COMMON AGRICULTURAL POLICY REGIONAL IMPACT ANALYSIS

Regionalisation of the Rest of the World Aggregate

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Abstract

This paper discusses the regionalisation of the Rest of the World Aggregate and the Gross Trade concept applied in market module of the CAPRI modelling system. A comparison is drawn between different modelling systems.

1 Introduction

The previous CAPRI data base treated the EU Member States, Norway and Switzerland as individual regions and the "Rest-of-the-World" (ROW) as one aggregate. The objective of this working package is to disaggregate ROW in both the market module and the data base into regions according to their importance, and similarity in trade policies in international commodity trade. These changes are one of the tasks of the new CAP-STRAT project. The further disaggregation aims at:

- improving upon the reliability and plausibility of the CAPRI market module,
- enhancing the representation of policy measures in ROW, and
- facilitating the use of data from and compare results with other international trade modelling systems.

This paper presents, in section 0, the countries and regions which are considered in the new CAP-STRAT project, followed, in section 0, by a theoretical presentation of the modifications of structure and equations of the market module.

2 Selection of ROW countries or regions

This section presents the dissaggregation of rest of world (ROW) countries. The grouping is mainly based on similarities in trade policies in order to support the representation of current international trade measures and potential WTO scenarios although the sheer importance of a given country is certainly a factor for considering it apart. We arrived at the following disaggregation:

1. ACP (Africa, Caribbean, Pacific)
2. ASEAN - Rim
3. Australia + New Zealand
4. Canada
5. China + Taiwan
6. CIS (Commonwealth of Independent States)
7. India
8. Japan
9. Mediterranean countries + Turkey
10. MERCOSUR + Chile
11. Rest of western Europe + PECO
12. USA
13. Remaining Countries

Table 1 shows the comparison of CAP-STRAT (named Extended CAPRI in the table) with other trade models. As we can see, this model bridges the gap of the other models. It considers European countries individually together with individual world countries or regions, as the other models either consider individual European countries and one world aggregate or a disaggregation of the world with the European Union being one region in the model.

Simulations are defined according to the regionalisation of the ROW aggregate and to data availability. Data from different sources (FAOSTAT, USDA, WATSIM modelling system) are collected and adapted (aggregated) to the regional, product and item specification of the CAP-STRAT market module. Time series on the compiled data relating to market balances, prices, and policy instruments of the different products are stored in the CAP-STRAT data base.

There are two main factors which determine the outcome of multi-commodity models where prices and quantities are endogenously determined: (1) parameters of the behavioural functions and (2) exogenous shifts relating, for example, to income, population growth, technical progress, and changes in preferences. The assumptions on exogenous shifts from different modelling systems such as WATSIM, FAPRI, OECD's AG-LINK or FAO's World Food Model are evaluated to derive comparable and plausible settings for CAP-STRAT. The parameters of the behavioural equations will mostly be taken from the WATSIM modelling system.
In order to allow for a smooth integration of the new regional demand and supply equations into the model, the same functional form as for the demand of EU Member States will be employed. Accordingly, the same tools will be applied to calibrate functional parameters to appropriately aggregated elasticities from WATSIM.

Table 1 Comparison of applied models of international trade in agriculture

<table>
<thead>
<tr>
<th>Regional scope</th>
<th>CAPMAT</th>
<th>WATSIM</th>
<th>FAPRI</th>
<th>AGLINK</th>
<th>EXTENDED CAPRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Countries/Regions</td>
<td>13(c)+1(r)</td>
<td>15(r)</td>
<td>29 c</td>
<td>11(c)+2(r)</td>
<td>22(c)+8(r)</td>
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<td>Austria</td>
<td>X</td>
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<tr>
<td>Belgium/Luxembourg</td>
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<td>Denmark</td>
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<td>Ireland</td>
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<td>Switzerland</td>
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<tr>
<td>United Kingdom</td>
<td>X</td>
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<tr>
<td>Rest of Western Europe</td>
<td>X</td>
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<td>CEEC</td>
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<td>Eastern Europe</td>
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<td>Slovak Republic</td>
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<td>Poland</td>
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<td>X</td>
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<td>X c</td>
<td>X</td>
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<tr>
<td>Non EU Mediterranean + Turkey</td>
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<td>Other (RO Europe)</td>
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EU: 1(r)
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<thead>
<tr>
<th>Region</th>
<th>CAPMAT</th>
<th>WATSIM</th>
<th>FAPRI</th>
<th>AGLINK</th>
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<td><strong>Brazil</strong></td>
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<tr>
<td><strong>Argentina</strong></td>
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<td>X</td>
<td>X</td>
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<tr>
<td><strong>MERCOSUR + Chile</strong></td>
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<tr>
<td><strong>Africa</strong></td>
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<td><strong>North Africa and west Asia</strong></td>
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<td><strong>Sub-Saharan Africa</strong></td>
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Table 1 Comparison of applied models of international trade in agriculture (Continued)

