Fehr, Hans; Wiegard, Wolfgang

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A Computable General Equilibrium Model for the Examination of Worldwide Agricultural Liberalization Policies: Model Structure and Preliminary Results

Hans Fehr
Wolfgang Wiegard

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A Computable General Equilibrium Model for the Examination of Worldwide Agricultural Liberalization Policies: Model Structure and Preliminary Results

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I. Introduction

This paper presents the technical background for our computable general equilibrium (CGE) analysis of different worldwide liberalization scenarios in agricultural markets. The main features of the examined agricultural protection policies are explained and descriptions of the applied economic model and the construction of a disaggregated multi-country dataset are provided, as well as documentation of calibration for a benchmark year. Finally we present some preliminary results of simulated liberalization schemes. The explanation of these results is not included. This will be done in more specific papers.

A vast number of CGE models designed to assess the impact of agricultural liberalization policies already exist. Depending on the specific issue being investigated, these models differ greatly in their country and commodity coverage. A number of single country models either try to represent the total farm and food system (i.e. Hertel et al. (1989)) or a specific government support program (i.e. Rutherford et al. (1990), Wajzman (1991)) in considerable detail. These models offer important insights into the domestic effects of different agricultural policies but they are of little help when evaluating the international effects. Existing multi-country models on the other hand provide some indication of the global impacts of uni- or multilateral liberalization policies, but at the cost of high country or commodity aggregation.

When considering the country aggregation of the different studies, two general approaches could be distinguished in the literature. On the one hand there are models which explicitly investigate the economic impact of the European Union (EU) on the different member states (i.e. Spencer (1985), Harrison et al. (1989,1990), Stoikek and Breckling (1989)). Since the Common Agricultural Policy (CAP) plays a dominant role in the budget of the EU, these models mainly try to capture the central characteristics of the CAP. While the EU is disaggregated into its different member states, non-EU countries are aggregated usually into one country so that the economic relationship among EU and non-EU countries is covered only superficially. On the other hand, due to the special characteristics of the CAP, the EU countries are aggregated in a number of models to one trading block which prevents an analysis of the impact of multilateral liberalization on the different EU member states. Examples are the WALRAS model of the OECD (Buriaux et al. (1989, 1990)), the RUNS model of the OECD and World Bank (Goldin et al. (1993)), the IIASA model of Frohberg et al. (1990) or the specific grains model of Trela et al. (1989).

The aim of our study is twofold: to improve the modelling of the EU budgetary mechanism while integrating the above mentioned directions of research. Therefore, although we cover the institutional features of the EU and the associated transfers between EU members in great detail, we also disaggregate the non-EU countries and evaluate their different agricultural policies. This paper provides an exact mathematical representation of the model as included in our computer program. Although not intended as such, the paper could therefore be viewed as a manual for the construction of an CGE model for the examination of issues in international trade and taxation. Readers unfamiliar with this type of model are referred to the relevant literature1.

The paper is organized as follows: In the next section we describe the mechanics of the agricultural policies in different OECD countries and explain how this is embedded in the model. Section III derives the equations of the economic model. Section IV describes our

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procedure of constructing a micro-consistent dataset for many countries and commodities. Section V shows how the parameters of production and utility functions can be calibrated from this benchmark dataset. In the final section we present some preliminary results.

II. Agricultural Policy in a CGE Model

Before the exact mathematical specification of our model is discussed, its two main features, i.e., the modelling of the agricultural policy and the EU budget, are briefly described. We start with the observed pattern of the agricultural policy and the central characteristics of the EU budget and explain how these features are incorporated into our model. A partial equilibrium analysis of the welfare implications completes this section.

In almost all OECD countries the markets for agricultural commodities are regulated to a large extent. The different national policy measures can be disaggregated into three different categories:

1. Market Price Support Measures: administered prices, tariffs, import quotas (IQs), voluntary export restraints (VERs), export subsidies, stockpiling, production restrictions (land set-aside programmes etc.)
2. Direct Payments: deficiency and disaster payments, farm feed adjustment payments.
3. Other Support: subsidies for purchased inputs, farm credit, and agricultural research, agricultural infrastructure programs, regional specific assistance measures, taxation concessions.

In our model we employ the Armington assumption, which states that commodities are distinct by their place of origin (see Armington (1969)). We therefore have to distinguish products by their place of origin. The payments of the two latter categories are added together and simply modelled as producer subsidies. In order to explain the mechanics of different market price support measures we use a diagramatical representation.

While Figure 1a analyzes the effects of (fixed and variable) tariffs for agricultural imports, Figures 1b and 1c explain the economics of export subsidies and stockpiling purchases respectively.

Figure 1a illustrates home country $h$ as an importer of an agricultural commodity, which is produced in country $k$ only. In the left-hand quadrant, $S$ is the (inverse) supply curve and $D_k$ the (inverse) demand curve in country $k$. The Armington assumption implies that these curves do not intersect. Hence at each price there is some excess supply, corresponding to country $k$'s export supply curve $X^k$, as shown in the right-hand quadrant. Here, $D^h_1$ is the home country's (import) demand curve. Suppose the home country applies a specific import tariff which causes it's demand curve to shift from $D^{h_1}$ to $D^{h_0}$. The equilibrium is therefore determined by point A with $p$ as the equilibrium world price and $p^h$ as the consumer price of the imported commodity in country $h$. Country $k$ produces the quantity $DK$ and consumes $DI$, whereas exports and imports are given by $KI$ (or DA). If country $h$ abolishes its import tariff, a new equilibrium at point G with a unique equilibrium world price $p^w$.

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2 For a more detailed description see the annually published OECD reports "Agricultural Policies, Markets and Trade. Monitoring and Outlook".
3 Of course it would be better to explicitly model the special support arrangements instead of such an ad-valorem production subsidy treatment, see Rutherford et al. (1990) or Whalley and Wigle (1990), but due to information constraints a better representation of the different programs is almost impossible.
4 If domestic markets are perfectly competitive, it does not matter whether the tariff is a specific tariff per physical unit or an ad-valorem tariff as a proportion of the producer price.
will be established. Subsequently, the new production and consumption quantities in the countries $k$ and $h$ would be $EJ$, $EH$ and $EG$ respectively.

Our main interests are the domestic, foreign and world welfare effects of such a liberalization policy. In a partial equilibrium context one can reasonably assume consumer and producer surpluses as a measure of welfare. Net social welfare is computed as the sum of these surpluses together with the government tax revenue. Starting with the foreign country, a higher producer price implies a loss in consumer surplus corresponding to the area $DEHI$, and a gain in producer surplus of the area $DEJK$. The net gain in country $k$ - the area $IHJK$ - is caused by the improvement of country $k$'s terms-of-trade by $(p^* - p)$ per unit. From country $h$'s point of view, this of course constitutes a terms-of-trade loss. The welfare effects of the home country have to be calculated as follows. The consumer surplus gain is equal to the area $BCEG$, while in contrast the revenue losses for the government are represented by the rectangle $ABCD$. The overall welfare effect for country $h$ is the difference between the consumer surplus gains and the revenue losses. Netting out the overlapping areas, the total welfare change is the difference between the area $ADEF$ and the area $BFG$. While the triangle may be regarded as the welfare gain due to the domestic substitution effect, the welfare loss $ADEF$ is due to the worsening of the terms-of-trade. The question then is whether the domestic substitution effect will be smaller or bigger than the terms-of-trade effect. From Figure 1a it becomes clear that welfare gains due to the domestic substitution effect increase with the extent of the tariff rate reduction, whereas the terms-of-trade varies with the elasticities of demand and supply. Given small tariff rate changes, the terms-of-trade effect will dominate the domestic substitution effect. As a final remark, the reader should note that the terms-of-trade gains in country $k$ exceed the terms-of-trade losses in country $h$ by the area $AFG$ (the areas $IHJK$ and $ADEG$ are the same). The
total gain in world welfare due to the abolition of the tariff in country $h$ is represented by the Harberger triangle $ABG$.

In EU countries, variable import levies for agricultural goods are aimed at maintaining a constant level of prices for domestic consumers and producers. This brings about a situation as represented in Figure 1a, where import prices are set at $p^m$ and the difference between the world price and the fixed import price is bridged by a sliding-scale tariff. Variable import levies insulate the domestic market from the impact of variations in the foreign markets while at the same time they amplify the price variations in the rest of the world. The economic effects of a reduction of (fixed) import tariffs and a reduction of (fixed) import prices will therefore differ.

**Figure 1b: Subsidies for Agricultural Exports**

Figure 1b illustrates the situation in the market for a domestic agricultural commodity. Again, the reader should distinguish between a (now domestic) supply curve, $S$, a domestic demand curve, $D^h$, and a residual export supply curve, $X^{hk}$. Due to a specific export subsidy the foreign demand curve is shifted from $D^k_1$ to $D^k_0$. The initial equilibrium is therefore determinied by the point $A$. While the domestic producer and consumer price is $p$, the foreign consumer price is -- as a consequence of the export subsidy -- driven down to $p^x$. Country $h$ produces the quantity $BD$ and consumes $BC$, so the foreign consumption must be $AB$. A complete abolition of export subsidies establishes a new equilibrium at $E$. This brings about a unique world price, $p^*$, a contraction in domestic output to $FH$, and levels of domestic and foreign consumption quantities at $FG$ and $EF$, respectively. The producer surplus loss of country $h$ is therefore the area $BDHF$, the consumer surplus gain is the area $BCGF$. To calculate the overall welfare shift in country $h$, add the revenue gains which are equal to the rectangular $ABKI$. The total welfare gain for country $h$ is therefore the area

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5 For a detailed examination of the mechanics of variable import levies and their quantitative evidence in the EU see Sampson and Snape (1980).
AEFKI. Subtracting the welfare loss of country \( k \) -- area EFKI -- from AEFKI, we get the triangle AEI, the total world welfare gain if export subsidies are completely removed.

Again variable export subsidies and controlled export prices, \( p^x \), for the respective countries are modelled for the EU. For non-EU countries, export subsidies are modelled with a fixed ad-valorem rate. As with import levies the distinction between variable and fixed export subsidy rates is important whenever a partial liberalization scenario is examined.

**Figure 1c: Stockpiling Interventions in Agricultural Markets**

Finally, Figure 1c illustrates the effects of market price stabilization through stockpiling interventions. The domestic supply curve is represented by \( S_1 \), the domestic and foreign demand curves by \( D^h \) and \( D^k \), respectively, and the residual export supply curve by \( X_{hk} \).

Stockpiling intervention purchases of quantity DE shift the supply curves to \( S_0 \) and \( X_{hk} \). The initial equilibrium is therefore characterized by point A and the unique world price by \( p \). The domestic production quantity is BE, domestic consumption is BC and exports are AB (equal to CD). Without government intervention purchases, the equilibrium world price would be \( p^* \), the domestic production would fall to GI, and domestic consumption and exports would rise to GH and FG respectively. The loss of producer surplus in the home country is the area BEIG, the gain in consumer surplus is the area BCHG. If outlays for stockpiling interventions -- the area DEKJ -- are subtracted as well as the overlapping areas, the total welfare change is the difference between area CDLH and LIEKJ. Again it is unclear if the positive domestic substitution effect outweights the negative terms of trade effect. Adding the foreign consumer surplus gain ABGF, the total world welfare gain is the area DJKEI.

In our model stockpiling purchases are exogeneously determined. The government specifies the quantity of intervention purchases (here DE) the equilibrium domestic supply price, \( p \), is calculated endogeneously. As already mentioned above, the CAP is the centerpiece of the EU. For agricultural products there exists one unified market with central administration of regulations, policies, and market organisations. Prices for agricultural
commodities are regulated above the competitive market prices with the help of variable import levies and variable export subsidies. The necessary funding of the CAP is financed by the European Agricultural Guarantee and Guidance Fund (EAGGF). While the "guarantee" section of the fund finances all intervention policies of the CAP, the "guidance" section administers funds intended for policies of structural reform. While the EAGGF budget absorbs almost 70% of the total EU budget, the remaining funds are basically used for regional and social policy programs within the EU. We model these programs as fixed transfers from the EU to the national governments.

On the revenue side of the budget the second central element of the EU, namely the Common External Tariff (CET) System, needs to be explained. While no tariffs are levied on trade among member states, all EU countries apply the same tariff rates for imports from non-EU countries. Except for trade in agricultural products, there is almost free trade among the EU and member countries of the European Free Trade Association (EFTA) (see Scott (1992, 44)). All national tariff revenues from the CET and the variable import levy system are used to finance the EU budget. Furthermore, the EAGGF expenditures are also financed with production levies on sugar and milk production. The main revenue source of the EU are value added tax (VAT) contributions of the member states which are calculated with a common percentage from the national VAT basis and are used to balance the budget. Our study captures these characteristics of the EU budget in the following ways. There are expenditures for variable export subsidies and intervention purchases of agricultural goods and fixed transfers from the EU level to the national governments (regional and social programs). Revenues are obtained from tariffs, variable import levies, production levies and VAT contributions. The production levies for sugar and milk are simply computed as a fixed fraction of the total national production tax payments in the respective sectors. The VAT contributions are calculated in two stages. First, the overall deficit is determined by subtracting the total tariff and levy revenues from the total expenditures. Then, a common share parameter is calculated and applied to each national VAT basis. These calculations therefore simultaneously provide national VAT contribution and balance the budget. Import quotas of EU countries are modelled with a tariff equivalent ad-valorem rate. The quota rents are acquired by the national governments. All direct producer subsidy payments within the EU are financed by the national governments.

III. The Structure of the Standard Multicountry Model

In principle, the theoretical model is a higher dimensional analogue of the standard 2x2x2 general equilibrium model commonly used in international trade theory. Of course it is much more complicated and deviates in a number of ways from the traditional Heckscher-Ohlin framework, most notably with the Armington assumption, as already mentioned above. When commodities are distinct by their place of origin, it is possible to include observable features as cross-hauling, but - unlike Heckscher-Ohlin models - this implies a complete specialization in every country.

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5 For a detailed description of the CAP see Hitiris (1988, 108ff.).
6 For intra-EU agricultural trade a system of Monetary Compulsory Amounts (MCAs) protects farmers from national currency fluctuations. We don't model these intra-EU import tariffs and export subsidies because the net expenditures are only 2.5% of the 1987 EAGGF budget (see Court of Auditors (1988, 25)). For an evaluation of the economic effects of the MCAs see Strauss (1983).
Our model identifies different world trade regions, which could be separated in the following way

The set for all the countries of the world \( W \) is split into EU countries and non-EU countries, the latter set is further disaggregated into EFTA countries and non-European countries. The EFTA countries and the EU countries are also aggregated to the European countries (\( ER \)). Every region consists of its member states or blocks of member states, i.e.

\[
\begin{align*}
EU &= \{B, D, \ldots\} \\
EFTA &= \{A, S, \ldots\}, \\
NER &= \{US, JAP, \ldots\}, \\
NEU &= \{EFTA, NER\}, \\
ER &= \{EU, EFTA\}, \\
W &= \{EU, NEU\} = \{ER, NER\}
\end{align*}
\]

where "B" stands for Belgium, "D" for Germany, "A" for Austria, "S" for Sweden, etc.\(^1\) In general, \( h \) denotes an element of one of the index sets. Finally, \( W \setminus h \) or \( EU \setminus h \) are the index sets for the relevant countries except for country \( h \).

