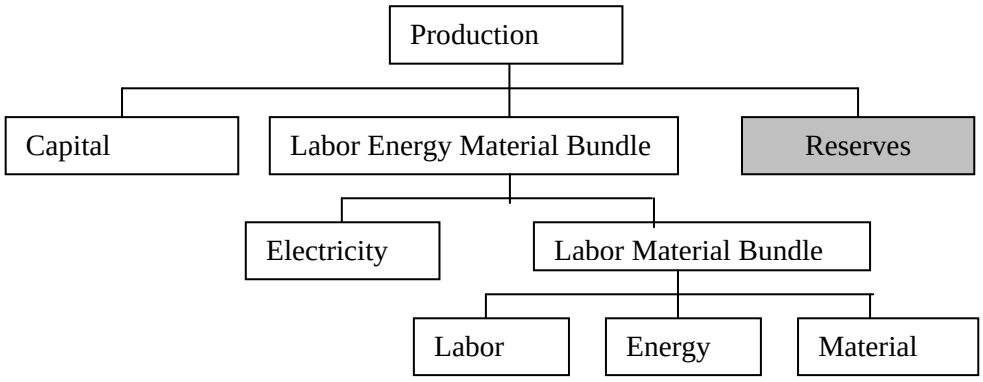
7.2. Depletable Resources Module Specification.

For the implementation of this task the oil and gas sectors of GEM E3 should be disaggregated into:

- Crude Oil Production.
- Primary Gas Production.
- Petroleum Refineries and Production of misc. Products.
- Distribution of Gaseous Fuels.

A second step is to make the supply of the crude oil and natural gas sector a function of the capital, labor, energy, materials bundle and reserves. In particular reserves are considered to be an additional production factor at the top level of the CES production function of GEM-E3. (Figure 7).

Figure 7 Nesting Scheme of the Production Function in GEM E3.



To make clear how reserves can be used in GEM E3 consider that oil is produced through a CES technology and for its production reserves (*RES*) and a bundle (X) of capital, labor, energy and material are required. Then the unit cost function derived from a CES type production function is:

$$P_{oil} = \left(\Theta RES \cdot PRES_{oil}^{1-S_{oil}} + \Theta X \cdot PX_{oil}^{1-S_{oil}}\right)^{\frac{1}{1-Soil}}$$

where P_e is the output price of oil , $PRES_{oil}$ is the price of the resource input, PX_{oil} is an aggregate price of the unit bundle of other inputs, ΘRES and ΘX are the values shares and S_{oil} is the elasticity of substitution. The unit demand function for Reserves RD_{oil} can be found by differentiating the unit cost function with respect to the price inputs:

$$R_{oil}^{D} = \Theta RES \cdot \left(\frac{PRES_{oil}}{P_{oil}}\right)^{-S_{oil}}$$

In this way supply and demand is specified. In GEM E3 a calibrated share form of the production function is adopted and the corresponding unit cost function and derived demand are:

$$P = \frac{1}{TFP}\left[\left(\Theta RES^{S1} \cdot PRES^{1-S_1} \cdot \frac{RESB}{XDB}\right)^{1-S_1} + \left(\Theta KAV^{S_1} \cdot \frac{PK}{TPK}\right)^{1-S_1} \cdot \left(\frac{KAVB}{TPKB} \cdot \frac{e^{-TGK \cdot t}}{XDB}\right)^{1-S_1} + \left(\Theta LEM^{S_1} \cdot PLEM^{1-S_1} \cdot \frac{LEMB}{XDB}\right)^{1-S_1}\right]^{1/1-S_1}$$

$$RES = \left(P \cdot \frac{\Theta RES}{PRES}\right)^{S_1} \cdot \left(\frac{XDB \cdot TFP}{RESB}\right)^{S_1 - 1} \cdot \frac{XD}{XXNUM}.$$

A crucial issue at this point is to define the supply of reserves within the model. In particular supply of reserves is derived from the following motion equation:

$$RES_{t,i} = RES_{t-1,i} + NRES_{t-1,i} - XD_{t-1,i}$$

where:

$RES_{t,i}$ = Reserves of fuel i at time t.

$NRES_{t,i}$ = New Reserves (discoveries) of fuel i at time t.

$XD_{t,i}$ = Production of fuel i at time t.

Moreover New Reserves (*NRES*) are a function of the Yet To Find Reserves[14] (*YTFR*) and the rate of discovery (*d*):

$$NRES_{t,i} = (1-d_i)*YTFR_{t-1,i} \text{ and } YTFR_{t,i} = d_i*YTFR_{t-1,i}.$$

Since a price signal might induce the producer to reduce or intensify exploration/drilling activity, the rate of discovery *d* can be modeled to be a function of the price of the respective fuel:

$$d(\tilde{p}_i) = \bar{d}_i \cdot \tilde{p}_i^{\,w}$$

What is left is the determination of the elasticity of substitution *S* in the production function. The key issue here is that *S* value cannot be greater than 1 because in such a case resources are not essential in the sense that they are not indispensable for output production (if *S >1* an amount of oil can be produced even with zero reserves!).

7.3. Difficulties.

For the needs of GEM E3, data related to reserves and oil and gas in place were acquired from the most recent publication of the U.S. National Geological Survey. However additional data required for the further disaggregation of the oil and gas sector were not available. However data related to the final demand, capital stock, wages, imports and taxes could be acquired from the GTAP v.4 database but only for the following countries: United Kingdom, Germany, Denmark, Sweden and Finland.

[14] Provided through geologist's estimates.

Furthermore since very few countries in the European Union are oil and gas producers adding a depletable resource mechanism into the GEM-E3 would greatly increase the complexity of the model for little representational gains.

7.4. Module Implemented in GEM-E3.

The crucial element within the alternative, but equivalently efficient methodology adopted is the endogenization of the energy import price for the Rest of the World. This was achieved by applying empirically estimated supply functions to these sectors.

In particular the following equations were added to the model

$$P_i = \begin{cases} \left[\dfrac{\sum_{EU} \left(IMP_{i,EU,RW} \right) - \sum_{EU} \left(EXPO_{i,EU,RW} \right)}{NETIMP} \right]^{ELAS \cdot P} \cdot PW, NETIMP > 0 \\ \left[\dfrac{\sum_{EU} \left(IMP_{i,EU,RW} \right) - \sum_{EU} \left(EXPO_{i,EU,RW} \right)}{NETIMP} \right]^{-ELAS} \cdot PW, NETIMP < 0 \end{cases}$$

where,

P is the import price of oil and gas for the EU countries.

i is the set that represents the oil and gas sectors,

EU is the set of the European Union Countries,

RW represents the rest of the world region,

IMP represents imports,

EXPO represents exports,

ELAS is an elasticity

PW represents the price of imports from the Rest of the World region (exogenously specified).

$$NETIMP = \sum_{EU} \left(BIMP_{i,EU,RW} \right) - \sum_{EU} \left(BEXPO_{i,EU,RW} \right)$$

where,

BIMP represents imports corresponding to a baseline,

EXPO represents exports corresponding to a baseline.

In this way, in the baseline the import price of oil and gas from the *RW* region evolves under exogenous assumptions. However while a policy scenario is implemented the import price of the energy goods is directly affected by the *NETIMP* variation. This modification, consistent in the general equilibrium context, provides the realism needed in GEM-E3 in order to evaluate policy scenarios regarding the secondary effects on/of oil and gas price variations.