### Regional scope (continued)

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<tr>
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<tr>
<td><strong>ASEAN</strong></td>
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<tr>
<td><strong>Rest of Asia</strong></td>
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<td><strong>Australia and New-Zealand</strong></td>
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<tr>
<td><strong>Australia</strong></td>
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<td><strong>New-Zealand</strong></td>
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<tr>
<td><strong>Rest OECD</strong></td>
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</tr>
<tr>
<td><strong>Total OECD</strong></td>
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<tr>
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### Commodities

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<th>AGLINK</th>
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<tr>
<td>Coarse grains</td>
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<tr>
<td>Barley</td>
<td></td>
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<td></td>
<td>X</td>
</tr>
<tr>
<td>Maize</td>
<td></td>
<td></td>
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<td>X</td>
</tr>
<tr>
<td>Sorghum</td>
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<td>Pulses</td>
<td>Potatoes</td>
<td>Oilseeds</td>
<td>Rice</td>
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<td>-------------------------------</td>
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<table>
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<tr>
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<th>Oilseeds meal and oil</th>
<th>Soybeans meal and oil</th>
<th>Oilseeds meal and oil</th>
<th>Oilseeds meal and oil</th>
<th>Oilseeds meal and oil</th>
<th>Oilseeds meal and oil</th>
<th>Oilseeds meal and oil</th>
<th>Oilseeds meal and oil</th>
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<thead>
<tr>
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<th>Recursive dynamic</th>
<th>General equilibrium</th>
<th>Partial equilibrium</th>
<th>Endogenous land allocation</th>
<th>Homogenous goods and pooled markets</th>
<th>Supply/demand</th>
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</table>
Table 1 Comparison of applied models of international trade in agriculture (Continued)

<table>
<thead>
<tr>
<th>Results</th>
<th>CAPMAT</th>
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<th>FAPRI</th>
<th>AGLINK</th>
<th>EXTENDED CAPRI</th>
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<td>X</td>
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<td>X</td>
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<tr>
<td>Demand</td>
<td>X</td>
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<td>X</td>
</tr>
<tr>
<td>Trade</td>
<td></td>
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<td>Prices</td>
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Policies modelled

<table>
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<th>Policies modelled</th>
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<th>X</th>
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<tbody>
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<td>Accession to the EU</td>
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<td>Uruguay Round (UR)</td>
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<tr>
<td>Exchange rate</td>
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<td>X</td>
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<td>? can be done</td>
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<tr>
<td>Trade protection</td>
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<td>X</td>
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<td>UR quantity restrictions</td>
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<tr>
<td>Opening of Asian market</td>
<td>X</td>
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<tr>
<td>Environmental change</td>
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<tr>
<td>Crop disease</td>
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<td>X</td>
<td></td>
<td></td>
<td>Could be done</td>
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</table>

Projections

<table>
<thead>
<tr>
<th>Projections</th>
<th>Variable</th>
<th>10 years</th>
<th>Variable</th>
</tr>
</thead>
</table>

* c=country, r=region, e=exogenous (not counted in number of countries)
* The Gold model, an extension from the Fapri model, disaggregates the EU region into its 15 member states
* No complete listing currently available
* Maize, barley, oats and sorghum
* exogenous (see (a))
* Soybeans, rapeseed and sunflower
* Meals and oils of the oilseeds defined plus palm oil
* Supply can be chosen to be exogenous or endogenous
* Can be chosen to be exognous or endogenous
* Includes Taiwan
3 Disaggregation of the market module

In the original CAPRI version, ROW was basically treated as an extra region similar to any other EU country. Since this new version still focuses on the EU but aims at better considering the effects of particular policies affecting particular regions, the ROW will still be seen as a black box from the EU point of view (???), however this black box will now be modelled. In order to better understand the changes undertaken, the following figure presents the trade flows as described here.
A and B represent European member states, X and Y represent regions (or countries) of the rest of world
I was not able to work on the graph – it seems there goes something wrong technically. But the flows for the ROW are not correctly labelled!