Each industry produces a single commodity and each country produces the same number of commodities. \( N \) is defined as the index set corresponding to all commodities. It is important to distinguish between agricultural goods, industrial goods, and services. Let \( a1 \) denote the sector of the non-processed agricultural goods (grains etc.) and \( a2 \) denote the sector of all processed agricultural goods (meat, milk etc.). Then \( N_{a1} \) and \( N_{a2} \) denote the sets of all commodities of the respective sectors. Similarly, \( N_a = \{N_{a1}, N_{a2}\} \) is the index set of all agricultural goods, \( N_m \) the index set of all (manufactured) industrial goods and \( N_s \) the index set of all services. We therefore have

\[
N = \{N_a, N_m, N_s\}
\]

As with countries, \( N \setminus i \) is the index set of all commodities except commodity \( i \). In the following, a subscript stands for commodities or industries, superscripts refer to countries. In order to avoid excessive notation, the index \( h \) is suppressed or replaced with a dot

\(^1\) Note that data set refers to 1987, where the EU consisted of twelve countries only.
whenever possible. More precisely, the notation $V_y$ and $V_y^k$ is used instead of $V_{y}^{hh}$ and $V_{y}^{hk}$, etc.

Each national economy exhibits the same dimensionality and the same structure of production and consumption decisions and government activities. Therefore, we can restrict ourselves to looking at the behavioral assumptions and equilibrium conditions of one typical country. This also enables us to suppress the country-specific index $h$ in most parts of the following presentation. All in all, there are $R$ countries with $J$ productions sectors each. Consequently, we have a total of $J \times R$ commodities in the model.

This section is organized in the same way as our computer program: given a set of factor prices, producers minimize costs which implicitly determines producer prices (section 1). On the basis of these producer prices and tax rates or transfer levels, household then calculate their demand quantities (section 2). Assuming that markets for goods and services always clear, commodity demand is set equal to supply, so that factor demand quantities can be derived. Finally, government revenues are calculated (section 3). This constitutes a system of non-linear equations, which may be solved for the equilibrium values of the endogenous variables (section 5). Due to Walras' Law, the foreign sector (section 4) is automatically in balance if all markets clear and all other agents fulfill their budget constraints.

1. The Production Sector

Within each country we identify $J - 1$ domestically produced commodities, which may be used for domestic consumption, as intermediate inputs in domestic production or as exports. Additionally, we consider a collective consumption good $G$ produced by the public sector. This commodity is not traded, but is consumed (free of charge) by the domestic household sector and is used as an intermediate input (at producer prices) in domestic production. There are three primary production factors, land, labor and capital. Land is only used in the agricultural production sector $a_1$, and labor is mobile between production sectors, but not internationally. Capital, however, is mobile between production sectors and countries. Moreover it is assumed to be homogeneous, i.e. firms do not distinguish between source countries and only face one international rental rate for capital. In addition to primary inputs and domestically produced inputs, firms use intermediates from abroad, which - according to the Armington assumption - might be similar, but are not identical to their domestic counterparts.

Since we assume a fixed coefficient technology with respect to intermediates, the structure of the production side of the model can most easily be represented by a "production tree", as shown in Figure 2. In the next sections we will describe the different nests of the tree in greater detail.
**Figure 2: Hierarchical Production Structure of the Sector \( i \in N_{a_1} \) in country \( h \)**

### Third level
- Capital and labor are aggregated to a composite capital/labor input \( KL_i \)

### Second level
- Composite capital/labor and land are combined by a value added function

### First level
- \( (K_i, L_i) \)
- Fixed coefficient technology between value added and intermediate inputs

The second level is skipped for all industries which do not use land as a primary factor, i.e. \( i \notin N_{a_1} \).

When computing an equilibrium, we generally start with the production side of the model. At given factor prices, and recalling that with constant-returns-to-scale technologies the zero profit condition holds, cost-covering producer prices can be calculated, which then serve as the basis of household decisions. Consequently, at every level of the price determination process we are interested in a per-unit representation of the use of (composite) factors and intermediates.

### 1.1 Value Added and Composite Intermediate Products

The production function on the first level of the firm's cost minimization problem is a Leontief technology, and does not depend on relative prices.

\[
Q_i = \min \left( \frac{1}{a_{ji}} f_i(K_i, L_i, LA_i), \frac{V_{ji}^k}{a_{ji}^k}, \ldots \right)
\]

(1)

where \( Q_i \) is total output of commodity \( i \) (produced in the home country \( h \) by industry or sector \( i \)), \( f_i \) the value added function, \( V_{ji}^k \) the intermediate use of commodity \( j \) from country \( k \) in the production of commodity \( i \), and \( a_{ji}^k \) the corresponding fixed coefficient, which represents the per-unit demand on this level.

### 1.2 Primary Input Demand for Land and Composite Capital/Labor

Let us first turn to the lower levels of the production tree in Figure 2. After having decided how much overall value added will be employed, firm \( i \) now determines its need of primary factors land, \( LA_i \), and composite capital/labor, \( KL_i \). We employ the following Constant Elasticity of Substitution (CES) function to describe the functional relationship between the two production factors:
\[
f_i(LA_i, KL_i) = \xi_i \left[ \lambda_i \ell_{i}^{\lambda_i} + (1 - \lambda_i) \ell_{i}^{\phi_i} \right]^{\frac{1}{\xi_i}},
\]
where \( \xi_i \) is the scale parameter, \( \lambda_i \) a share parameter and \( \omega_i \) the elasticity of substitution between land and composite capital/labor. To simplify the notation, we have set \( \theta_i = \frac{\omega_i - 1}{\omega_i} \).

The cost function is
\[
Cost_i(LA_i, KL_i) = rmLA_i + rw_iKL_i,
\]
where \( rm \) is the domestic rental rate for land and \( rw_i \) represents a rental rate index of the composite primary input bundle. It is calculated as
\[
rm = \frac{KL_i}{KL_i} - \frac{L_i}{KL_i} - w,
\]
where \( w \) is the domestic wage rate, and \( r \) a rental rate on the world capital market (remember that capital is homogeneous, i.e. there is no difference between capital from different source countries). Note that the composite rental rates may differ from industry to industry within a country depending on the relative capital and labor intensities.

Minimizing the cost function (3) subject to \( f_i = a_i \theta_i \) gives us factor demands for land and composite capital/labor at a given output level \( \bar{Q}_i \):

\[
LA_i = \frac{a_{ii}}{\xi_i} \bar{Q}_i \left\{ \lambda_i + (1 - \lambda_i) \left[ \frac{\lambda_i \ell_{i}^{\omega_i}}{(1 - \lambda_i)rm} \right]^{1-\theta_i} \right\}^{\frac{1}{\theta_i}}
\]

and

\[
KL_i = \frac{a_{ii}}{\xi_i} \bar{Q}_i \left\{ (1 - \lambda_i) + \lambda_i \left[ \frac{(1 - \lambda_i)rm}{\lambda_i \ell_{i}^{\omega_i}} \right]^{1-\theta_i} \right\}^{\frac{1}{\theta_i}}.
\]

The per unit factor requirements we are interested in are derived by dividing (5) and (6) by the given output quantity \( \bar{Q}_i \). This yields

\[
la_i = \frac{LA_i}{\bar{Q}_i}
\]

and

\[
kl_i = \frac{KL_i}{\bar{Q}_i}.
\]

### 1.3 Demand for Capital and Labor

After having decided how much overall capital/labor will be employed, firm \( i \) now determines its demand for primary factors labor, \( L_i \), and capital, \( K_i \). We employ the following CES function for composite capital/labor:

\[
KL_i = \phi \left[ \delta_i K_i^{\phi_i} + (1 - \delta_i) L_i^{\phi_i} \right]^{\frac{1}{\delta_i}},
\]
where \( \phi_i \) is a scale parameter, \( \delta_i \) a share parameter, and \( \sigma_i \) the elasticity of substitution between capital and labor. To simplify the notation, we have set \( \varphi_i = \frac{\sigma_i - 1}{\sigma_i} \).

The cost function is now

\[
\text{CostKL}_i(K_i, L_i) = rK_i + wL_i. \tag{8}
\]

Minimizing (8) subject to (7), and then dividing by the given composite capital/labor demand yields demand coefficients for capital and labor:

\[
k_i = \frac{K_i}{KL_i} = \frac{1}{\varphi_i} \left\{ \delta_i + (1 - \delta_i) \left[ \frac{\partial_i r}{(1 - \delta_i)w} \right]^{-1/\varphi_i} \right\}
\]

and

\[
l_i = \frac{L_i}{KL_i} = \frac{1}{\varphi_i} \left\{ (1 - \delta_i) + \delta_i \left[ \frac{(1 - \delta_i)w}{\delta_i r} \right]^{-1/\varphi_i} \right\}.
\]

In all sectors \( i \in \mathcal{N}_{a1} \land \text{is not used as a production factor}. Therefore we can directly derive the per-unit demands for capital and labor as

\[
k_i = \frac{a_{0i}}{\varphi_i} \left\{ \delta_i + (1 - \delta_i) \left[ \frac{\partial_i r}{(1 - \delta_i)w} \right]^{-1/\varphi_i} \right\}
\]

and

\[
l_i = \frac{a_{0i}}{\varphi_i} \left\{ (1 - \delta_i) + \delta_i \left[ \frac{(1 - \delta_i)w}{\delta_i r} \right]^{-1/\varphi_i} \right\}.
\]

1.4 Calculating Producer Prices

For the calculation of the producer prices we need to introduce the tariff system and the country specific border measures for agricultural trade. We distinguish between a fixed tariff rate \( t_{jk} \) (applied by country \( h \) on commodity \( j \) from country \( k \)) and a variable tariff rate \( t_{jk}^v \) which is only applied by countries \( h \in EU \) for commodities \( j \in \mathcal{N}_a \). There are no tariffs for trade within the EU and for trade in non-agricultural products between EU and EFTA. Whenever an EU country uses a variable tariff, no additional fixed one is applied. For fixed tariffs we therefore have

\[
j_{jk} = \begin{cases} 0 & \text{if } j \notin \mathcal{N}_a \text{ and } h, k \in \mathcal{E}R; \text{ or if } j \in \mathcal{N}_a \text{ and } h, k \in EU; \\ \neq 0 & \text{otherwise.}
\end{cases}
\]

All countries \( h \in \mathcal{N}EU \) employ fixed export subsidy rates \( s_j \) in order to sell their production of commodity \( j \in \mathcal{N}_a \) to other countries \( k \in \mathcal{W} \setminus h \). We assume in countries \( h \in EU \) specific threshold prices \( (qm_j) \) for imports of commodity \( j \in \mathcal{N}_a \) from countries \( k \in \mathcal{N}EU \).
Similarly, we fix the export prices of EU exports of agricultural goods to non-EU countries \((q_{ij})\).

We are now able to compute producer prices for all \(J \times R\) commodities. This is possible because in our model the zero-profit condition holds, enabling us to write every producer price as a function of factor prices and all (including its own) producer prices. Applying the destination principle with the tax-credit method for calculation of VAT liabilities yields the following zero-profit condition for industry \(i\) in country \(h \in EU^2\)

\[
q_i \overline{Q} = \sum_{j \in N_a} \sum_{k \in dW} q_{ij}^k (1 + t_j^k) Y_{jj}^k + \sum_{j \in N_a} \sum_{k \in EU} \sum_{k \in NEU} \frac{qm_j Y_{jj}^k}{k} + B_i + \frac{\tau_{qi}}{1 + \tau_{qi}} q_i \overline{Q},
\]

with

\[
B_i = \begin{cases} wL_i + rK_i + rmLA_i & \text{if } i \in N_{a1}; \\
 wL_i + rK_i & \text{if } i \not\in N_{a1}. \end{cases}
\]

Dividing (9) by the output quantity \(\overline{Q}\), gives us the cost-covering producer price

\[
q_i = \left( \sum_{j \in N_a} \sum_{k \in dW} a_{ij}^k q_{ij}^k (1 + t_j^k) + \sum_{j \in N_a} \sum_{k \in EU} \sum_{k \in NEU} a_{ij}^k q_{ij}^k \frac{qm_j}{k} \right) + a_0 b_i \left(1 + \tau_{qi}\right).
\]

Again, we have set

\[
b_i = \begin{cases} kl_i (wL_i + rk_i) + rmL_i & \text{if } i \in N_{a1}; \\
 wL_i + rk_i & \text{if } i \not\in N_{a1}. \end{cases}
\]

Rearranging this equation and summing the already known variables on the right hand side we get

\[
(1 - \frac{\tau_{qi}}{1 + \tau_{qi}})q_i - \sum_{j \in N_a} \sum_{k \in dW} a_{ij}^k q_{ij}^k (1 + t_j^k) - \sum_{j \in N_a} \sum_{k \in EU} \sum_{k \in NEU} a_{ij}^k q_{ij}^k \frac{qm_j}{k} = a_0 b_i + \sum_{j \in N_a} \sum_{k \in NEU} a_{ij}^k \overline{q}_{ij}^k.
\]

Similarly, for industry \(i\) of country \(h \in NEU\) we get\(^3\)

\[
(1 - \frac{\tau_{qi}}{1 + \tau_{qi}})q_i - \sum_{j \in N_a} \sum_{k \in dW} a_{ij}^k q_{ij}^k (1 + t_j^k) - \sum_{j \in N_a} \sum_{k \in NEU} \sum_{k \in NEU} a_{ij}^k q_{ij}^k (1 - s^k) (1 + t_j^k) =
\]

\[
a_0 b_i + \sum_{j \in N_a} \sum_{k \in NEU} a_{ij}^k q_{ij}^k (1 + t_j^k)
\]

Here the export subsidy rates of non-EU countries are introduced. Writing these \(J \times R\) equations in matrix notation we have

\[
(E - A^T)P = B,
\]

\(^2\) Note that we have to distinguish between producer prices and manufacturing prices, where the first exceed the latter by the production taxes net of subsidies paid per tax assessment unit. The tax base of production taxes is the output valued at manufacturing prices. In order to avoid a separate symbol we compute tax liability as a percentage of output, valued at producer prices.

