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CAPSIM - Documentation of Model Structure and Implementation

Table of contents

CAPSIM - Documentation of Model Structure and Implementation

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1. Introduction

CAPSIM is the most recent modelling tool for policy relevant analysis of the CAP, which was developed on behalf of Eurostat. Since the early 1980s Eurostat supported the development of a complete, consistent, up to date database for modelling efforts world-wide ("SPEL/EU Base System"). These activities were soon complemented to set up the "SPEL/EU Medium-term Forecasting and Simulation System" (MFSS) which was applied on various occasions for the EU Commission (see Henrichsmeyer 1995 for this history).

Nonetheless the grown complexity of MFSS together with its FORTRAN written code rendered it finally quite intransparent such that in the beginning of 1999 Eurostat lanced a new effort to trigger the development of a transparent, flexible and user-friendly policy information system for the CAP. The new system should also rely on Eurostat data, in particular on the revised EAA, but it should only retain those elements of MFSS, which turned out useful. The corresponding tender was won by the European Centre for Agricultural, Regional and Environmental Policy Research (EuroCARE) in Bonn, which had intimate knowledge about strengths and weaknesses of this historically grown modelling framework. Among the few characteristics maintained was an activity-based structure on the supply side. The first phase in system development resulted in the so-called "MFSS99" model (Witzke, Verhoog, Zintl 2001) which achieved a significant increase in technical transparency when moving from FORTRAN to the GAMS code. The second phase of model development was devoted to address a certain number of unresolved problems, keeping in mind later applicability to the Candidate Countries:

Improvements on the database

The base year has been updated to 1997/99, incorporating the revised Economic Accounts on Agriculture (EAA) data, an improved procedure to ensure completeness and consistency of the database, revised consumer and feed prices, a disaggregated milk sector, revised procedures for trend projections and various improvements on other issues. More time than planned and desired was invested on these tasks as some difficulties were recognised only gradually. The model covers the EU15 Member States, aggregated to a single region in case of Belgium and Luxembourg, whereas the Candidate Countries have not been included when this documentation was prepared (2003).

[1] Both EuroCARE Bonn. While funding and guidance by Eurostat is acknowledged the views expressed in this documentation are the authors' and do not necessarily reflect the opinions of the European Commission. Critical remarks by Gerald Weber, David Verhoog and the CAPSIM reference group greatly improved our work, but all remaining errors are ours.

Improvements on parameters and functional forms

MFSS99 relied on double log behavioural functions, which could not maintain microeconomic consistency globally and had to rely on crude assumptions or fairly old sets of elasticities. On the contrary, CAPSIM features demand and supply side systems fully consistent with microtheory. All parameters have been re-calibrated incorporating whatever a priori information was available. The calibration procedures developed should be applicable to Candidate Countries as well after suitable modification. An innovative approach has been developed to incorporate balances on energy and protein in the revised supply side.

Additional model components

A simplified budget component and a component for consumer and processing industry welfare automatically permit to give a complete welfare analysis for each policy simulation rather than only agricultural income effects. The sugar CMO has been incorporated with considerable detail at least compared to most other complete sector models. EU border prices are rendered endogenous now with the help of a very simple trade component.

User-friendliness

Ad hoc specification of exogenous parameters in the source code has been replaced with transparent import from input files. Exogenous input facilities have been thoroughly reorganised. Various options for exogenous input to the reference run have been created which are automatically taken over in policy simulations. This improves the clarity of the source code and helps the user to translate his ideas into corresponding technical specifications. Additional output facilities have been created.

The following report gives a rather detailed account of the revised model and the associated infrastructure. It should help the model expert reading the source code to understand the technical solution and comments therein, such that variable names have been chosen similar to those in the code if readability permits. Operators of CAPSIM using GSE should find a detailed explanation of the model's functionality. They will find additional help in Appendix II: User Manual . Finally readers and users of model results should find the information necessary for a correct interpretation and evaluation of these results. Appendix III: Coverage of Candidate Countries is an illustration of current capabilities and their limitations to cover Canditate Countries.