Figure 1 Trade flows between CAP-STRAT modelling units
3.1 Market clearance

Market clearance is guaranteed by constraints for each European country and rest of the world.\(^1\)

3.1.1 European countries

\[
PRD_{i,r} + \sum_j PRC_{j,r} PRC_{-Y_{i,j,r}} + IMPEE_{i,r} + IMPEW_{i,r} = CNS_{i,r} + PRC_{i,r} + INT_{i,r} + FED_{i,r} + EXPEE_{i,r} + EXPEW_{i,r}
\]

where:

- \(i, j\) denote the products
- \(r\) denotes European member states
- \(PRD\) production
- \(PRC\) processing
- \(PRC_{Y}\) processing yields
- \(IMPEE\) EU imports from other EU countries
- \(IMPEW\) EU imports from the ROW (an aggregate of the above defined countries or regions)
- \(CNS\) human consumption
- \(INT\) internal use of young animals
- \(FED\) feed use
- \(EXPEE\) EU exports to other European countries
- \(EXPEW\) EU exports to ROW

3.1.2 World countries

\[
SUP_{i,c} + IMPW_{i,c} + IMPWE_{i,c} = USE_{i,c} + EXPW_{i,c} + EXPWE_{i,c}
\]

where:

- \(i\) denotes the products
- \(c\) ROW countries or regions

---

\(^1\) The notation in the paper follows as close as possible the notation in the GAMS program used as technical solution for the described framework. GAMS does not support Greek symbols which prevents a more usual notation in some cases. The authors apologise to readers outside of the project who cannot profit from an easy comparison between the paper and the GAMS program, and suffer from the notation.
3.1.3 Trade balance

Balance of the EU "pool" market for quantities traded between EU countries:

$$\sum_r IMPEE_{i,r} = \sum_r EXPEE_{i,r}$$

.. and of world market quantities traded between EU and the rest of the world:

$$\sum_r IMPEW_{i,r} = \sum_c EXPWE_{i,c}$$

$$\sum_r EXPEW_{i,r} + ITSE_i = \sum_c IMPWE_{i,c}$$

.. and of world market quantities traded among world countries or regions:

$$\sum_c IMPWW_{i,c} = \sum_c EXPWW_{i,c}$$

where:

- ITSE sales on world market from EU intervention stocks
- the other symbols follow the same definitions as in previous sections.

3.2 Demand

3.2.1 Demand for EU member states, Norway and Switzerland

3.2.1.1 Final consumption in EU member states, Norway and Switzerland

Aggregate consumer demand is modelled on the basis of the different countries of Europe (EU + Switzerland + Norway). During simulations, European consumers react to price changes based on double log functions:
\[
\log \left( \text{CNS} \right)_{i,r} = \text{sped}_{i,r} + \sum_j \varepsilon^D_{i,j,r} \log \left( \text{PF} \right)_{i,j,r}
\]

\[
\text{sped}_{i,r} = \log \left( \text{CNS} \right)_{i,r} - \sum_j \varepsilon^D_{i,j,r} \log \left( \text{PF} \right)_{i,j,r}
\]

where:

- CNS denote final consumption quantities
- spd denote the shift parameters of the demand functions
- \( \varepsilon^D \) denote demand elasticities
- PF final consumption price
- s simulation
- t trend

The trend values CNS\(^t\) depict effects of income changes and shifts in the consumption pattern over time. The effects of changes of agricultural income on aggregated consumer demand are neglected. The elasticities are calibrated for a three average around 1993 and stem from various sources. (for details see Witzke & Britz 1998)

### 3.2.1.2 Processing in EU member states, Norway and Switzerland

The SPEL-EU data base covers a number of derived products (rice, molasses, potato starch, sugar, vegetable fats and oils, oil cakes, milk powder, butter and other milk products) which are linked to raw products. The connection is shown in the market balance by the position PPRO (processing) of the raw product and MAPR (marketable production) of the derived one.