\(^3\) It is obvious that whenever \(k = h\) then \(t_j^k = s_j^k = 0\).
where \( P \) and \( B \) are the column vectors of the producer prices and the (per unit) primary input costs plus the already known import costs of agricultural goods. \( E \) is the identity matrix and \( A^T \) is the transposed matrix of the input coefficients including tariff and subsidy rates as well as production tax rates. Producer prices are therefore given by

\[
P = (E - A^T)^{-1} B.
\]

Next we turn to the import quotas of the EU countries for agricultural imports from non-EU countries. They are modelled as ad-valorem tariff rate equivalents but, unlike the tariff revenue, the quota rents accrue to the national governments. We define \( t_q \) as the ad-valorem quota rate for the non-EU imports of the agricultural product \( i \). In our model import quotas are only used in the \( a2 \) subsector, i.e.

\[
t_q \begin{cases} 
0 & \text{if } i \in N_{a1}; \\
\ne 0 & \text{if } i \in N_{a2}.
\end{cases}
\]

Now we are able to calculate the variable import levies and export subsidies which EU countries apply to their agricultural commodities. Taking into account the subsidy rates of non-EU countries, these rates are computed from the difference between the exogeneous threshold prices and the market prices, i.e.

\[
\nu_j^k = \frac{qm_j}{q_j^s(1-s_j^s)} - t_q - 1;
\]

\[
s_j = 1 - \frac{qe_j}{q_j}.
\]

2. The Household Sector

We assume only one representative household in each country. In CGE studies it has become standard to model the decision-making process of the household sector as a multistage utility maximization problem regarding various aggregates of consumption. The underlying idea is that a representative agent makes his choices step by step. Therefore, decisions on a higher level determine the budget set for choices on the next, lower, level. In our model, we distinguish three such utility nests regarding the choice between different consumption goods, imported and domestic commodities and, finally, imported consumption goods from different source countries. Note that collective consumption goods are provided free of charge and enter the utility function in an additively separable manner (and consequently can be omitted).

Figure 3 shows the structure of the decision-making process of the representative household as a utility tree. The different utility nests will be described in the following sections.

2.1 Calculating the Price Indices

As a first step, we have to compute all consumer prices and consumer price indices. The latter is necessary because the calculation of demand quantities starts at the first level of the utility tree, and requires price indices that are are derived on lower levels. For given producer prices and utility function parameters we work our way up from third level to first level price indices. Because we attempt to keep our representation as close as possible to the
actual computation procedure, we present the calculation of price indices in this first section, and not - as rigorous economic modelling would probably require - as constraints of the maximization problems at every stage of the decision making process.

Figure 3: Nested Utility Functions

Third level

Aggregation of direct consumption of commodity $i \in N$, imported from country $k \in W \setminus h$, to a composite imported commodity ($C_i^{kh}$)

Second level

Aggregation of comparable imported and domestic consumption goods to a composite consumption commodity ($C_i''$).

First level

CES utility function over different consumption categories

In the following, $p_i^h$ (with index $h$ omitted whenever possible) denotes the consumer price for commodity $i$ produced and consumed in country $h$. It is related to the respective producer price by

$$p_i^h = (1 + \tau_i^h)q_i^h$$

where $\tau_i^h$ is the VAT rate applied to commodity $i$. We define $p_i^{kh}$ to be the consumer price of the $i$-th commodity which is produced in country $k$ but consumed in country $h$. Since the destination principle of international commodity taxation is applied, all demand categories are taxed at the same rate, no matter whether they come from abroad or from domestic production. Keeping in mind the tariff and subsidy system explained above, we now have
Because the utility function on the lowest level is a CES function, we can calculate the price index at this level \((p_i^M)\) from the consumer prices for commodities \(i\) from country \(k\) as follows\(^4\)

\[
p_i^M = \left[ \sum_{k \in h} \beta_i^k (p_i^h)^{1-\nu^h} \right]^{\frac{1}{1-\nu^h}} \quad \text{with} \quad \sum_{k \in h} \beta_i^k = 1.
\]

At the next level we use a CES function again. The price index at this level is calculated by using \(p_i^M\) and the consumer price of domestically produced goods \(p_i^d\):

\[
p_i^H = \left[ \beta_i^H (p_i^d)^{-\nu^H} + (1 - \beta_i^H) (p_i^M)^{-\nu^H} \right]^{\frac{1}{1-\nu^H}}.
\]

### 2.2 Demand for Different Consumption Commodities

On the first level the representative consumer decides on the demand for different consumption categories \(C_i^H\), for example cars or food. His preferences are represented by the following CES utility function

\[
(C_1^H, \ldots, C_j^H) = \left[ \sum_{j \in h} \frac{1}{\nu^H} (C_i^H)^{\mu^H} \right]^{\frac{1}{\mu^H}},
\]

where \(\beta_i\) is the share parameter, and \(\nu^H\) represents the elasticity of substitution between demand categories. We have set \(\mu^H = \frac{\nu^H}{\nu^H - 1}\) for notational simplification. At this stage the consumer's budget is constrained by the disposable market income \(Y\) which is not allocated to savings. The disposable market income is the aggregate of the factor payments of the firms and government transfers minus income tax payments.

\[
Y = rK + wL + rmLA - T_r + Tr,
\]

where \(K, L, LA\) are (fixed) capital, labor and land endowment of the household in country \(h\), \(T_r\) income tax payments and \(Tr\) transfer payments received. Applying the residence principle to international capital transactions, income tax payments are determined by

\(^4\) Price indices are derived by rearranging the indirect utility function to fulfill the budget constraint. For details see Keller (1976).
\[ T_r = \tau_y \left[ r \bar{K} + w \bar{L} + rm\bar{L}A - All \right], \]  
where \( All \) is an income tax allowance for the representative domestic consumer.

After substituting \( T_r \) in (14) and performing some rearrangements we obtain
\[ Y = (1 - \tau_y) \left[ r \bar{K} + w \bar{L} + rm\bar{L}A \right] + \tau_y All + Tr. \]

Assuming a fixed saving rate \( \gamma \) the final budget constraint therefore is
\[ \sum_{i \in n} p_i^H C_i^H = (1 - \gamma)Y. \]  

Maximizing (13) subject to (16) yields the demand for different commodity categories \( C_i^H \):
\[ C_i^H = \frac{\beta_i (1 - \gamma)Y}{(p_i^H)^{\gamma}, \Omega_e} \]

with
\[ \Omega_e = \sum_{i \in n} \beta_i (p_i^H)^{1 - \gamma}. \]

Again, \( p_i^H \) represents a price index which is derived as described in equation (12) above.

2.3 Demand for Domestic and Imported Commodities

On the second level, the representative agent decides whether to buy a commodity at home or abroad, for example, whether to purchase an imported or a domestic car. According to the Armington assumption, commodities are distinguished by their place of origin and are consequently treated as different, though closely substitutable, commodities. This enables us to model the choice of comparable commodities from domestic or foreign origin as a CES utility function for home products \( C_i \) and composite imports \( C_i^M \):

\[ C_i^H(C_i^M, C_i) = \left[ \frac{1}{\nu_i} (C_i^M)^{\mu_i} + (1 - \beta_i^H)^{\nu_i} (C_i^M)^{\mu_i} \right]^{-\frac{1}{\mu_i}}, \]  

with the share parameter \( \beta_i^H \) and the elasticity of substitution \( \nu_i \) between domestic and composite imported commodity. Again we set \( \mu_i = \frac{\nu_i - 1}{\nu_i} \).

Given the choices made at the previous stages of the decision making process, the representative agent is now confined by the disposable income which has not yet been "planned" for other commodity categories. Hence, his budget constraint is
\[ Y_i = (1 - \gamma)Y - \sum_{j \in n \setminus i} p_j^H C_j = p_i C_i + p_i^M C_i^M. \]  

Maximization of the utility function (17) subject to the budget constraint (18) yields the demand for the composite imported commodity.
\[ C_i^M = \frac{(1 - \beta_i^H)Y_i}{(p_i^M)^\alpha_i} \]

and the demand for the comparable good of domestic origin

\[ C_i = \frac{\beta_i^H Y_i}{(p_i)^\alpha_i} \]

with

\[ \Omega_i = \beta_i^H (p_i)^{1-v_i} + (1 - \beta_i^H)(p_i^M)^{1-v_i}. \]

### 2.4 Demand for Different Imported Commodities

At the last level, the representative consumer decides where to buy his direct consumption imports; for example, a German final consumer decides whether to buy an imported car from Italy or from France. Again using CES utility functions, we have:

\[ C_i^M(C_i^k, \ldots, C_i^R) = \left[ \sum (\beta_i^k)^{\frac{1}{\nu_i^M}} (C_i^k)^{\nu_i^M} \right]^{\frac{1}{\nu_i^M}}, \]

where \( C_i^k \) is the final demand for commodity \( i \) from country \( k \), \( \beta_i^k \) the corresponding share parameter, \( \nu_i^M \) is the elasticity of substitution between commodity categories \( i \) from different source countries, and \( R \) the number of countries in the model. We have set \( \mu_i^M = \frac{\nu_i^{M-1}}{\nu_i^M} \).

The household faces as a budget constraint that part of disposable income disposable income that has not been allocated to other demand categories or to domestic commodities \( C_i \) comparable to commodity \( C_i^k \) with \( k \in W \setminus h \):

\[ Y_i^M = Y_i - p_i C_i = \sum_{k \in W \setminus h} p_i^k C_i^k. \]  

Maximizing (19) subject to (20) gives us the following CES-demand functions for imported commodities \( i \):

\[ C_i^k = \frac{\beta_i^k Y_i^M}{(p_i^k)^{\nu_i^M} \Omega_i^M} \]

with

\[ \Omega_i^M = \sum_{k \in W \setminus h} \beta_i^k (p_i^k)^{1-v_i^M}. \]

### 2.5 Investment Demand

Investment expenditures are included in order to distinguish the consumption type VAT (which is used here) from the income type VAT. In a static model it is almost impossible to include investment demand satisfactorily. Therefore some kind of "corporate" consumer is assumed, who allocates a fixed share of the savings of the household sector to the different investment demand categories.

---

5 For more details see Ballard et al. (1985).
Total savings of the private consumer

\[ S = \gamma Y \]

are therefore translated into investment demand \( I_i^k \) for the \( i \)th industry of country \( k \) by

\[ I_i^k = \frac{\kappa_i^k}{p_i^k / (1 + \tau_i)} S. \]  

(21)

Although there is no VAT to be paid for investment goods, all tariffs have to be paid. In order to avoid a separate symbol for the prices of investment goods we have divided the consumer prices by the VAT component.

3. The Public Sector

In this subsection revenues associated with the different instruments of the agricultural policies as well as the EU budget is computed. We start with the different revenue and expenditure categories which are common to all countries and then explain the institutional modelling of the EU budget.

3.1 Tax and Tariff Revenue

In our model the national governments levy various taxes and tariffs in order to finance their expenditures. First, let us first turn to the tariff system.

The tariff rates of the EU CET system are applied to all (intermediate and direct) imports of industrial goods and services from non-European countries. Consequently, tariff revenue for EU member countries \( h \in EU \) is

\[ TAR = \sum_{j \in N} TAR_j^Q + TAR_j^H = \sum_{i \in N, k \in NEU} t_i^k q_i^k M_i^k \]

with \( M_i^k \) as country \( h \)'s total imports of commodity \( i \) from country \( k \), i.e.

\[ M_i^k = \sum_{j \in N} V_{ij}^k + C_i^k + I_i^k. \]

EU imports of agricultural goods from non-EU countries are subject to import quotas and variable import levies. The levy revenue and the quota rents are computed by

\[ TARV = \sum_{j \in N} TARV_j^Q + TARV_j^H = \sum_{i \in N, k \in NEU} t_i^k (1 - s_i^k) q_i^k M_i^k \]

and

\[ RENT = \sum_{j \in N} RENT_j^Q + RENT_j^H = \sum_{i \in N, k \in NEU} t_{iQ}^k (1 - s_i^k) q_i^k M_i^k. \]

Tariff revenue for countries \( h \in NEU \) is

\[ TAR = \sum_{i \in N, k \in NEU} t_i^k q_i^k M_i^k + \sum_{i \in N} \left[ \sum_{k \in NEU} \left( t_i^k (1 - s_i^k) q_i^k M_i^k + \sum_{k \in NEU \setminus h} t_i^k (1 - s_i^k) q_i^k M_i^k \right) \right]. \]
The value-added tax (VAT) is administered according to the credit (invoice) method within the destination principle. This implies that a good is taxed where it is consumed. Exports leave the country free of tax (in effect they are zero-rated), the VAT on exported goods is refunded, and VAT is collected on all imported goods. Since tariff payments have to be included into the tax base, VAT revenue $T_c$ is calculated for countries $h \in EU$ as follows:

$$T_c = \sum_{k \in EU} \sum_{i \in N} \tau_i q_i^k C_i^k + \sum_{k \in NEU} \left[ \sum_{i \in N} \tau_i (1 + t_{qi}) (1 - s_i^k) q_i^k C_i^k + \sum_{i \in N} \tau_i (1 + t_{qi}) q_i^k C_i^k \right].$$

For countries $h \in NEU$ we get

$$T_c = \sum_{i \in N} \tau_i q_i C_i + \sum_{i \in N} \tau_i (1 + t_i^k) q_i^k C_i^k + \sum_{k \in NEU} \left[ \sum_{i \in N} \tau_i (1 + t_i^k) (1 - s_i^k) q_i^k C_i^k + \sum_{k \in NEU} \tau_i (1 + t_i^k) (1 - s_i^k) q_i^k C_i^k \right].$$

Note that there is a zero rating for the public good in every country, i.e. this sector is permitted to claim a credit for taxes paid on purchases of intermediate goods.

Income taxes $T_I$ are another major source of revenue. We assume a constant marginal tax rate and an allowance which diminishes the tax base. In accordance with common practice we apply the residence principle. The linear income tax function already given above is

$$T_I = \tau \left[ rK + wL + rmaA - All \right].$$

Furthermore, the government levies production taxes $T_Q$ which, in our model, also include certain excises such as the gasoline tax. The tax base is the (gross) value of domestic production of commodity $i$:

$$T_Q = \sum_{i \in N} T_{Q_i} = \sum_{i \in N} \frac{\tau_{qi}}{1 + \tau_{qi}} q_i Q_i.$$

Note that especially in the agricultural sectors production taxes may also be negative. In such cases they can be interpreted as subsidies and represent a public expenditure.

### 3.2 Public Expenditure

There are two general expenditure categories in the government sector and two expenditure categories which are instruments of the agricultural policy.

In all countries lump-sum transfers $Tr$ are paid to the representative consumer. The second general expenditure category are outlays on the provision of a collective commodity (or non-market services), that - as already mentioned above - is offered free of charge to the domestic household sector (public services such as police and health care) and sold at producer prices to domestic firms. The public commodity is not traded and is produced in the same way as any other good, combining primary factors and intermediates, bought at market prices. Furthermore we assume that the total supply of the public good is fixed. Net public expenditure for the collective commodity in country $h$ is $q^h G^h$.

The expenditure items of the agricultural policy are the export subsidies on the one hand and payments for stockpiling purchases on the other hand. The export subsidies of a country $h \in EU$ are computed by
\[ SUBV = \sum_{i \in N, k \in NEU} s_i q_i X_i^k, \]

while the export subsidies of a country \( h \in NEU \) are
\[ SUB = \sum_{i \in N, k \in h} s_i q_i X_i^k. \]

Here \( X_i^k \) denotes country \( h \)'s total exports of commodity \( i \) to country \( k \)
\[ X_i^k = \sum_{j \in N} v_{ij}^k + C_i^k + I_i^k. \]

All the subsidy payments are received by firms and households in other countries, i.e.
\[ \sum_{k \in EU} SUBV^k + \sum_{h \in NEU} SUB^h = \sum_{k \in NEU} \left[ \sum_{i \in N} SUBQ_i^k + SUBH_i^k \right]. \]

In all countries there exists a semigovernmental agency which buys agricultural goods of sector \( a1 \) in order to stabilize the markets. These market interventions of the Stabilization Agencies (\( q_iSA_i \)) are modelled as an additional final demand category. The purchased stocks are assumed to be simply destroyed.