The next section 2 presents the "Model structure and empirical specification". The following section 3 is on different types of "Model input" from the database, policy variables to exogenous expert data. This has the character of a general reference manual whereas Appendix II: User Manual is an introduction for operators. Section 4 presents "Model output" in different technical forms, which are available to users. The next section 5 "Software" gives additional guidance through the interlinked set of programs. A final main section 6 presents Options for further development".

2. Model structure and empirical specification

CAPSIM is a straightforward partial equilibrium modelling tool with behavioural functions for activity levels, input demand, consumer demand and processing. It is designed for policy relevant analysis of the CAP and consequently covers the whole of agriculture of EU Member

States in the concepts of the EAA in a high level of disaggregation, both in the list of included items as well as in policy coverage. The sector wide approach is an opportunity to recognise various interdependencies within the sector but it is also a challenge regarding the empirical specification. A firm microeconomic basis is considered useful here to increase the plausibility of simulation behaviour, to understand the models properties and to substitute to some extent for thorough econometric analysis which has not been possible so far given available resources. This exposition will explain the model structure from the theoretical background to the empirical specification in some detail, however omitting less important special cases and some empirical aspects of the implementation which are described in detail in the comments included in the GAMS code.

The following description will distinguish several components:

- The supply component with supply of agricultural products and input demand,
- the final demand component portraying consumer behaviour,
- the market and policy component including the linkage to world markets,
- and finally auxiliary output routines.

We will use the following notation[2]:

Table 2.1-1: Notational principles

Item	**Example**	**Notation**
Exogenous variables for all values of set indices (possibly changed in different simulations)	$\underline{\mathrm{XY}}$	At least two upper-case Latin letters, underlined
Exogenous variables for some values of set indices, endogenous for other values	*XY*	At least two upper-case Latin letters in italics
Endogenous variables for all values of set indices	XY	At least two upper-case Latin letters in regular font
Matrix of endogenous Variables	**XY**	At least two upper-case Latin letters in bold font
Parameters (invariant in different simulations)	α	Single small Greek letters
Matrix of parameters	**A**	Single upper-case Latin letters in bold font
Indices	i,j	Single small Latin letters
Functions	$\pi(.)$, V(.)	Single small Greek letters or single upper-case Latin letters in regular font
Sets	ITEM	Upper-case Latin letters in regular font
Set members	SHWE	Small caps

2 A variable is considered exogenous if it is a policy instrument or if it is directly determined by exogenous assumptions, for example trends. All other variables are considered at least formally endogenous.

2.1 Supply side

2.1.1 Conceptual framework

Exogenous yields

Yields are assumed to be exogenous, specified according to recent trends. There is empirical some evidence to the contrary (Jensen 1996; Guyomard, Baudry, Carpentier, 1996), but it appears that variations in intensity add little to the total supply response. It appeared therefore that some benefits of a simplified structure were available at rather low cost. The specification for production is therefore:

PRD_[3] $$PRD_{m,i} = \Sigma_j \left(\underline{YLD}_{m,i,j} * LVL_{m,j}\right) \qquad (1)$$

where

$PRD_{m,i}$ = production of item i ∈ ITEM in Member State m

$LVL_{m,j}$ = level (usually ha or hd) of production (crop or animal) activity j ∈ PACT in EU Member State m

$\underline{YLD}_{m,i,j}$ = (exogenous) yield of activity j in terms of output i in Member State m

Profit function framework

An innovative element on the supply side will be to combine the dual profit function approach with some aspects of an explicit primal technology description, namely explicit land and nutrient constraints. In this way we may impose some technological constraints, but without the requirement to specify the primal technology in full detail as would be the case in a standard programming model. Because we want to use microeconomic restrictions in the calibration of behavioural functions, we will proceed from a standard profit maximisation setting and end up with behavioural functions firmly rooted in this framework. Activity levels and input demands are thus considered maximising choices of the Member State's agricultural sector, subject to balances on land, energy and protein (to be included explicitly in CAPSIM), and an additional technology constraint T_m. The latter summarises the effects of other nutrients and scarce labour and capital, which are not explicitly represented in CAPSIM:

$$\begin{aligned}
&\tilde{\pi}_m(\mathbf{REV}_m, \mathbf{PP}_m) = \\
&\max_{\mathbf{LVL}_m, \mathbf{INP}_m} \Big\{ \mathbf{REV}_m{}' \boldsymbol{LVL}_m - \mathbf{PP}_m{}' \mathbf{INP}_m : \\
&\quad \underline{\text{AREA}} = \textstyle\sum_j \lambda_{m,j} LVL_{m,j} \\
&\quad \sum_{j \in AACT} \eta_{m,j} LVL_{m,j} = \sum_{i \in FEED} \eta_{m,i} \text{INP}_{m,i} \\
&\quad \sum_{j \in AACT} \rho_{m,j} LVL_{m,j} = \sum_{i \in FEED} \rho_{m,i} \text{INP}_{m,i} \\
&\quad T_m(\boldsymbol{LVL}_m, \mathbf{INP}_m) = 0 \Big\}
\end{aligned} \qquad (2)$$

[3] If an equation of this documentation corresponds closely with an equation from the code of the CAPSIM core model, we give its GAMS name for the reader interested in the technical implementation.

where

$\tilde{\pi}_m$	=	profit function in Member State m
$\mathbf{REV}_m$	=	column vector of revenues $REV_{m,j}$ of activity j $\in$ PACT in Member State m
$\boldsymbol{LVL}_m$	=	column vector of levels $LVL_{m,j}$ of activity j $\in$ PACT in Member State m
$\mathbf{PP}_m$	=	column vector of producer prices $PP_{m,i}$ of input i $\in$ NOFEED $\cup$ FEED in Member State m
$\mathbf{INP}_m$	=	column vector of quantities $INP_{m,i}$ of input i $\in$ NOFEED $\cup$ FEED in Member State m
$\underline{AREA}_m$	=	Total (arable) area in Member State m (= total less grassland)
$\lambda_{m,j}$	=	land requirement of activity j (=0 for j$\in$ AACT) in Member State m
$\eta_{m,s}$	=	energy requirement (s $\in$ AACT) or content (s $\in$ FEED) in Member State m
$\rho_{m,s}$	=	protein requirement (s $\in$ AACT) or content (s $\in$ FEED) in Member State m
T_m	=	technology constraint in Member State m

Forming the Lagrangean corresponding to problem (2),

$$\begin{aligned}
&\tilde{L}_m(\mathbf{LVL}_m, \mathbf{INP}_m, PLND_m, PENE_m, PPRT_m, PT_m) \\
&= \mathbf{REV}_m' \,\boldsymbol{LVL}_m - \mathbf{PP}_m' \,\mathbf{INP}_m \\
&+ PLND_m \cdot \left(\underline{AREA} - \sum_{j \in CACT} LVL_{m,j} \right) \\
&+ PENE_m \cdot \left(\sum_{i \in FEED} \eta_{m,i} INP_{m,i} - \sum_{j \in AACT} \eta_{m,j} LVL_{m,j} \right) \\
&+ PPRT_m \cdot \left(\sum_{i \in FEED} \rho_{m,i} INP_{m,i} - \sum_{j \in AACT} \rho_{m,j} LVL_{m,j} \right) \\
&+ PT_m \cdot T_m(\boldsymbol{LVL}_m, \mathbf{INP}_m)
\end{aligned} \tag{3}$$

will yield among the first order conditions (for nonnegative variables):

$$REV_{m,j} - PLND_m \lambda_{m,j} - PENE_m \eta_{m,j} - PPRT_m \rho_{m,j} = -PT_m T_{m,j} \tag{4}$$

and

$$PP_{m,i} - PENE_m \eta_{m,i} - PPRT_m \rho_{m,i} = PT_m T_{m,i} \tag{5}$$

where

$REV_{m,j}$	=	revenue of activity j $\in$ PACT in Member State m
$PP_{m,i}$	=	producer price for input i $\in$ NOFEED $\cup$ FEED in Member State m
λ_j	=	land requirement of activity j (=0 for j$\in$ AACT)
$\eta_{m,s}$	=	energy requirement (s $\in$ AACT) or content (s $\in$ FEED) in Member State m

$\rho_{m,s}$	=	protein requirement ($s \in$ AACT) or content ($s \in$ FEED) in Member State m
$PLND_m$	=	shadow rental price of land in Member State m
$PENE_m$	=	shadow price of energy in Member State m
$PPRT_m$	=	shadow price of protein in Member State m
PT_m	=	shadow price of technology constraint T_m in Member State m
$T_{m,s}$	=	derivative of technology constraint T_m wrt activity $s \in$ PACT or input $s \in$ NOFEED $\cup$ FEED in Member State m