Ex-post, the processing yield PRC\(_Y\) for each year and country can be determined by dividing the position “marketable production” (MAPR) from the market balance of the derived product by the processed quantities (PPRO) of the connected raw one:

\[
\text{prc}_y_{i,r} = \frac{\text{MAPR}_{i,r}}{\text{PPRO}_{j,r}}
\]

A processing yield of e.g. 0.5 for a oil cake indicates that crushing 1 t of the oilseed will produce 0.5 t of cake. The processing yield of the base year is used in simulation runs. Processing is hence treated as a linear-limitational production process.
The price difference between the value of the derived products and the raw one is interpreted as processing costs and kept constant per unit, too. Let denote PRC the processed quantities of the raw product $j$. The constant price difference is then defined as

$$PD_{i,r} - \sum_j p_{rc,j} y_{ij} PD_{jr} = \text{const} = PDB_{i,r} - \sum_j p_{rc,j} y_{ij} PDB_{jr}$$

where:

- $PD$ denotes domestic price in the model
- $PDB$ denotes domestic price in the base year

### 3.2.1.3 Feed use in EU member states, Norway and Switzerland

The CAPRI differentiates based on the SPEL-EU data base on the supply side seven “bulk” feeding stuffs $f$ (cereals, protein rich, energy rich, milk based, dried not marketable, fresh and ensilaged not marketable) which are each mixed together from raw and derived products $i$.

The supply part determines the quantities fed of these aggregates $FED$ based on the their average energy, protein and dry matter content and their prices by minimising feed cost under requirement constraints for the animal activities.

For given total use of the "bulk" feeding stuff, the demand part must hence define the shares $SFED$ of the ingredients:

$$\log \left( SFED_{i,r} \right) = spf_{i,r} + \sum_j \varepsilon_{i,j,r} \log \left( PD_{jr} \right)$$

$$FED_{i,r} = \frac{SFED_{i,r}}{\sum_{j \neq f} SFED_{j,r}} BULK_{i,r}$$

Where:

- $SFED$ denote the share of feed $i$ on the related bulk $f$
- $FED$ denote the quantity of feed use
- $BULK$ denote the predetermined quantity of bulk

The parameters $spf$ are calculated based on the base year values:

$$spf_{i,r} = \log (FEDB_{i,r}) - \log (BULK_f) - \sum_j \varepsilon_{i,j,r} \log (PDB_{jr})$$

### 3.2.1.4 EU member states, Norway and Switzerland imports
Armington (1969) approach is used to model substitution among European imports from the EU, world markets and domestic supply. The Armington approach describes the substitution between goods stemming from different markets by constant elasticity of substitution function (CES). The starting equation is an aggregation function for the demand quantities, the so-called "Armington" equation:

\[
DEM = CNS + PRC + FED + INT
= \text{asp} \left[ dpee \ IMPEE^{-\rho e} + dpew \ IMPEW^{-\rho e} + dped \ SLS^{-\rho e} \right]^{1/\rho e}
\]

where:
- DEM is demand (final consumption, processing and feed use)
- IMPEE are European imports from the EU market
- IMPEW are European imports from the world market
- SLS are European domestic supply sales of goods
- asp is a shift parameter
- dp.. are the so-called distribution parameters: \( dpee + dpew + dped = 1 \)
- \( \rho e \) is a constant greater than \(-1\) such that the elasticity of substitution \( \sigma = \frac{1}{1 + \rho e} \)

The Armington equation has constant returns of scale, i.e. if all quantities on the right side are increased by one unit, total demand is increased by the same amount. If we derive from 0 a cost minimisation problem for given demand, demand functions for goods from the different locations \( R \) (IMPEE, IMPEW, SLS) can be derived whose relations are defined as follows (Scheper 1965) for one of the pairs as an example:

\[
\frac{PD}{PIW} = \frac{dped}{dpew} \left( \frac{SLS}{IMPEW} \right)^{\frac{1}{\sigma - \rho e}}
\]

where:
- PIW denotes the price of European imports from the world market

In order to calculate the parameters for given prices and demand quantities in the base year, the following equations are used (let \( R \) denote the quantities and \( P \) the related prices):
The calculation of the missing parameters is straightforward. The actual calculations are sometimes simplified when one of the three quantity positions is missing in the base year.