### 3.3 The EU Budget

All EU countries pay funds to the supranational EU budget and receive payments from it. As already explained in section II our model includes expenditures for export subsidies, stockpiling interventions, and fixed transfers to the national governments (\( TREU \)). These payments are financed by the contributions of the national EU governments which consist of their tariff and variable levy revenue, a production levy for sugar and milk production (\( TEU_q \)) and a fixed part of their VAT basis (\( TEU_C \)), which is used to balance the budget. For simplicity we assume that the production levy is a fixed share of the total production tax in sector \( a2 \), i.e.
\[ TEU_q = \psi \sum_{i \in N_{a2}} T_q. \]

The transfers to the EU level are therefore computed in a two-stage process: first, the overall deficit without the VAT contributions is derived as well as the total EU VAT basis; then the coefficient of the VAT basis which is necessary to finance the deficit and the VAT contributions of the individual member countries is calculated.
\[ DE = \sum_{k \in EU} \left[ TAR_k + TAR V_k + TEU_q^k - TREU_k - SUBV_k - \sum_{i \in N_{a1}} q_i^k SA_i \right] \]
\[ VATB_{EU} = \sum_{h \in EU} VATB_h = \sum_{h \in EU} \left[ \sum_{k \in NEU} \sum_{i \in N} q_i^k C_i^k + \sum_{i \in N_{a1}} q_i^h SA_i^h \right]. \]

Note that services are not included in the calculation of the VAT basis. Since a large part of the service sector is tax exempted this assumption seems justified. On the other hand the intervention purchases of commodity \( i \) by the EAGGF in the national markets are added to the national VAT basis.

The next step is to calculate the overall VAT share \( \mu \) and the individual contributions of each EU member country:
\[ \mu = \frac{DE}{VATB^{EU}} \]

and

\[ TEU_c = \mu VATB. \]

### 4. The Foreign Sector

#### 4.1. Balance of Payments

Our model includes several transborder activities: international trade in goods and services, international capital income flows and international transfer payments between national governments and the subnational EU authority. All these transactions are captured in the balance of payments (BP), which may be decomposed - in our context - into three parts. Note that in our static context the balance of payment is reduced to the current account.

First, the trade balance (TB) captures all international transactions in (physical) goods. In our model the trade balance of country \( h \in EU \) is

\[
TB = \sum_{i \in N_h, k \in EU} \left[ q_i X_i^h - q_i^k M_i^h \right] + \sum_{i \in N_h, k \in EU} \left( q_i X_i^h - q_i^k M_i^h \right) + \sum_{k \in EU} \left( q_i (1 - s_V) X_i^h - q_i^k (1 - s_i^k) M_i^h \right).
\]

For countries \( h \in NEU \) we have similarly

\[
TB = \sum_{i \in N_h, k \in EU} \left[ q_i X_i^h - q_i^k M_i^h \right] + \sum_{i \in N_h, k \in EU} q_i (1 - s_i) X_i^h - \sum_{k \in EU} q_i (1 - s_V) M_i^h + \sum_{k \in EU} \sum_{i \in N} q_i^k (1 - s_i^k) M_i^k.
\]

Note that since the destination principle applies, all international transactions leave the country tax-free and therefore have to be valued at producer prices adjusted by export subsidies.

The second relevant sub-account in our model is the service account. This account not only captures international transaction in services, but also flows of capital income between countries. We can then write the service balance (SB) for country \( h \) as

\[
SB = \sum_{k \in EU, i \in N} \left[ q_i X_i^h - q_i^k M_i^h \right] + r(\bar{K} - \sum_{i \in N} K_i).
\]

The flow of funds between the supranational EU government and the national governments enter the balance of payments in the transfer balance (TRB)

\[
TRB = TREU + SUBV + \sum_{i \in N_{V_{at}}} q_i S_{at} - TAR - TARV - TEU_Q - TEU_C.
\]
For every country the sum of these three accounts has to equal zero:

\[ BP = TB + SB + TRB = 0. \]

The current account is balanced unilaterally. Bilateral accounts, however, do not have to be balanced.

### 4.2 Terms of Trade

The terms of trade (ToT) are an important interpretational device when attempting to explain our simulation results. Our aim is to measure the change in the trade position of a country vis-à-vis its trading partners, thus isolating "domestic" and "external" effects on national welfare. The basic measure we use is the net-barter ToT. This is the most common ToT-definition in the empirical literature and is often used in simulation studies as that by Whalley (1985).\(^1\)

The net-barter ToT are generally defined as

\[ ToT^N = \frac{P_x - P_m}{P_m} \cdot 100, \]

where \(P_x\) and \(P_m\) represent price index numbers for exports and imports. Using a Laspeyres price index with the base year's export and import quantities as weights, the indices for country \(h\) are\(^2\):

\[ P_m = \frac{\sum_{k \in i \in h} (q_i^h)_0 (M_{i,h}^h)_0}{\sum_{k \in i \in h} (q_i^h)_0 (M_{i,h}^h)_0} \]

and

\[ P_x = \frac{\sum_{k \in i \in h} (q_i^h)_0 (X_{i,h})_0}{\sum_{k \in i \in h} (q_i^h)_0 (X_{i,h})_0}. \]

For the agricultural goods \(i \in N\) the producer prices have to be adjusted by the export subsidies. The additional index 0 indicates quantities and prices in the benchmark equilibrium and index 1 stands for the counterfactual equilibrium. In the former, all prices \((q^i)_0\) are all equal to unity to one and we can simply add up quantities. This is due to the special normalization assumptions for the benchmark data set, which will be described in the next section.

### 5. Equilibrium Conditions of the Model

As a final step, we have to specify equilibrium conditions in markets for commodities\(^3\) and factors:

**Commodity market \(i\):**

\[ Q_i = \sum_{k \in F} \left( \sum_{j \in N} a_{y}^k Q_j^k + C_i^k + I_i^k \right) + SA_i. \]
Factor markets:

\[ \sum_{k \in K} K_i^k = \sum_{k \in K} \sum_{i \in N} K_i^k \] (24)

\[ \bar{L}A = \sum_{i \in N_{a1}} LA_i \] (25)

\[ \bar{L} = \sum_{i \in N} L_i \] (26)

Additionally the government budgets have to be balanced:

For countries \( h \in EU \)

\[ q_s G + Tr = (T_c - TEU) + (T_Q - EU Q) + RENT + T_r + TREU. \] (27)

For countries \( h \in NEU \)

\[ q_s G + Tr + \sum_{i \in N_{a1}} q_i SA_i + SUB = T_c + T_Q + T_r + TAR. \] (28)

According to Walras' Law, the current account is automatically balanced if all agents fulfill their budget constraints.

The special structure of our model, however, enables us to reduce the dimensionality of the problem drastically. Since we assume constant returns to scale and, consequently, zero profits, commodity prices are a function of factor prices. Hence, any vector of factor prices that clears the markets for capital, labor and land automatically ensures that commodity markets are cleared as well. So the problem of finding an equilibrium for the economy can be confined to finding a set of factor prices and government parameters (tax rates or transfer payment levels) that balance factor markets and the government budget in each country.

The factor demands in each country are derived as follows. Rearranging (23) and writing in matrix notation we have

\[ Q = (E - A)^{-1} [C + I + G], \]

where \( Q \) is a column vector of the output quantities \( Q_i^h(i \in N; h \in W) \), \( E \) is the identity matrix and \( A \) is the matrix of the input coefficients, \( C \) is a column vector with elements \( \sum_{k \in K} C_i^h \), \( I \) is a column vector with elements \( \sum_{i \in N} I_i^h \), and \( G \) is a column vector with the provision of the collective commodity and the final demand of government agencies for agricultural goods as elements. The factor demand quantities in each industry (of every country) are then calculated as follows:

\[ L_i = \begin{cases} l_i k_i Q_i , & \text{if } i \in N_{a1}; \\ l_i Q_i , & \text{if } i \not\in N_{a1} \end{cases} \]

and

\[ K_i = \begin{cases} k_i k_i Q_i , & \text{if } i \in N_{a1}; \\ k_i Q_i , & \text{if } i \not\in N_{a1} \end{cases} \]
and

\[ LA_i = l a_i Q_i \quad \text{if } i \in N_{al}. \]

Unit factor demands and output supplies depend only on factor prices. Inserting factor demands \( L_i, K_i \) and \( LA_i \) into the equilibrium conditions (24) - (26), we can solve for the equilibrium factor prices. Because only relative prices matter, we can normalize the price system by choosing one numeraire commodity.

Figure 4 presents a flow chart of the entire model, summarizing the derivation of market clearing conditions for any set of factor prices and government parameters, as described in detail above. The final system of non-linear equations was solved by using a "state of the art" algorithm available in any FORTRAN library.

**Figure 4: Flow Chart for the Model**

1. Input of factor prices and government parameters
   - Computation of producer prices (Section 1)
   - Computation of consumer decisions (Section 2)
   - Computation of output and factor demand quantities
   - Computation of government balances (Section 3)
2. Excess Demand = Zero?
   - Yes
     - Consistency Check: Walras law fulfilled?
       - Computation of foreign balances (Section 4)
       - STOP
IV. The Construction of a Microconsistent Data Set

This section develops step by step our multi-country data set. The first section uses an artificial three-country data set in order to illustrate the structure and the consistency requirements of our multi-country data set. Then the raw data and some key figures of our data set are presented. The final section explains our manipulations of the raw data.

1. The Structure of a Multicountry Microconsistent Data Set

Just like the model itself, the benchmark data set has to meet certain requirements of consistency. These shall be briefly outlined and illustrated using a simple numerical example.

1. Intermediate plus final demands of each of the \( J \times R \) commodities must equal their supply, i.e. the economies are at an equilibrium with no excess demand or supply for goods and services. Hence, for every commodity \( i \) the following identity must hold:

\[
Q_i = \sum_{k \in W} \left( \sum_{j \in N} x_{ij} + C_i^k + I_i^k \right) + S A_i . 
\]  

2. No industry exhibits profits. Net surpluses are captured as returns to factors capital and labor employed by the household sector and appear in the primary input table:

\[
q_i Q_i = B_i + \sum_{j \in N, k \in W} q_{ij} V_{ij} + T_Q + TAR^Q + TARV^Q + RENT^Q - SUBQ_i 
\]  

for countries \( h \in EU \) and

\[
q_i Q_i = B_i + \sum_{j \in N, k \in W} q_{ij} V_{ij} + T_Q + TAR^Q - SUBQ_i 
\]  

for countries \( h \in NEU \).

3. All economic agents satisfy their budget constraints. For the representative consumer in each of our \( R \) countries this implies for countries \( h \in EU \)

\[
B + Tr - T_r = \sum_{k \in W \in N} \left( q_{ij}(C_i^k + I_i^k) + T_c + TAR^H + TARV^H + RENT^H - SUB^H \right) \]

and

\[
B + Tr - T_r = \sum_{k \in W \in N} \left( q_{ij}(C_i^k + I_i^k) + T_c + TAR^H - SUB^H \right) \]

for countries \( h \in NEU \). We have set \( B = wL + mLA \) in the last equations. Furthermore, the supranational \( EU \) budget and the national government's budget have to be balanced, so

\[
\sum_{k \in EU} \left[ TAR^k + TARV^k + TEU_Q^k + TEU_C^k \right] = \sum_{k \in EU} \left[ SUBV^k + \sum_{i \in N_{ei}} q_i S A_i^k + TREU^k \right] \]

and

\[
T_c - TEU_C + T_r + T_Q - TEU_Q + RENT + TREU = Tr + q_s G 
\]  

for countries \( h \in EU \) and

\[
T_c + T_r + T_Q + TAR^Q + TAR^H = Tr + q_s G + \sum_{i \in N_{ei}} q_i S A_i + SUB 
\]  

for countries \( h \in NEU \) must hold.
4. The foreign sector must be unilaterally balanced for every country \( h \), i.e. the value of all incoming transactions has to equal the value of all outgoing transactions\(^1\):

\[
BP = TB + SB + TRB = 0.
\]

Our data set is constructed for the year 1987 to fulfill all these necessary conditions. The basic structure of our data set can be best understood by considering an extremely simplified world economy with only three countries (\( A, B \in EU, C = NEU \)) and nine commodities. Each country produces three goods, an agricultural, an industrial and a public good. The production process involves all domestic and traded foreign commodities as intermediates, as well as primary factors labor, capital and land. All primary factors are provided by the household sector. Land is only used in the production of the agricultural good, labor is only used for domestic production and capital may also come from abroad. On the final demand side there is household expenditure on all traded commodities (consumption and investment) and public expenditure for the public good. The government in every country levies various taxes and tariffs and provides the public good and transfer payments to the household sector. Countries A and B have to pay part of their revenue to a supranational authority, which buys part of the agricultural output and pays export subsidies for exports of the agricultural good to country C.

All these pieces of information are captured in our artificial data set. Table 1 shows the three national input-output (I/O) tables of country A, B and C. Given the tax and tariff parameters of Table 2 we construct from these tables our interregional I/O table (Table 3) and the EU budget (Table 4). Three parts of the interregional/intersectoral I/O table can be isolated: the intermediate transaction table, the final demand table and the primary input table. The income/outlay accounts of Table 5 clearly show that all agents fulfill their budget constraints. The reader may verify the above described consistency conditions by applying formulas (I) to (IV) to the simplified data set in Tables 3, 4 and 5.