The integration in the framework of the model is based on the one hand on the Armington equation itself \(0\), and related equations based on \(0\) which determine the relations of the prices based on a cost minimising behaviour for the given Armington:

\[ I \quad dp_1 = dp_2 \left( \frac{R_1}{R_2} \right) \left( \frac{P_1}{P_2} \right) \]

\[ II \quad dp_2 = 1 - dp_1 - dp_3 \]

\[ III \quad dp_3 = dp_2 \left( \frac{R_1}{R_2} \right) \left( \frac{P_1}{P_1} \right) \]

\[ \Rightarrow 1 - dp_1 - dp_3 = dp_2 \left( \frac{R_1}{R_2} \right) \left( \frac{P_1}{P_1} \right) \]

\[ \Rightarrow 1 - dp_2 \left( \frac{R_1}{R_2} \right) \left( \frac{P_1}{P_1} \right) - dp_3 = \left( dp_2 \left( \frac{R_1}{R_2} \right) \left( \frac{P_1}{P_1} \right) \right) \left( \frac{R_1}{R_1} \right) \left( \frac{P_1}{P_1} \right) \]

\[ \Rightarrow 1 = \left( \frac{R_2}{R_1} \right) \left( \frac{P_1}{P_2} \right) + 1 + \left( \frac{R_1}{R_1} \right) \left( \frac{P_1}{P_2} \right) \left( \frac{R_1}{R_1} \right) \left( \frac{P_1}{P_1} \right) \]

\[ \Rightarrow dp_3 = \frac{1}{\left( \frac{R_2}{R_1} \right) \left( \frac{P_1}{P_2} \right) + 1 + \left( \frac{R_1}{R_1} \right) \left( \frac{P_1}{P_2} \right) \left( \frac{R_1}{R_1} \right) \left( \frac{P_1}{P_1} \right) } \]

PD, PTE, PIW denote the domestic, the intra-EU trade and the world import price.
The last of the three equations is redundant if the first two are given and is used in the model only in the case where no imports from the world market occurred in the base year.

As the last element in the Armington approach, the average consumer price PC must be determined, the so-called "absorption" equation:

\[
PC_{i,s} \cdot DEM_{i,s} = SLS_{i,s} \cdot PD_{i,s} + IMPEW_{i,s} \cdot PIW_{i,s} + IMPEE_{i,s} \cdot PTE_{i,s}
\]

### 3.2.2 Demand for rest of world countries or regions

#### 3.2.2.1 Rest of world country or region demand

Contrary to European countries where demand is determined in regional demand models and therefore fixed in the supply part, the non-European country demands are modelled by a double-log function:

\[
\begin{align*}
\log(USE_{i,c}) &= spcd_{i,c} + \sum_j e_{i,j,c}^d \log(PP_{j,c}') \\
spcd_{i,c} &= \log(USE_{i,c}) - \sum_j e_{i,j,c}^d \log(PP_{j,c}')
\end{align*}
\]

#### 3.2.2.2 Rest of world country or region imports

Armington approach is used here also to model substitution among extra-European imports from world markets, the EU, and domestic supply. The Armington approach describes the substitution between goods stemming from different markets by constant elasticity of substitution function (CES). The starting equation is an aggregation function for the demand quantities, the so-called "Armington" equation:

\[
DEM = USE + EXPWW + EXPWE
\]

\[
= asp \left[ dpww \cdot IMPWW^{-\rhohoc} + dpwe \cdot IMPWE^{-\rhohoc} + dpwd \cdot SLS^{-\rhohoc} \right]^{1/\rhohoc}
\]

where:

- \( DEM \) is demand (final consumption, processing and feed use)
- \( IMPWW \) are world country imports from the world market
IMPWE are world country imports from the EU market
SLS are world country domestic supply sales of goods
asp is a shift parameter
dp.. are the so-called distribution parameters: $dpww + dpwe + dpwd = 1$