Table 1: Example of three National I/O Tables Involving Three Commodities per Country

<table>
<thead>
<tr>
<th>Intermediate Transaction</th>
<th>Final Demand</th>
<th>Exports</th>
<th>Σ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cons.</td>
<td>Inves.</td>
<td>Gover.</td>
</tr>
<tr>
<td>( V_{ij} )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 4 2</td>
<td>13</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>3 0 1</td>
<td>8</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>1 2 3</td>
<td>-</td>
<td>-</td>
<td>21</td>
</tr>
<tr>
<td>( V_{ij}^{BA} )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 1 1</td>
<td>2</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>1 1 0</td>
<td>5</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>0 0 0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>( V_{ij}^{CA} )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 1 1</td>
<td>3</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>2 2 1</td>
<td>4</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>0 0 0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>( rK )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 12 7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( wL )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 10 10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( rmLA )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 0 0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( T_{0Q} )</td>
<td>.4</td>
<td>.6</td>
<td>.7</td>
</tr>
<tr>
<td>( TAR_{0Q} )</td>
<td>.2</td>
<td>.2</td>
<td>.1</td>
</tr>
<tr>
<td>( TARV_{0Q} )</td>
<td>.2</td>
<td>.2</td>
<td>.2</td>
</tr>
<tr>
<td>( qQ )</td>
<td>33</td>
<td>34</td>
<td>27</td>
</tr>
</tbody>
</table>

\(^1\) One can show that this condition is automatically fulfilled if the first three consistency requirements hold.
... for country B

<table>
<thead>
<tr>
<th>Intermediate Transaction</th>
<th>Final Demand</th>
<th>Exports</th>
<th>Σ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cons.</td>
<td>Inves.</td>
<td>Gover.</td>
</tr>
<tr>
<td>V_{ij}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td>V_{ij}^{AB}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>V_{ij}^{CB}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>rK</td>
<td>10</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>wL</td>
<td>10</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>rmLA</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>T_{0}</td>
<td>.4</td>
<td>.8</td>
<td>.7</td>
</tr>
<tr>
<td>TAR_{Q}</td>
<td>.0</td>
<td>.1</td>
<td>.4</td>
</tr>
<tr>
<td>TAR_{V}Q</td>
<td>.2</td>
<td>.2</td>
<td>.2</td>
</tr>
<tr>
<td>qQ</td>
<td>38</td>
<td>35</td>
<td>24</td>
</tr>
</tbody>
</table>

... for country C

<table>
<thead>
<tr>
<th>Intermediate Transaction</th>
<th>Final Demand</th>
<th>Exports</th>
<th>Σ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cons.</td>
<td>Inves.</td>
<td>Gover.</td>
</tr>
<tr>
<td>V_{ij}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>2</td>
<td>13</td>
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<tr>
<td>1</td>
<td>3</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>3</td>
<td>23</td>
</tr>
<tr>
<td>V_{ij}^{AC}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>2</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>V_{ij}^{BC}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>rK</td>
<td>7</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>wL</td>
<td>7</td>
<td>18</td>
<td>10</td>
</tr>
<tr>
<td>rmLA</td>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>T_{0}</td>
<td>.1</td>
<td>.9</td>
<td>.5</td>
</tr>
<tr>
<td>TAR_{Q}</td>
<td>.4</td>
<td>.6</td>
<td>.5</td>
</tr>
<tr>
<td>SUB_{Q}</td>
<td>-1.5</td>
<td>-1.5</td>
<td>-1.0</td>
</tr>
<tr>
<td>qQ</td>
<td>32</td>
<td>44</td>
<td>29</td>
</tr>
</tbody>
</table>

Table 2: Tax and Tariff Parameters

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tariff rates</td>
<td>$t_{1}^{A}$ = 0.2</td>
<td>$t_{1}^{B}$ = 0.2</td>
<td>$t_{1}^{C}$ = 0.2</td>
</tr>
<tr>
<td>Subsidy rates</td>
<td>$s_{1}^{A}$ = 0.5</td>
<td>$s_{1}^{B}$ = 0.5</td>
<td>$s_{1}^{C}$ = 0.5</td>
</tr>
<tr>
<td>Quota rates</td>
<td>$q_{1}^{A}$ = 0.0</td>
<td>$q_{1}^{B}$ = 0.0</td>
<td>$q_{1}^{C}$ = 0.0</td>
</tr>
<tr>
<td>VAT rates</td>
<td>$\tau_{1}^{A}$ = 0.15</td>
<td>$\tau_{1}^{B}$ = 0.2</td>
<td>$\tau_{1}^{C}$ = 0.1</td>
</tr>
</tbody>
</table>
Table 3: Construction of the Interregional 3-Country Data Base

<table>
<thead>
<tr>
<th>Production Side</th>
<th>Intermediate Transactions</th>
<th>Consumption Side</th>
<th>Final Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>C</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Σ</td>
<td>10</td>
<td>9</td>
<td>12</td>
</tr>
</tbody>
</table>

Primary Inputs

<table>
<thead>
<tr>
<th>rK</th>
<th>wL</th>
<th>rmLA</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>Σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>12</td>
<td>7</td>
<td>10</td>
<td>15</td>
<td>6</td>
<td>14</td>
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<td>10</td>
<td>10</td>
<td>10</td>
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<td>10</td>
<td>8</td>
<td>18</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 4: EU Budget

<table>
<thead>
<tr>
<th>TAR</th>
<th>TARV</th>
<th>VAT</th>
<th>SA</th>
<th>SUBV</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.1</td>
<td>1.2</td>
<td>3.7</td>
<td>2.0</td>
</tr>
<tr>
<td>B</td>
<td>0.6</td>
<td>1.4</td>
<td>4.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Σ</td>
<td>1.7</td>
<td>2.6</td>
<td>7.7</td>
<td>12.0</td>
</tr>
</tbody>
</table>

\[ VAT_{EU} = 35 + 37 + 5 = 77 = >10\% \]
Table 5: Income/Outlay Accounts

<table>
<thead>
<tr>
<th></th>
<th>Country A</th>
<th>Country B</th>
<th>Country C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Government Sector</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$T_C$</td>
<td>5.4</td>
<td>6.6</td>
<td>3.4</td>
</tr>
<tr>
<td>$T_{EU_C}$</td>
<td>3.7</td>
<td>-4.0</td>
<td>-</td>
</tr>
<tr>
<td>$TAR$</td>
<td>-</td>
<td>-</td>
<td>2.9</td>
</tr>
<tr>
<td>$T_Q$</td>
<td>.9</td>
<td>1.1</td>
<td>1.5</td>
</tr>
<tr>
<td>$T_Y$</td>
<td>19.0</td>
<td>22.0</td>
<td>18.0</td>
</tr>
<tr>
<td><strong>Outlays</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$q_s G$</td>
<td>21.0</td>
<td>18.0</td>
<td>23.0</td>
</tr>
<tr>
<td>$Tr$</td>
<td>.6</td>
<td>7.7</td>
<td>2.8</td>
</tr>
<tr>
<td><strong>Household Sector</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$r \bar{K}$</td>
<td>32.0</td>
<td>33.0</td>
<td>18.0</td>
</tr>
<tr>
<td>$w \bar{L}$</td>
<td>30.0</td>
<td>28.0</td>
<td>35.0</td>
</tr>
<tr>
<td>$rm \bar{LA}$</td>
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<td>6.0</td>
<td>10.0</td>
</tr>
<tr>
<td>$Tr$</td>
<td>0.6</td>
<td>7.7</td>
<td>2.8</td>
</tr>
<tr>
<td><strong>Outlays</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final Demand</td>
<td>43.0</td>
<td>45.0</td>
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</tr>
<tr>
<td>$T_C$</td>
<td>5.4</td>
<td>6.6</td>
<td>3.4</td>
</tr>
<tr>
<td>$TAR^H$</td>
<td>1.2</td>
<td>1.1</td>
<td>1.4</td>
</tr>
<tr>
<td>$T_Y$</td>
<td>19.0</td>
<td>22.0</td>
<td>18.0</td>
</tr>
<tr>
<td>$SUBV$</td>
<td>-</td>
<td>-</td>
<td>-3.0</td>
</tr>
<tr>
<td><strong>Balance of Payments</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>$TB$</td>
<td>-5.0</td>
<td>-3.0</td>
<td>8.0</td>
</tr>
<tr>
<td>$SB$</td>
<td>6.0</td>
<td>2.0</td>
<td>-8.0</td>
</tr>
<tr>
<td>$TRB$</td>
<td>-1.0</td>
<td>1.0</td>
<td>-</td>
</tr>
</tbody>
</table>

Hence, our numerical example reflects most of the important features of our model, which once again seem worth mentioning:

- Every country consists of one household and the government;
- There exists a (supranational) federal government for countries A and B, which carries out the main agricultural policy.
- The public good in every country is zero-rated and not traded.
- The government budget is always balanced; there is no public debt.
Households do save and spend their savings for investment demand, which is VAT-exempt.

Capital is internationally mobile, so households also have income from capital ownership abroad.

The model we use for the examination of the different liberalization scenarios distinguishes eleven countries or regions ($R = 11$). These countries are:

1. Belgium, Luxembourg, Netherlands, Denmark (B-L-NL-DK)
2. Spain, Portugal, Greece, Ireland (E-P-GR-IRL)
3. Germany (D)
4. France (F)
5. Italy (I)
6. United Kingdom (UK)
7. Austria, Switzerland, Iceland, Sweden, Norway, Finland (EFTA)
8. USA, Canada (US-CAN)
9. Japan (JAP)
10. Australia, New Zealand, Indonesia, Malaysia, Philippines, Thailand, Argentina, Brazil, Chile, Colombia, Uruguay (CAIRNS)
11. Rest of the world (ROW).

Each country (or region) produces seven commodities ($J = 7$):

1. Agriculture and Forestry
2. Foodstuff
3. Basic Materials (Mining, Chemicals, Iron and Steel Prod. etc.)
4. Machinery and Transport equipment
5. Other Manufactured Products (Textiles, Leather etc.)
6. Market Services

All countries together therefore produce 77 commodities.

2. Basic Data Sources

This section presents the major data sources and describes the construction of our raw data. Four different kinds of such raw data are necessary for our model. The starting point is input-output tables for each national economy or region of our model. In order to update these tables we need data on bilateral international trade flows and the central macroeconomic variables. Finally some data on tax rates and revenues is necessary for the calculation of government balances.

2.1 National Input-Output Tables

The first building-blocks of the data set are eleven input-output tables. Since the aggregation level of the raw tables is different from that of our model they have to be consolidated first to our sectoral aggregation. After that every national table is composed of four sub-matrices:
• a 7×7 matrix of domestic intermediate transaction;
• a 7×4 matrix of domestic final demand (columns: private and collective consumption, gross investment and exports);
• a 7×9 import matrix (columns: intermediate demand, private consumption and investment);
• a 3×7 matrix for primary inputs (rows: compensation of employees, net operating surplus, net taxes linked to production (excluding VAT)).

National I/O tables for the EU countries are supplied by the Statistical Office of the European Communities (EUROSTAT, 1992). These harmonized tables use the EU's NACE-CLIO classification concept with a level of detail of 59 branches (R59) or 44 branches (R44) (for Portugal). The base year of the United Kingdom table is 1980, for all other countries it is 1985. Instead of using an aggregated table for our two EU regions we decided to use the I/O tables of Denmark and Spain. Similarly for EFTA we took the 1976 I/O table of Austria. This table was already aggregated to 19 sectors, see Keuschnigg and Kohler (1991), Table A3 for the sectoral classification. The national I/O tables of the United States and Japan are provided by MITI (1989) for the base year 1985 and an aggregation level of 26 sectors. Finally for CAIRNS we used the 1978-79 I/O table of Australia (United Nations, 1987) and for ROW the 1980 I/O table of Portugal\(^2\).

All these tables were aggregated to our seven sectors as described below in Table 6.

<table>
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<tr>
<th>Model Sectors</th>
<th>NACE-CLIO R59 code</th>
<th>Austrian I/O Table 19 sectors</th>
<th>MITI I/O Table 26 sectors</th>
<th>Australian I/O Table 28 sectors</th>
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</thead>
<tbody>
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<td>1</td>
<td>001-003</td>
<td>1,2,4,5,9</td>
</tr>
<tr>
<td>2</td>
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<tr>
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<td>004,008-013</td>
<td>3,11-15</td>
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<td>014-017</td>
<td>16-20</td>
</tr>
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<td>5</td>
<td>X410-X530</td>
<td>4-6</td>
<td>006,007,018</td>
<td>7,8,10</td>
</tr>
<tr>
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<td>13-18</td>
<td>019-023</td>
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<td>X810-X930</td>
<td>19</td>
<td>024-026</td>
<td>26-28</td>
</tr>
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</table>

The final demand and the primary input tables had to be consolidated as well. For the former we added collective consumption of private non-profit institutions to the collective consumption of general government and changes in stocks to the gross fixed capital formation. For the latter we aggregated gross wages and salaries and employers social contributions as well as consumption of fixed capital and net operating surplus.

### 2.2 International Trade Tables for Goods and Services

The second building-stone are three 11 × 11 external trade tables for agricultural goods, industrial goods and services. This data was computed in a two stage procedure. First a bilateral table of total merchandise trade as well as specific sums of exports and imports of agricultural goods and services for our eleven countries was calculated. Then the bilateral figures of agricultural and service trade were estimated with the RAS method.

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\(^2\) We would like to thank Jos Heuschling from EUROSTAT for supplying the EUROSTAT data diskettes, Dr. Christian Keuschnigg for supplying the Austrian data and Prof. Yoshinaga for supplying the MITI tables.
The main data sources for our bilateral merchandise trade table were EUROSTAT (1990, 52-93) for EU trade and GATT (1989, Table A3) for non-EU trade. Some supplementary data for Canada, Australia and New Zealand was taken from EUROSTAT (1988, 108-109). The main problem was to derive the bilateral trade figures of the CAIRNS group. For EU trade the bilateral trade data of Latin America, ASEAN and Oceania was taken. Then these numbers were multiplied with the export (or import) shares of the respective CAIRNS members. Finally the three regional components were added together. For non-EU trade the bilateral trade data of Latin America, South and East Asia and Other Developed Countries was taken from GATT (1989, Table A3) and the same procedure as above was applied to these figures. The export and import shares of the CAIRNS member countries in the different country sets were calculated from trade data provided by UNCTAD (1992). The conversion factor for ECU into dollars was taken from EUROSTAT (1990, 132).

Next the bilateral agricultural trade table was calculated. The starting point here was the computation of the total exports and imports of agricultural products in 1987 for the eleven countries from data given in FAO (1990, 45-47). Since the export values are f.o.b. and the import values are c.i.f. the export values were converted in order to get the same total sum of exports and imports. Then the row and column sums of the three subtables involving EU trade were derived from data provided by EUROSTAT (1988, 178f.). The row and column sums of intra-non-EU trade were then calculated as residuals. The final step was to adjust the submatrices of total merchandise trade with the RAS method (see Bacharach (1970)) until they had the desired row and column sums.

The trade table of industrial goods was then derived straightforwardly: the figures of bilateral agricultural trade were subtracted from the corresponding figures of total merchandise trade.

The last step was to compute a bilateral trade table in services. For all countries except ROW the data for total exports and imports of services provided by IMF (1992) was taken. For ROW no data was available, therefore the average share of service imports in total imports of all other countries was assumed. Because total service imports have to be equal to total service exports, ROW’s service exports are computed as a residual. The bilateral trade figures were then derived by adjusting the total merchandise trade figures again with the RAS method.

Tables 7 a, b, c report the final bilateral trade tables which were entered into our computer program.

2.3. International Macroeconomic Indicators

In order to update the internal final demand matrix of every country, data on the central macroeconomic variables private consumption (Cpr), collective consumption (Cst) and investment (Inv) for the base year 1987 had to be supplied. Except for ROW this data was taken from IMF (1992). The national currencies of every country were converted into dollars with the simultaneously given exchange rates. The GDP of every country is computed by summing up these figures and adding the difference of imports minus exports of goods and services. ROW GDP was calculated by subtracting the sum of the already known GDP’s from the total world GDP provided by United Nations (1991, 6). The average percent of private and collective consumption of GDP in all countries other than ROW was then applied to ROW’s GDP in order to get the absolute values for private and collective consumption in ROW. Since ROW’s net trade figure is already known, investment demand could be derived as a residual. Table 8 sums up the main macroeconomic variables of our data set.
### Table 7a: Bilateral Trade (Agricultural Goods)

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<th>D</th>
<th>F</th>
<th>I</th>
<th>GB</th>
<th>EFTA</th>
<th>US-CAN</th>
<th>JAP</th>
<th>CAIRNS</th>
<th>ROW</th>
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| ∑ Imports   | 19631 | 10422 | 29688 | 17611 | 19488 | 18329 | 11004 | 19078 | 20931 | 6475 | 47774 |

<p>| ∑ Exports   |      |      |      |      |      |      |      |        |     |        |     |      |</p>
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<th>F</th>
<th>I</th>
<th>GB</th>
<th>EFTA</th>
<th>US-CAN</th>
<th>JAP</th>
<th>CAIRNS</th>
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<th>Σ Exports</th>
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Table 7b: Bilateral Trade ( Manufactured Goods)
Table 7c: Bilateral Trade (Services)

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<th>Ex-Im</th>
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</table>

2.4 Government Parameters

The last prerequisite needed for the construction of the microconsistent data set were some figures on the country specific agricultural and tax policy. The starting point was the balanced EU budget in 1987 as presented in Table 9.