**rhoc** is a constant greater than $-1$ such that the elasticity of substitution $\sigma = \frac{1}{1 + \rho_{oc}}$

### 3.3 Supply

#### 3.3.1 Supply for EU member states, Norway and Switzerland

##### 3.3.1.1 Domestic Supply
The production quantities stem from the supply part, regionalised optimisation models and are fixed:

$$PRD_{MS,r} = \text{fix}$$

In addition, supply is determined by the quantities stemming from processing:

$$SUP_{MS,r} = PRD_{MS,r} + \sum_{j} PRC_{j,MS} PRC - Y_{i,j,MS}$$

##### 3.3.1.2 Constant Elasticity of Transformation (CET) functions for exports
Analogous to the Armington approach on the demand side, the supply side features a CET function to decide if the supplied quantities are sold in the national, EU or world market. The CET function is an aggregator function for the quantities sold:

$$SUP = csp \left[ gpee \ IMPEE^{-\rho_{ote}} + gpew \ IMPEW^{-\rho_{ote}} + gped \ SLS^{-\rho_{ote}} \right]^{1/\rho_{ote}}$$

where:

- **csp** denotes the shift parameter of the CET function
- **gp..** denotes the distribution parameters of the CET function
- **rhote** is a constant smaller than 1 such that the transformation elasticity of substitution $\sigma = \frac{1}{1 + \rho_{ote}}$
By defining a profit maximisation problem based on $0$, the following definition functions for the price relations can be derived:

$$\frac{PD_{i,r}}{PEW_{i,r}} = \frac{gped_{i,r}}{gpew_{i,r}} \left[ \frac{EXPEW_{i,r}}{SLS_{i,r}} \right]^{-\sigma}$$

$$\frac{PTE_{i,r}}{PEW_{i,r}} = \frac{gpee_{i,r}}{gpew_{i,r}} \left[ \frac{EXPEW_{i,r}}{IMPEW_{i,r}} \right]^{-\sigma}$$

$$\frac{PD_{i,r}}{PTE_{i,r}} = \frac{gped_{i,r}}{gpee_{i,r}} \left[ \frac{EXPEE_{i,r}}{SLS_{i,r}} \right]^{-\sigma}$$

The last of the three equations is redundant if the first two are given and is used in the model only in the case where no exports to the world market occurred in the base year.

As the last element in the CET approach, the average producer price $PP$ must be determined:

$$PP_{i,r}^{SUP} = SLS_{i,r}^{PD} + EXPEW_{i,r}^{PEW} + EMPEE_{i,r}^{PTE}$$

### 3.3.2 Supply for rest of world countries or regions

#### 3.3.2.1 Domestic supply

Contrary to European countries where supply is determined in regional supply models and therefore fixed in the demand part, the non-European country supplies are modelled by a double-log function:

$$\log(SUP_{i,c}^t) = sps_{i,c} + \sum_j \varepsilon_{i,j,c}^S \log(P_{P,j,c}^t)$$

$$sps_{i,c} = \log(SUP_{i,c}^t) - \sum_j \varepsilon_{i,j,c}^S \log(P_{P,j,c}^t)$$

The parameters for the net trade response of rest of the world are based on elasticities and base data from WATSIM (Lampe 1997). However, as often in so-called “heuristic approaches, some treatment is necessary to adjust borrowed parameters to the model at hand.

WATSIM differentiates between supply, final demand and feed elasticities, the later ones depicting substitution between feeding stuff for a given total constant energy content.
Therefore, the feed elasticities were converted first to “normal” ones by adding the effect of the supply reaction of the animal products on total energy intake.

The product coverage of WATSIM is less differentiated than in the case of CAPRI. Hence, a mapping from CAPRI to WATSIM products was defined. Let i and j denote the products from CAPRI, k and l the products from WATSIM and g(i,k) a mapping set. The net trade elasticities for rest of the world $\varepsilon_{\text{row}}$ were then defined based on the elasticities from WATIM $\varepsilon_{\text{wat}}$ as follows:

$$
\varepsilon_{i,j}^{\text{row}} = \varepsilon_{k,k}^{\text{wat}} \land g(i,k) \forall i \\
\varepsilon_{i,j}^{\text{row}} = \varepsilon_{k,l}^{\text{wat}} \land g(i,k) \land g(j,l) \forall i,k \neq l \\
\varepsilon_{i,j}^{\text{row}} = -0.1\varepsilon_{k,k}^{\text{wat}} \land g(i,k) \land g(j,k) \forall i,i \neq j
$$

Before the shift parameters of the double log function for non-European countries can be calculated, consistency between net trade positions derived from the WATSIM and the SPEL/EU data base must be ensured. If the sign of the net trade is identical, feed, demand and supply for rest of world are scaled with an uniform correction factor. Otherwise, in the case of exports reported in the WATSIM data base for rest of the world, final demand and feed are increased to ensure the consistency. In the remaining cases, the supply side is adjusted.