Table 9: The EU Budget 1987 (in Mio. Dollar)

<table>
<thead>
<tr>
<th>Country</th>
<th>Revenue</th>
<th>Expenditures</th>
<th>Σ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Agricul.</td>
<td>Sugar</td>
<td>Customs</td>
</tr>
<tr>
<td></td>
<td>Levies</td>
<td>Levies</td>
<td>Duties</td>
</tr>
<tr>
<td>B-L-NL-DK</td>
<td>458</td>
<td>336</td>
<td>1786</td>
</tr>
<tr>
<td>E-P-GR-IRL</td>
<td>167</td>
<td>90</td>
<td>786</td>
</tr>
<tr>
<td>D</td>
<td>179</td>
<td>455</td>
<td>3021</td>
</tr>
<tr>
<td>F</td>
<td>125</td>
<td>523</td>
<td>1400</td>
</tr>
<tr>
<td>I</td>
<td>474</td>
<td>193</td>
<td>1011</td>
</tr>
<tr>
<td>GB</td>
<td>473</td>
<td>103</td>
<td>2309</td>
</tr>
<tr>
<td>Σ</td>
<td>1876</td>
<td>1700</td>
<td>10313</td>
</tr>
<tr>
<td>Export subsidies</td>
<td>10818</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Market interventions</td>
<td>15663</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

These figures were calculated from data given in Court of Auditors (1988). The numbers on the revenue side could be found (in ECU) in Court of Auditors (1988, 211). Given the total sum of revenues, the total expenditures for every country were calculated with the shares from Court of Auditors (1988, 217). Then the EAGGF guarantee payments were subtracted to get "Other Transfers" as residuals. These transfers mainly consist of payments for regional and social policy, a smaller part are the payments of the EAGGF guidance section. For our later calculations we need on the revenue side the levy and tariff revenue figures. Furthermore we need the VAT basis of every country. In 1987, 1.4 % of the VAT basis of every country had to be payed in order to balance the EU budget (Europäische Gemeinschaften (1989, 23)). With this figure (and the revenues) it is possible to calculate
the VAT basis of every country. Due to exemptions, the VAT basis must be smaller than total privat consumption (Cpr). Therefore services were not included in the VAT basis. On the expenditure side, information on the (fixed) transfers to the national governments and the total payments of the EAGGF guarantee section had to be supplied. The latter is split in our data set program into export subsidies and market price support interventions. Table 9 reports their respective total sums in the 1987 budget.

In addition to the payments of the EU sections all national EU governments pay direct subsidies to their agricultural sector. This data is of central importance for the results of the model, therefore we did not rely on the production tax figures of the agricultural sector in the national input-output tables. Instead the 1987 figures for taxes linked to production excluding VAT from EUROSTAT (1991a) were taken and the national agricultural expenditures in 1987 provided by OECD (1989, 82-83) were subtracted. For the two EU regions 1.1% (B-L-NL-DK) and 3.0% (E-P-GR-IRL) of the respective total government expenditure was computed as agricultural subsidy payments. Similarly, for Italy 3.1% of the total budget expenditures was calculated as agricultural subsidies.

The data for the producer subsidy payments in non-EU countries was also collected from the agricultural expenditure figures in OECD (1989, 82-83). For EFTA the national expenditures were simply summed. The US farm policy also uses stockholding for grains in order to stabilize the market prices - see OECD (1989, 113) - therefore 6 billion dollars were assumed to be spent by a federal stabilization agency. In the computer program these stockholding expenses and the expenses for export subsidies are subtracted from the total agricultural expenses. The difference are the direct producer subsidy payments. For Japan, Hayami (1990, 196) estimated the stockpiling expenditures in 1984 to about 20% of the total agricultural expenditures. The total Japanese agricultural expenditures in 1987 were taken from OECD (1989) and 10% were subtracted for stockpiling interventions. For the last two country groups no special subsidy payments were considered. The production tax rates were simply calculated from the input-output tables.

Finally, tariff and export subsidy rates have to be specified, as well as VAT rates and specific income tax parameters. The tariff and export subsidy rates for agricultural goods for the EU, US/Canada and Japan are calculated from the estimates of Lienert (1990, 113). Our benchmark rates are simply a weighted sum of his ad-valorem rates. All other tariff rates are computed from the sum of the Post-Tokyo Round tariff levels and the estimated ad valorem equivalents of NTB's in Deardorf and Stern (1990), Table A8 and Table A10. The standard and reduced VAT rates of the EU countries are taken from Hitiris (1988, 74). Additionally the VAT revenues reported in EUROSTAT (1991b) were supplied to calculate later the average VAT rate for services. The reported VAT rates of non-EU countries are a best guess. In order to calculate the income tax allowances, income tax revenues and the marginal income tax rates of every country or region had to be supplied. The revenues of the most EU countries were taken from EUROSTAT (1991b). For the non-EU countries and E-P-GR-IRL the ratio of income tax revenue to GDP was computed from data of United Nations (1991), then this ratio was applied to our GDP figures. The marginal

3 For simplicity we ignored the VAT rebates for UK which are financed by higher contributions of the other countries (Europäische Gemeinschaften (1989, 21-22)).
4 For the first EU region the budget share of the Netherlands, for the second the budget share of Ireland and for Italy the budget share of France was taken. All budget shares are given in OECD (1989, 82-83).
5 The weights are the import(export) shares of the respective sectors in the total agricultural imports (exports). These weights are derived either from EUROSTAT (1988) or from FAO (1990).
income tax rates - except for Japan - were derived from OECD (1990, 13) by dividing the average tax rates reported there with the ratio of taxable income to income subject to tax. The marginal income tax rate for Japan was calculated from Ishi (1989) by dividing the actual tax yield in 1984 (12.6 tril. yen, p. 89) with the actual tax base in 1984 (73.5 tril. yen, p. 98).

All tax and tariff rates applied in the benchmark are reported below in Table 10. Except for the production tax these rates have to be supplied to our computer program as ad-valorem rates. The production tax rates are calculated with the data from the input-output tables and the direct production subsidy payments in the agricultural sectors.

3. Computation of the Multicountry Microconsistent Data Set

Now we have collected all the raw data which is necessary for the computation of our multicountry data set. Obviously, a number of problems arise when combining data from all these different sources. The most important shall be briefly mentioned here.

- **Different classification concepts:** *sectoral* classification in I/O statistics may not always match *commodity* classification in trade statistics. Moreover, the definition of the government sector in the US-Japan I/O tables differs considerably from that in the EUROSTAT tables.

- **Different price concepts:** international trade statistics are sometimes based on c.i.f., sometimes on f.o.b. prices. Industry output values may be measured on a net-of-retail, wholesale margin or net-of-transportation cost basis as in I/O data, or on a gross basis as in consumer expenditure data.

- **Different 'nationality' concepts:** national accounting data are generally estimated on a national basis, i.e. income is assigned to the residence of the owners of factors of production, while I/O data are determined on a domestic basis, allocating income to the region in which it is earned.

Even within the EU, where most measurement concepts are harmonized by the Statistical Office of the European Communities, considerable differences prevail between bilateral trade flows reported by the exporting countries and those reported by the importing countries.

Such practical rather than conceptual problems make a number of assumptions and adjustments necessary, which may be arguable in their details, but nevertheless are crucial for the consistency of the model. This section contains a detailed description of all the adjustments concerning the raw data.

3.1 The Intermediate Transaction and Final Demand Tables

The first task is to combine the input-output tables, the international trade data and the macro data to get the interregional intermediate transaction and final demand tables. This work can be separated into three steps. First, a preliminary international trade structure is calculated, then the EU-NEU trade is rearranged in order to get the tariff revenues of Table 9 and finally the domestic final consumption and investment demand is computed in

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6 These problems are common to any CGE data set construction efforts. See St.Hillaire/Whalley (1983) and St.Hillaire/Whalley (1987) for a detailed description of a dataset adjustment procedure for Canada.
Table 10: Tax and Tariff Rates (%) in the Benchmark; Base Year 1987

<table>
<thead>
<tr>
<th></th>
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<td>-5.6</td>
<td>7.0</td>
<td>-5.2</td>
<td>5.5</td>
<td>-8.4</td>
<td>5.0</td>
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<td>(25.5)</td>
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<td>0.0</td>
<td>16.4</td>
<td>(55.5)</td>
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<td>14.0</td>
<td>3.8</td>
<td>18.6</td>
<td>6.3</td>
<td>17.0</td>
<td>5.7</td>
<td>15.0</td>
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<td>3.0</td>
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<td>0.8</td>
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<td>-0.5</td>
<td>3.0</td>
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<td>10.0</td>
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<th>Prod. Taxes</th>
<th>Tariffs (Subs.)</th>
<th>US-CAN VAT</th>
<th>Prod. Taxes</th>
<th>Tariffs (Subs.)</th>
<th>JAP VAT</th>
<th>Prod. Taxes</th>
<th>Tariffs (Subs.)</th>
<th>CAIRNS VAT</th>
<th>Prod. Taxes</th>
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<th>Tariffs (Subs.)</th>
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<td>4.6</td>
<td>10.0</td>
<td>0.0</td>
<td>17.9</td>
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<tr>
<td>2. Foodstuff</td>
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<td>3.4</td>
<td>26.0</td>
<td>3.0</td>
<td>4.5</td>
<td>16.9</td>
<td>0.0</td>
<td>13.7</td>
<td>37.0</td>
<td>5.0</td>
<td>1.9</td>
<td>12.9</td>
<td>10.0</td>
<td>5.4</td>
<td>18.9</td>
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<td>3. Basic Materials</td>
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<td>5.7</td>
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<td>Marginal Income Tax Rates</td>
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<td>30.0</td>
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<td></td>
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</tbody>
</table>
order to get the macro variables of Table 8 and the desired VAT base for the EU-countries.

Two central assumptions are necessary for the construction of the preliminary international trade structure: first, the export structure of one country is constant and therefore does not depend on the destination countries and second, the structure of demand for an import good does not depend on the origin of that good. Now the bilateral trade matrix for two countries can be computed straightforwardly. From the total bilateral trade figures and the export structure of the exporting country, the row sums of the bilateral import matrix are computed. Then each row of the import matrix of the importing country is scaled up in order to get the desired row sum. This procedure has to be repeated for every country combination.

Next this initial trade structure has to be manipulated in order to get the levy and tariff revenue figures for every EU country. In the first step a preliminary agricultural levy revenue of a country is computed by multiplying the EU's agricultural tariff rate from Table 10 with the respective country's total agricultural imports from non-EU countries. If this preliminary levy revenue is less than the desired levy revenue of Table 9 the trade structure is retained and the variable levy of the foodstuffs sector is calculated from the residual levy revenue and the total non-EU foodstuffs imports. The difference between this country specific variable levy rate and the EU foodstuff tariff rate of Table 10 is then the country specific (fixed) ad valorem quota rate. This quota rate will be used to calculate the import quota revenues which accrue to the national governments. If the preliminary levy revenue is higher than the desired levy revenue of Table 9, the agricultural imports from non-EU countries are lowered until the levy revenue is 66 % of the total desired levy revenues. Then the total non-EU foodstuffs imports are raised by the same amount as the agricultural imports are lowered. After that rearrangement the country specific variable levy rate and ad-valorem quota rate can be calculated as explained above. This procedure has to be repeated for every EU country. Similarly, each EU-country's imports of industrial goods are rearranged in order to get the tariff revenues of Table 9 with the tariff rates of Table 10. This is done by changing the import structure of industrial goods from non-european countries in favor of the higher (or lower) tariffed good. It is obvious that whenever the import structure has been rearranged the respective import demands of branches and households have to be recalculated.

For every EU country the total exports of the two agrarian sectors to non-EU countries is known, therefore the export subsidy expenditures of the EAGGF for every country can be computed. The stockpiling expenditures in every EU country are then calculated by subtracting export subsidy payments from the total EAGGF guarantee payments of Table 9. The bilateral matrices of the multicountry intermediate and final demand tables are now completed. The calculation of the domestic intermediate and final demand tables still remains. The country specific column sum of final demand tables is known from the macro data of Table 8. Subtracting in every country the sum of the already known imports of consumption and investment goods, the resulting figures are the column sums of the domestic final demand matrix. The domestic demand columns of the I/O tables were then scaled up to these figures. Whenever stockpiling interventions are specified, these values

7 On the average 66 % of the variable levy revenues are obtained in the agricultural sector, see Court of Auditors (1988, 56).

8 In EU countries the service imports and merchandise goods imports were summed up separately in order to get the desired VAT basis in every country.
were subtracted from the total domestic demand for agricultural goods and booked -- together with the collective demand of Table 8 -- in a separate column. Finally, each country's domestic intermediate demand table was updated. Each row of a national table was scaled with the same factor as the respective final demand row.

The last job of this section is to compute the total row sums of the intermediate and final demand table as well as the column sums of the intermediate demand table. Subtracting the latter from the former gives the column sums of the primary input table.

### 3.2 The Government Sector Balances

The model features four different kinds of taxes: taxes on production, value added, income and tariffs. The national governments in the EU countries furthermore receive quota revenues from nontariff trade barriers. On the other side the government has three spending categories: the provision of the public good, transfer payments to the households and outlays for the agricultural policy. Since the tax rates and the expenditures for the public good and agricultural policy are already specified exogenously, the transfer payments are computed endogenously in order to ensure public sector balance.

In the agricultural sector of every country it is necessary to distinguish between the production tax payments of the respective sector to the national government and the subsidy payments which flow in the other direction. As explained already above, the production tax as well as the subsidy payments of EU countries are supplied exogenously to the computer program. For non-EU countries the total net production tax payments is first computed from the production tax rates given in the national I/O tables and the total outputs (which are already known from the respective row sums). Then the exogenously supplied subsidy payments are subtracted in order to get the production tax payments. For all other sectors the production tax payments are computed by multiplying the production tax rates from the input-output tables with the respective row sums. Table 11 reports the total budget expenditures for agricultural policy in our benchmark data set.

**Table 11: Budget Expenditures (in Mio. Dollars)**

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
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<td>B-L-NL-DK</td>
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<td>18456</td>
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</tbody>
</table>

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9 This distinction is necessary because we want to make sure that a cut of the subsidy payments in our later simulations will lead to a rise in the net production tax rates of the respective sector.
Given the tax structure described in Table 10 and the already computed final consumption data, the VAT revenues per country could easily be calculated by applying the formulas of section III.1.3.1 above. For the EU member states the VAT revenue was already exogenously given. Therefore the VAT rate for services was endogenously determined. Similarly we have to compute the revenues from the import quotas which accrue to the national EU-governments and the tariff revenues and subsidy payments of non-EU countries. Since all other government parameters are exogenously given (income tax revenues, EU transfers, stockpiling interventions, etc.) the transfer payments in every country can now be calculated.