### 3.3.2.2 Constant Elasticity of Transformation (CET) functions for exports

Analogous to the Armington approach on the demand side, the supply side features a CET function to decide if the supplied quantities are sold in the national, EU or world market. The CET function is an aggregator function for the quantities sold:

$$
SUP = csp [gp\text{we IMPWE}^{\text{cet}} + gp\text{ww IMPWW}^{\text{cet}} + gp\text{wd SLS}^{\text{cet}}]^\text{cet}
$$

where:

- $csp$ denotes the shift parameter of the CET function
- $gp..$ denotes the distribution parameters of the CET function
- $\rho_{\text{hotw}}$ the transformation elasticity multiplied by minus unity

By defining a profit maximisation problem based on $0$, the following definition functions for the price relations can be derived:
The last of the three equations is redundant if the first two are given and is used in the model only in the case where no exports to the world market occurred in the base year.

As the last element in the CET approach, the average producer price \( PP \) must be determined:

\[
PP_{i,t} = SLS_{i,t} PD_{i,t} + \text{EXPWW}_{i,t} PEW_{i,t} + \text{EMPWE}_{i,t} PTE_{i,t}
\]

### 3.4 Price transmission

Prices in the model have three dimensions: per product, per regions and differentiated by producer (raw product) and consumer (manufactured in raw product equivalent) prices.

#### 3.4.1 Price transmission between EU pool and Rest of the World

The price transmission between the Rest of the World and EU-pool is based on trade instruments (tariffs, flexible levies). The price for imported goods inside the EU is therefore determined as:

\[
PIW_{i,EU} = PEW_{i,W} \left(1 + TARR_i \right) + \text{TARS}_i + \text{FLEV}_i
\]

where:

- \( TARR \) denotes relative (ad-valorem) tariff
- \( TARA \) denotes absolute (specific) tariff
- \( FLEV \) denotes flexible levy

The price for exports from the EU to the world market is set equal to the price for imports inside rest of the world:

\[
PWE_{i,EU} = PEW_{i,W}
\]
3.4.2 Price transmission between Member State and EU pool

As long as no further data sources are available, the trade prices across the EU member states are set equal:

\[ PIW_{i,MS} = PIW_{i,EU} \]
\[ PTE_{i,MS} = PTE_{i,EU} \]
\[ PEW_{i,MS} = PEW_{i,EU} \]

3.4.3 Determination of flexible levies

Flexible levies are introduced only if the EU border price plus exogenously pre-determined tariffs falls below a predefined administrative entry or threshold price PADM:

\[ \left( WP_i^r \left( 1 + TARR_i \right) + TARS_i - PADM_i \right) FLEV_i \leq 0 \]

Additionally, flexible levies can be applied only if the EU pool price is equal or below the administrated one:

\[ \left( EUP_i^r - PADM_i \right) FLEV_i \leq 0 \]

The two constraints are quadratic and not-differentiable, however tests with the model did not reveal problems.

3.4.4 Price transmission between consumer and producer prices

As found in a lot of other studies, differences between consumer and producer prices are kept fixed in absolute terms according to observed levels of the base year.

\[ PF_{i,r} - PC_{i,r} = const = PFB_{i,r} - PCB_{i,r} \]

The differences is interpreted as covering all costs occurring between the farm gate and the retail shop. The final consumption prices in the base year PFB are calculated along the lines of Schein 1993.

3.5 Market equilibrium
Market clearance is enforced by constraints for each country and the EU pool market. Artificial slacks are introduced in the market balances whose squares enter the objective. They allow the model to "survive" small numerical deviations from equal conditions in the complex NLP framework.

4 Technical solution

The equations shown so far had been written in GAMS and integrated to form a quadratic programming model with partially linear, partially non-linear constraints. In order to make result listing easy to read, automatic scaling was used. High upper bounds in critical variables (prices, consumption and feed quantities) of thousand times the base year value allow an easy comparison of current results to the base year situation without influencing the solution.

In order to speed up the solution process, it is worth to fix variables were only small levels were observed in the base year. Start values for all endogenous variables were set to the base year levels. CONOPT2 was used as the solver.

GAMS allows by so-called options files to change certain control parameters of the solvers. Changes to these input parameters were few: in order to account for the dimensions used on the SPEL data base, the values for the maximum values of variable and their Jacobian elements were raised.

5 Symbols used

Indices:

r EU regions
c World countries or regions
i, j products
f feeding stuff aggregates
b base year
s simulation
t trend
**Endogenous variables:**

*Prices and price elements*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PP</td>
<td>Producer price</td>
</tr>
<tr>
<td>PC</td>
<td>Consumer price</td>
</tr>
<tr>
<td>PF</td>
<td>Final demand price</td>
</tr>
<tr>
<td>PD</td>
<td>Domestic price</td>
</tr>
<tr>
<td>PTE</td>
<td>Trade price internal of EU</td>
</tr>
<tr>
<td>PIW</td>
<td>Import price for goods from world market</td>
</tr>
<tr>
<td>PEW</td>
<td>Export prices for goods to world market</td>
</tr>
<tr>
<td>FLEV</td>
<td>Flexible levy</td>
</tr>
</tbody>
</table>

*Quantities*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRD</td>
<td>Marketable Production minus seed and industrial use</td>
</tr>
<tr>
<td>CNS</td>
<td>Human consumption</td>
</tr>
<tr>
<td>PRC</td>
<td>Processed quantities</td>
</tr>
<tr>
<td>FED</td>
<td>Feed use</td>
</tr>
<tr>
<td>SFED</td>
<td>Share of ingredients on bulk feeding stuff</td>
</tr>
<tr>
<td>INT</td>
<td>Internal use of young animals</td>
</tr>
<tr>
<td>SUP</td>
<td>Domestic supply from agricultural production and processing</td>
</tr>
<tr>
<td>DEM</td>
<td>Domestic demand (human consumption, processing, feed use, internal use of young animals)</td>
</tr>
<tr>
<td>IMPEE</td>
<td>European country imports from the EU market</td>
</tr>
<tr>
<td>EXPEE</td>
<td>European country exports to the EU market</td>
</tr>
<tr>
<td>IMPEW</td>
<td>European country imports from world market</td>
</tr>
<tr>
<td>EXPEW</td>
<td>European country exports to world market</td>
</tr>
<tr>
<td>IMPWE</td>
<td>World country imports from European market</td>
</tr>
<tr>
<td>EXPWE</td>
<td>World country exports to European market</td>
</tr>
</tbody>
</table>
IMPWW  World country Imports from world market
EXPWW  World country Exports to world market
ITS     Intervention sales to stock

*Functional Parameters*

spd     constant parameters of double log demand function
spf     constant parameters of double log feed share function
sps     constant parameters of double log supply function
rhoe    constant greater than –1
rhoc    constant greater than –1

\[ \sigma = \frac{1}{1 + \rho_{\text{e}}} \]  Transformation elasticity parameter of Armington function

\[ \sigma = \frac{1}{1 + \rho_{\text{c}}} \]  Transformation elasticity parameter of Armington function

asp     Armington function shift parameter
dped, dpee, dpew     distribution parameter of Armington function of a European country
dpcd, dpce, dpcw     distribution parameter of Armington function of a world country
rhot    constant greater than –1

\[ \sigma' = \frac{1}{1 + \rho_{\text{t}}} \]  Transformation elasticity parameter of Armington function

csp     CET function shift parameter
gped, gpee, gpew    distribution parameter of CET function of a European country
gpcd, gpce, gpcw    distribution parameter of CET function of a world country
prec_y  processing yield

PADM    Administered prices
6 References


Scheper W.: Produktionsfuntionen mit konstanten Substitutionselastizitäten, in: Jahrbuch für Nationalökonomik und Statistik, Bd.177 1-21