Finally the (fixed and variable) tariff and quota rent payments and subsidy revenues of the branches \((TAR^Q_t, TARV^Q_t, RENT^Q_t, SUBQ_t)\) have to be calculated. They will be used in the next section.

### 3.3 Construction of the Primary Input Table

Each column of the primary input table consists of the sectoral payments for the three primary production factors, the payments for tariffs and production taxes and the received funds of direct agricultural subsidies or export subsidies (see Table 3). From the above computations the total column sum and the tax, tariff and subsidy figures are already known. Therefore the column sum of the primary production factors for each sector are calculated and split into labor and capital use by applying the ratios of the national input output tables. For the agricultural sector in each country, land use had to be specified as well. The splitting ratio from Harrison et al. (1991, 99) was used in order to get the primary input figures. Next the national supplies of labor and land are calculated directly. The national supply of capital is then derived by subtracting these figures from total primary factor income, which was calculated already.

If all calculations were correct, the difference between total supply and total demand for capital in every country has to match exactly the sum of the overall trade, transfer and remaining service balance.

### 3.4 Specification of the exogenous elasticity parameter values

In order to calibrate the parameters of the model, a number of exogenous parameters have to be specified. On the production side, the elasticity of substitution between capital and labor and (for the agricultural sector) the elasticity of substitution between composite capital and land has to be supplied. On the household side the substitution elasticities \(\nu_c, \nu_l\) and \(\nu_l^M\) have to be specified. Experience with CGE models shows that the simulation outcomes can be much more sensitive to changes in these parameters than to changes of the data set. Unfortunately, however, the econometric literature in many cases offers a wide range of parameter values, which all seem justifiable from the empirical and theoretical point of view. The only way to overcome this problem is to take some values given in the literature or best guesses, conduct sensitivity analysis with different parameter values and see how the model reacts to these changes.

Our "first choice" exogenous parameter values are as follows:

\[
\sigma_l = 0.8 \quad \sigma_t = 0.8 \\
\nu_l^M = 2.0 \quad \nu_l = 1.5 \\
\nu_c = 1.1
\]
V. Calibration to a Benchmark Equilibrium

The parameters of the demand functions for commodities, intermediates, and factors described above can be calculated by rearranging the equations and plugging in the data of the benchmark equilibrium. For readers not familiar with CGE modelling, this procedure, known as calibration, may seem a bit fishy. After all, parameters are "forced to fit the model". However, this is necessary because parameter values from the empirical literature - if they exist at all - will most probably not reproduce the benchmark data set and hence not be consistent with our general equilibrium framework.

The data of the benchmark equilibrium data base are actually given in value terms. But for calibration, a separation of prices and quantities is needed. Here we use a common trick: choose physical quantities such that all factor and commodity prices can be normalized to unity. Thus, a separation of prices (which in the benchmark equilibrium are all assumed to be one dollar net of taxes, subsidies and tariffs) and physical quantities is possible.

Since our starting-point is the observed values in the data set, calibration generally begins at the final branches of the utility and production tree and gradually works its way up to the higher levels.

1. Calibration in the Production Sector

Let us first consider the primary input side of the production tree in Figure 2. With the substitution elasticities \( \sigma_i \) being given, the remaining parameters to be determined by calibration are the share parameters \( \delta_i \) and the scale parameters \( \phi_i \). The former are obtained by simply rearranging the marginal condition for each producer's cost minimization problem to yield

\[
\delta_i = \frac{wL_i^1}{wL_i^\nu + rK_i^1}. \tag{2}
\]

The latter then follows from rearranging the CES value-added function (7)

\[
\phi_i = \frac{KL_i}{[\delta_i L_i^\nu + (1 - \delta_i)K_i^\nu]^{1/(\nu - 1)}} \quad \text{with} \quad KL_i = wL_i + rK_i \quad \text{for} \quad i \in N_{al}. \tag{7}
\]

Next for goods \( i \in N_{al} \) the weighted average price index for composite capital/labor \( rw_i \) has to be calculated according to (4). Then the share parameter on the second stage are solved:

\[
\lambda_i = \frac{rmL_i^{\nu}}{rmL_i^{\nu} + rw_i KL_i^{\nu}}. \tag{7'}
\]

Again we compute the scale parameters \( \xi_i \) by rearranging the CES value-added function (2):

\[
\xi_i = \frac{f_i}{\left[\lambda_i L_i^{\nu} + (1 - \lambda_i)K_i^\nu\right]^{1/\nu}} \quad \text{with} \quad f_i = wL_i + rK_i + rmL_i. \tag{2'}
\]

\(^{1}\)See Mansur/Whalley (1984) and Lau (1984) for a critical evaluation of this approach.
The fixed coefficients of the production function (1) are obtained by the following equations

\[ a_{ji}^k = \frac{V_{ji}^k}{Q_i} \quad \text{and} \quad a_{qi} = \frac{f_i}{Q_i}. \]

On the production side, two tax parameters have to be computed: the production tax rates \( \tau_{qi} \) and the coefficients for calculating the EU production levy in every country \( \psi^k \). From the benchmark data set we can calculate the values of \( T_Q \) as well as the values of \( TEU_Q \). The tax rates and coefficients are therefore computed by

\[ \tau_{qi} = \frac{T_Q}{q_i Q_i - T_Q} \quad \text{and} \quad \psi = \frac{TEU_Q}{T_Q}. \]

2. Calibration in the Household Sector

Once again we start at the lowest level of the utility tree (Figure 3). The exogenous parameters are the substitution elasticities \( v_{ij}^M \). From the marginal conditions of the utility maximization problem at this level we get

\[ \beta_{ik} = \frac{\left( p^k_i \right)^{v_{ik}} C_i^k}{\sum_{n \in \mathbb{N}} \left( p^k_i \right)^{v_{ik}} C_i^k} \]

where \( C_i^k \) comes directly from the data set and consumer prices can easily be calculated for given tax, tariff and subsidy rates, provided our unit convention \( q_i^k = 1 \) dollar holds.

Proceeding to the demand functions for composite imports and domestic commodities, the CES function on the second level of the utility tree involves the composite import commodity \( C_i^M \). Its value is not contained in the data set, but, given the \( \beta_{ik} \) on the third level, can be computed according to equation (19).

The price index \( p_i^M \) of the composite import commodity is calculated from consumer prices on the third level as described above in equation (11). A key parameter of the CES function is the elasticity of substitution between imported and domestic commodities, \( v_i \). This value is given, therefore the share parameter \( \beta_{ik}^n \) can be derived from

\[ \beta_{ik}^n = \frac{(p_i^*)^{v_i} C_i}{(p_i^*)^{v_i} C_i + (p_i^M)^{v_i} C_i^M}. \]

On the first level of the utility tree, the parameter \( \beta_i \) has to be calibrated. This again involves several values which are not directly contained in the data base, but can be calculated given the parameters on the next lower level. Hence, we first evaluate composite commodities \( C_i^H \) according to (17) and price indices \( p_i^H \) according to (12). Because the elasticity of substitution at this level \( \psi \) is specified exogenously, the share parameter of the CES function is given by

\[ \beta_i = \frac{(p_i^H)^{v_i} C_i^H}{\sum_{n \in \mathbb{N}} (p_i^H)^{v_i} C_i^H}. \]
In order to calculate the investment demand decisions of the household sector, the fixed savings rate $\gamma$ and the shares of the different investment categories $\kappa_i^k$ have to be known. From the quantities of the investment demand in the benchmark data set the saving rate is calculated according to

$$\gamma = \frac{\sum_{k \in W} \sum_{i \in Y} \frac{\hat{I}_{1+i} I_i^k}{Y}}{Y}.$$ 

The total disposable income $Y$ can be computed with equation (14) since all values are known from the benchmark data set.

The share parameters $\kappa_i^k$ are simply derived by rearranging equation (21), i.e.

$$\kappa_i^k = \frac{\hat{I}_{1+i} I_i^k}{\gamma Y}.$$ 

Finally, the country specific income tax allowances have to be calibrated. From the benchmark data set the primary factor supplies, the marginal income tax rates and the income tax revenue are known, therefore the allowances could be calculated by rearranging equation (15)

$$All = r\bar{K} + w\bar{L} + rm\bar{L}\bar{A} - \frac{T_r}{\tau_y}.$$ 

Note that the factor prices in the benchmark are set to $r = w = rm = 1$ dollar.

VI. Simulation Results

In this section we present some preliminary results of simulation experiments with the model. Starting with the data set of 1987, we used the fully specified CGE model to compute a number of hypothetical ("counterfactual") equilibria corresponding to different agricultural reform options. Using the summary statistics, the results are then compared with the original pre-change ("benchmark") equilibrium. The numerical results, however, are not explained in economic terms. This will be done in subsequent papers.

Our main focus is the comparison of welfare levels in different states of the economy. We use the Hicksian equivalent variation (HEV), which is now widely accepted as a monetary welfare measure. The equivalent variation is defined as the amount of money that must be given to or taken from a consumer in order to make him as well off as he would have been after a change in prices. A positive HEV indicates a welfare improvement, a negative one a welfare loss.

Table 12 contains the quantitative effects of a unilateral reduction of export subsidies. While on the left hand side of Table 12 US-CAN abolish their export subsidies, on the right hand side the EU is increasing its export prices of agricultural commodities by 20 % (sector a1) and 50 % (sector a2). This reduces the export subsidy rates to 12 % and 34 %
respectively. The HEV values for each country are represented in millions of dollars as well as a percentage rate of the output of the agricultural sector. Finally, the terms of trade effects (in per cent) associated with the policy switch are contained in the last column of every simulation. In both simulations those countries gain, which reduce export subsidies. Note however that the total welfare effect is only positive for the case of the EU export subsidy reduction. Table 13 reports the effects of the second experiment on the EU Budget.

Table 12: Welfare of a Reduction of Export Subsidies:

<table>
<thead>
<tr>
<th>Country</th>
<th>USA HEV in Mill. $</th>
<th>USA HEV in %</th>
<th>USA ToT in %</th>
<th>EU HEV in Mill. $</th>
<th>EU HEV in %</th>
<th>EU ToT in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-L-NL-DK</td>
<td>336</td>
<td>-0.34</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E-P-GR-IRL</td>
<td>487</td>
<td>0.32</td>
<td>-0.08</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>-191</td>
<td>0.20</td>
<td>-0.02</td>
<td>2548</td>
<td>0.73</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>-174</td>
<td>0.13</td>
<td>-0.02</td>
<td>1973</td>
<td>0.53</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>-96</td>
<td>0.06</td>
<td>-0.02</td>
<td>1157</td>
<td>0.52</td>
<td></td>
</tr>
<tr>
<td>GB</td>
<td>-93</td>
<td>0.08</td>
<td>-0.02</td>
<td>1085</td>
<td>0.47</td>
<td></td>
</tr>
<tr>
<td>EFTA</td>
<td>-71</td>
<td>0.00</td>
<td>-0.02</td>
<td>-1545</td>
<td>-1.03</td>
<td></td>
</tr>
<tr>
<td>US-CAN</td>
<td>1959</td>
<td>-0.02</td>
<td>-0.02</td>
<td>-1040</td>
<td>-0.13</td>
<td></td>
</tr>
<tr>
<td>JAP</td>
<td>-415</td>
<td>0.07</td>
<td>-0.02</td>
<td>-330</td>
<td>-0.07</td>
<td></td>
</tr>
<tr>
<td>CAIRNS</td>
<td>-165</td>
<td>0.01</td>
<td>-0.02</td>
<td>-139</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>ROW</td>
<td>-874</td>
<td>0.04</td>
<td>-0.02</td>
<td>-3666</td>
<td>0.26</td>
<td></td>
</tr>
<tr>
<td>EU</td>
<td>-667</td>
<td>0.00</td>
<td>-0.02</td>
<td>7586</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>-234</td>
<td>0.00</td>
<td>-0.02</td>
<td>866</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 13: Effects on EU Budget:

<table>
<thead>
<tr>
<th>Country</th>
<th>Customs Duties</th>
<th>Sugar Levies</th>
<th>VAT</th>
<th>Export Subsidies</th>
<th>Market Intervention</th>
<th>Other Transfers</th>
<th>Σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-L-NL-DK</td>
<td>2106</td>
<td>337</td>
<td>2304</td>
<td>2443</td>
<td>336</td>
<td>1344</td>
<td>625</td>
</tr>
<tr>
<td>E-P-GR-IRL</td>
<td>874</td>
<td>91</td>
<td>1534</td>
<td>915</td>
<td>1697</td>
<td>4470</td>
<td>-4583</td>
</tr>
<tr>
<td>D</td>
<td>3006</td>
<td>463</td>
<td>5243</td>
<td>1252</td>
<td>2129</td>
<td>1405</td>
<td>3926</td>
</tr>
<tr>
<td>F</td>
<td>1433</td>
<td>532</td>
<td>4682</td>
<td>1658</td>
<td>3264</td>
<td>2401</td>
<td>-677</td>
</tr>
<tr>
<td>I</td>
<td>1406</td>
<td>196</td>
<td>3145</td>
<td>716</td>
<td>3113</td>
<td>2458</td>
<td>-1539</td>
</tr>
<tr>
<td>GB</td>
<td>2700</td>
<td>105</td>
<td>2714</td>
<td>942</td>
<td>100</td>
<td>2229</td>
<td>2248</td>
</tr>
</tbody>
</table>

Table 14 reports the welfare effects of a multilateral reduction of agricultural import tariffs. On the left hand side of Table 14 all non-EU countries are reducing their tariff rates by 50%. On the right hand side the EU reduces its import prices by 3% (sector a1) and 15%. The variable import tariffs are then 1% and 15% respectively. In the first experiment in Table 14 all tariff reducing countries experience welfare gains. For EU countries, however,
the welfare effects of a tariff rate reduction are mixed. Table 15 reports again the effects of the second experiment on the EU Budget.

Table 14: Welfare Effects of a Reduction of Import Tariffs:

<table>
<thead>
<tr>
<th>Country</th>
<th>USA</th>
<th>EC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HEV</td>
<td>HEV</td>
</tr>
<tr>
<td></td>
<td>in Mill. $</td>
<td>in %</td>
</tr>
<tr>
<td>B-L-NL-DK</td>
<td>156</td>
<td>0.05</td>
</tr>
<tr>
<td>DK</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E-P-GR-IRL</td>
<td>-4</td>
<td>0.00</td>
</tr>
<tr>
<td>D</td>
<td>-175</td>
<td>-0.05</td>
</tr>
<tr>
<td>F</td>
<td>-78</td>
<td>-0.02</td>
</tr>
<tr>
<td>I</td>
<td>-69</td>
<td>-0.03</td>
</tr>
<tr>
<td>GB</td>
<td>-45</td>
<td>-0.02</td>
</tr>
<tr>
<td>EFTA</td>
<td>62</td>
<td>0.04</td>
</tr>
<tr>
<td>US-CAN</td>
<td>208</td>
<td>0.03</td>
</tr>
<tr>
<td>JAP</td>
<td>657</td>
<td>0.14</td>
</tr>
<tr>
<td>CAIRNS</td>
<td>116</td>
<td>0.04</td>
</tr>
<tr>
<td>ROW</td>
<td>-60</td>
<td>0.00</td>
</tr>
<tr>
<td>EU</td>
<td>-216</td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>887</td>
<td></td>
</tr>
</tbody>
</table>

Table 15: Effects on EC Budget:

<table>
<thead>
<tr>
<th>Country</th>
<th>Customs Duties</th>
<th>Sugar Levies</th>
<th>VAT</th>
<th>Export Subsidies</th>
<th>Market Intervention</th>
<th>Other Transfers</th>
<th>Σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-L-NL-DK</td>
<td>1347</td>
<td>335</td>
<td>3838</td>
<td>5017</td>
<td>332</td>
<td>1344</td>
<td>-1173</td>
</tr>
<tr>
<td>DK</td>
<td>432</td>
<td>90</td>
<td>2553</td>
<td>1862</td>
<td>1677</td>
<td>4470</td>
<td>-4934</td>
</tr>
<tr>
<td>E-P-GR-IRL</td>
<td>1270</td>
<td>455</td>
<td>8685</td>
<td>2538</td>
<td>2094</td>
<td>1405</td>
<td>4373</td>
</tr>
<tr>
<td>D</td>
<td>654</td>
<td>523</td>
<td>7747</td>
<td>3349</td>
<td>3212</td>
<td>2401</td>
<td>-39</td>
</tr>
<tr>
<td>F</td>
<td>894</td>
<td>193</td>
<td>5222</td>
<td>1458</td>
<td>3067</td>
<td>2458</td>
<td>-673</td>
</tr>
<tr>
<td>GB</td>
<td>2102</td>
<td>103</td>
<td>4505</td>
<td>1938</td>
<td>98</td>
<td>2229</td>
<td>2446</td>
</tr>
</tbody>
</table>

Table 16 reports the welfare effects of a reduction of other support programs. On the left hand side the EU countries reduce their import quotas by 50%. Basically this results in a redistribution within the EU countries. Due to the fixed import prices non-EU countries remain practically unaffected. In the second experiment in Table 16 all countries reduce their intervention purchases by 50%. Such a policy has positive welfare effects in almost all countries. Table 17 again reports the effects on the EU budget.
### Table 16: Welfare Effects of a Reduction of other Support Programs:

<table>
<thead>
<tr>
<th>Country</th>
<th>Import Quotas</th>
<th>Market Interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HEV in Mill. $</td>
<td>ToT in %</td>
</tr>
<tr>
<td>B-L-NL-DK</td>
<td>-100</td>
<td>-0.03</td>
</tr>
<tr>
<td>E-P-GR-IRL</td>
<td>-50</td>
<td>-0.03</td>
</tr>
<tr>
<td>D</td>
<td>-594</td>
<td>-0.17</td>
</tr>
<tr>
<td>F</td>
<td>221</td>
<td>0.06</td>
</tr>
<tr>
<td>I</td>
<td>261</td>
<td>0.12</td>
</tr>
<tr>
<td>GB</td>
<td>178</td>
<td>0.08</td>
</tr>
<tr>
<td>EFTA</td>
<td>26</td>
<td>0.02</td>
</tr>
<tr>
<td>US-CAN</td>
<td>11</td>
<td>0.00</td>
</tr>
<tr>
<td>JAP</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>CAIRNS</td>
<td>3</td>
<td>0.00</td>
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<tr>
<td>ROW</td>
<td>9</td>
<td>0.00</td>
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<tr>
<td>EU</td>
<td>-85</td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>-37</td>
<td></td>
</tr>
</tbody>
</table>

### Table 17: Effects on EU Budget:

<table>
<thead>
<tr>
<th>Country</th>
<th>Customs Duties</th>
<th>Sugar Levies</th>
<th>VAT</th>
<th>Export Subsidies</th>
<th>Market Intervention</th>
<th>Other Transfers</th>
<th>Σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-L-NL-DK</td>
<td>2260</td>
<td>337</td>
<td>2541</td>
<td>4985</td>
<td>166</td>
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<tr>
<td>E-P-GR-IRL</td>
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<td>90</td>
<td>1672</td>
<td>1815</td>
<td>828</td>
<td>4470</td>
<td>-4393</td>
</tr>
<tr>
<td>D</td>
<td>3218</td>
<td>455</td>
<td>5733</td>
<td>2507</td>
<td>1040</td>
<td>1405</td>
<td>4455</td>
</tr>
<tr>
<td>F</td>
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<td>522</td>
<td>5105</td>
<td>3280</td>
<td>1592</td>
<td>2401</td>
<td>-113</td>
</tr>
<tr>
<td>I</td>
<td>1491</td>
<td>192</td>
<td>3425</td>
<td>1416</td>
<td>1511</td>
<td>2458</td>
<td>-277</td>
</tr>
<tr>
<td>GB</td>
<td>2797</td>
<td>103</td>
<td>2983</td>
<td>1921</td>
<td>49</td>
<td>2229</td>
<td>1684</td>
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</table>

In Table 18 we report the results of worldwide agricultural liberalization reforms. On the left hand side the above reported experiments are conducted in all countries simultaneously. On the right hand side of Table 18 all countries completely liberalize their agricultural markets. The final Tables 19 and 20 report the respective changes in the EU budget.
### Table 18: Welfare Effects of Worldwide Policies:

<table>
<thead>
<tr>
<th>Country</th>
<th>Partial Liberalization</th>
<th>Complete Liberalization</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HEV in Mill. $</td>
<td>in %</td>
</tr>
<tr>
<td>B-L-NL-DK</td>
<td>1187</td>
<td>0.41</td>
</tr>
<tr>
<td>E-P-GR-IRL</td>
<td>796</td>
<td>0.53</td>
</tr>
<tr>
<td>D</td>
<td>2966</td>
<td>0.86</td>
</tr>
<tr>
<td>F</td>
<td>2987</td>
<td>0.82</td>
</tr>
<tr>
<td>I</td>
<td>2337</td>
<td>1.07</td>
</tr>
<tr>
<td>GB</td>
<td>2347</td>
<td>1.01</td>
</tr>
<tr>
<td>EFTA</td>
<td>-1148</td>
<td>-0.77</td>
</tr>
<tr>
<td>US-CAN</td>
<td>4544</td>
<td>0.57</td>
</tr>
<tr>
<td>JAP</td>
<td>1385</td>
<td>0.30</td>
</tr>
<tr>
<td>CAIRNS</td>
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<td>0.01</td>
</tr>
<tr>
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<tr>
<td>EU</td>
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</tr>
<tr>
<td>W</td>
<td>13735</td>
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</tr>
</tbody>
</table>

### Table 19: Effects on EC Budget (Partial Liberalization):

<table>
<thead>
<tr>
<th>Country</th>
<th>Customs Duties</th>
<th>Sugar Levies</th>
<th>VAT</th>
<th>Export Subsidies</th>
<th>Market Intervention</th>
<th>Other Transfers</th>
<th>Σ</th>
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<td>B-L-NL-DK</td>
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<td>105</td>
<td>1814</td>
<td>1000</td>
<td>50</td>
<td>2229</td>
<td>1250</td>
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</table>

### Table 20: Effects on EC Budget (Complete Liberalization):

<table>
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<tr>
<th>Country</th>
<th>Customs Duties</th>
<th>Sugar Levies</th>
<th>VAT</th>
<th>Export Subsidies</th>
<th>Market Intervention</th>
<th>Other Transfers</th>
<th>Σ</th>
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<td>538</td>
</tr>
</tbody>
</table>
Appendix: List of Variables

Production Sector $i$ in Country $h$

First level

$Q_i$ production of commodity $i$
$\nu^k_i$ intermediate use of input $j$ from country $k$ for the production of commodity $i$
$f_i$ value-added function of commodity $i$
$a_{hi}$ (fixed) coefficient of the value-added function of commodity $i$
$a_{ji}^k$ (fixed) coefficient of the input $j$ from country $k$ for the production of commodity $i$

Second level (primary inputs)

$KL_i$ ($kl_i$) demand for composite capital/labor in the production of commodity $i \in N_{ai}$ (per-unit form)
$LA_i$ ($la_i$) demand for land in the production of commodity $i \in N_{ai}$ (per-unit form)
$\xi_i$ scale parameter of the value-added function
$\lambda_{ji}$ share parameter of land
$\omega_{ji}$ elasticity of substitution between land and composite capital/labor
$\theta_{ji}$ auxiliary parameter
$Cost_i$ primary input cost function
$b_i$ primary input cost per unit
$rw_i$ price index of composite primary input
$rm$ land rental rate

Third level (primary inputs)

$K_i$ ($k_i$) demand for composite capital (per-unit form)
$L_i$ ($l_i$) demand for labor (per-unit form)
$\phi_i$ scale parameter of the value-added function
$\delta_i$ share parameter of labor
$\sigma_i$ elasticity of substitution between capital and labor
$\rho_i$ auxiliary parameter
$CostKL_i$ primary input cost function
$w$ wage rate in country $h$
$r$ international interest rate for capital

Household Sector in country $h$

First Level

$U$ utility function
$C_i^H$ composite demand category $i$
$\beta_i$ share parameter of composite demand category $i$
$\nu_c$ elasticity of substitution between composite demand categories
$\mu_i^H$ auxiliary parameter
$P_i^H$ price index of composite demand category $i$
$\bar{K}$ total capital stock owned by household sector
\[ \bar{L} \]  
\[ \bar{L}A \]  
\[ Y \]  

**Second level**
\[ C_i^M \]  composite imported consumption commodity \( i \)  
\[ C_i \]  consumption of domestically produced commodity \( i \)  
\[ \beta_i^H \]  share parameter of domestic consumption commodity \( i \)  
\[ \nu_i \]  elasticity of substitution between composite imported and domestic consumption commodity \( i \)  
\[ \mu_i \]  auxiliary parameter  
\[ Y_i \]  disposable income for commodity category \( i \)  
\[ p_i^M \]  price index of imported consumption commodities  
\[ p_i \]  consumer price of domestically produced commodity \( i \) 

**Third level**
\[ C_i^k \]  consumption of commodity \( i \) produced in country \( k \)  
\[ \beta_i^k \]  share parameter of consumption commodity \( i \) from country \( k \)  
\[ \nu_i^M \]  elasticity of substitution between imports of commodity \( i \) from different source countries  
\[ \mu_i^M \]  auxiliary parameter  
\[ Y_i^M \]  disposable income for direct imports of commodity \( i \)  
\[ p_i^k \]  consumer price of commodity \( i \) from country \( k \)  
\[ q_i^k \]  producer price of commodity \( i \) from country \( k \) 

**Investment demand**
\[ S \]  total savings of country \( h \)  
\[ \gamma_i \]  saving rate of country \( h \)  
\[ I_i^{kh} \]  Investment demand for commodity \( i \) from country \( k \) in country \( h \)  
\[ \kappa_i^{kh} \]  share of Investment expenditure of good \( i \) from country \( k \) in total investment 

**Government Sector**
\[ \tau_{qi} \]  production tax in the production sector \( i \)  
\[ t_{ik}^k \]  (fixed) tariff rate of country \( h \) for commodity \( i \) from country \( k \)  
\[ t_{vk}^h \]  (variable) tariff rate of country \( h \in \text{EU} \) for commodity \( i \in N_a \) from country \( k \in \text{NEU} \)  
\[ s_{v_i} \]  (variable) export subsidy rate of country \( h \in \text{EU} \) for exports of commodity \( i \in N_a \) in countries \( k \in \text{NEU} \)  
\[ s_i \]  (fixed) export subsidy rate of country \( h \in \text{NEU} \) for exports of commodity \( i \in N_a \) in countries \( k \in W \setminus h \)  
\[ t_{qi} \]  ad valorem import quota rate of sector \( i \) in country \( h \in \text{EU} \)  
\[ f_y \]  marginal income tax rate  
\[ \tau_i \]  consumption tax rate of country \( h \) for commodity \( i \)  
\[ \tau_{qm} \]  (fixed) threshold price for EU imports of commodity \( i \in N_a \) from non-EU
countries

\( q_e \)  
(fixed) threshold price for EU exports of commodity \( i \in N_a \) to non-EU countries

\( T_C \)  
value-added tax revenue of the government sector

\( T_Y \)  
income tax revenue

\( All \)  
income tax allowance

\( T_Q (T_Q) \)  
production tax revenue (from sector \( i \))

\( TAR_H \)  
tariff payment of the household sector

\( TAR_Q^i \)  
tariff payment of production sector \( i \)

\( TAR \)  
total tariff revenue

\( TAR^H \)  
variable tariff payment of the household sector

\( TAR^Q^i \)  
variable tariff payment of production sector \( i \)

\( TARV \)  
total variable levy revenue

\( RENT^H \)  
import quota rents payments by household in country \( h \in EU \)

\( RENT^Q^i \)  
import quota rents payments by sector \( i \) in country \( h \in EU \)

\( RENT \)  
import quota rents received by country \( h \in EU \)

\( SUBH \)  
subsidy revenues received by the households

\( SUBQ^i \)  
subsidy revenues received by sector \( i \)

\( SUBV \)  
variable export subsidy payments of country \( h \in EU \)

\( SUB \)  
total export subsidy payments of country \( h \in NEU \)

\( Tr \)  
transfer payments received by household sector

\( G \)  
quantity of public good

\( q_g \)  
producer price of the public good

\( TREU \)  
(fixed) transfers from the EU to the national governments

\( S_A \)  
stockpiling purchases in country \( h \in W \) for commodity \( i \in N_{a1} \)

\( TEU_Q \)  
sugar and milk production levy for the EU budget

\( TEU_C \)  
VAT payments of country \( h \in EU \) to the EU budget

\( DE \)  
deficit of the EU without VAT contributions

\( VATB \)  
national VAT basis

\( VATB^{EC} \)  
total EU VAT basis

\( \mu \)  
common VAT share of EU countries

\( \psi \)  
share of sugar and milk levy in total production tax of industries \( i \in N_{a2} \) in EU countries

**Foreign Sector**

\( TB \)  
trade balance

\( SB \)  
service balance

\( TRB \)  
transfer balance

\( BP \)  
balance of payments

\( Pm \)  
price index for imports

\( px \)  
price index for exports

\( ToTG \)  
gross-barter terms-of-trade

\( ToTN \)  
net-barter terms-of-trade

\( M_{k}^{i} \)  
total imports of commodity \( i \) from country \( k \)

\( X_{k}^{i} \)  
total exports of commodity \( i \) to country \( k \)
References


EUROPÄISCHE GEMEINSCHAFTEN, 1989, Die öffentlichen Finanzen der Gemeinschaft, Luxembourg.


KELLER, W., 1976, A Nested CES-Type Utility Function and its Demand and Price Index Functions, European Economic Review 7, 175-186.


**STATISTICAL OFFICE OF THE EUROPEAN COMMUNITIES (EUROSTAT),** 1988, External Trade, Monthly Statistics 4-6, Luxembourg.


**WHALLEY, J., 1985, Trade Liberalization among Major World Trading Areas, Cambridge and London.**