With explicit assumptions on the technology constraint (T_m), we could solve equations (4) and (5) for the shadow price (PT_m) and the behavioural functions ($\boldsymbol{LVL}_m$, $\mathbf{INP}_m$) in terms of net revenues and net prices:

SREV_

$$NREV_{m,j} = REV_{m,j} - \lambda_{m,j} * PLND_m - \eta_{m,j} * PENE_m - \rho_{m,j} * PPRT_m \qquad (6)$$

and

PTN_

$$NP_{m,i} = PP_{m,i} - \eta_{m,i} * PENE_m - \rho_{m,i} * PPRT_m \qquad (7)$$

where

$NREV_{m,j}$	=	net (shadow) revenue of activity $j \in$ PACT in Member State m
$NP_{m,i}$	=	net price of item $i \in$ NOFEED $\cup$ FEED in Member State m

and other symbols as explained under equations (4) and (5).

However, this would be the approach in a programming model based on the same technology assumptions. To move to the dual specification in CAPSIM rewrite the Lagrangean (3) as follows, using definitions (6) and (7) from above:

$$\begin{aligned} &\tilde{L}_m(\boldsymbol{LVL}_m, \mathbf{INP}_m, PLND_m, PENE_m, PPRT_m, PT_m) = \\ &L_m(\boldsymbol{LVL}_m, \mathbf{INP}_m, PT_m) \\ &+ PLND_m \cdot \underline{AREA} = \\ &\mathbf{NREV}_m' \boldsymbol{LVL}_m - \mathbf{NP}_m' \mathbf{INP}_m + PT_m \cdot T_m(\boldsymbol{LVL}_m, \mathbf{INP}_m) \\ &+ PLND_m \cdot \underline{AREA} \end{aligned} \qquad (8)$$

Function L_m may be recognised as the Lagrangean of a simplified profit maximisation problem, which disregards the existence of land and nutrient constraints and takes the net revenues and residual prices as parametric:

$$\begin{aligned} &\pi_m(\mathbf{NREV}_m, \mathbf{NP}_m) \\ &= \max_{\mathbf{LVL}_m, \mathbf{INP}_m} \left\{ \mathbf{NREV}_m' \boldsymbol{LVL}_m - \mathbf{NP}_m' \mathbf{INP}_m : T_m(\boldsymbol{LVL}_m, \mathbf{INP}_m) = 0 \right\} \end{aligned} \qquad (9)$$

where

π_m	=	profit function in Member State m (in terms of $\mathbf{NREV}_m$ and $\mathbf{RP}_m$)
$\boldsymbol{LVL}_m$	=	column vector of levels $LVL_{m,j}$ of activity j $\in$ PACT in Member State m
$\mathbf{NREV}_m$	=	column vector of shadow revenues $NREVS_{m,j}$ of activity j $\in$ PACT in Member State m
$\mathbf{INP}_m$	=	column vector of quantities $INP_{m,i}$ of input i $\in$ FEED $\cup$ NOFEED in Member State m
$\mathbf{NP}_m$	=	column vector of net prices $NP_{m,i}$ of input i $\in$ FEED $\cup$ NOFEED in Member State m

Remembering the definitions (6) and (7) we note that the first order conditions of the simplified problem (9) are identical to those of the full problem (2), except for the fact that the land and nutrient constraints are missing. These constraints are required to determine the appropriate values for the shadow prices $PLND_m$, $PENE_m$, and $PPRT_m$, see below. However, conditional on certain values of these shadow prices, problem (9) will define a standard system of behavioural functions as profit maximising solutions of (4) and (5) in terms of net revenues (6) and net prices (7). This is the theoretical framework for the supply side in CAPSIM. It incorporates the technology constraint (T_m) in its dual representation that is in terms of a profit function.

Explicit constraints

To determine the shadow prices of land and nutrients we have to add the explicit constraints:

LBAL_ $$\underline{AREA}_m = \Sigma_j LVL_{m,j} \tag{10}$$

ENPRBAL_ $$\Sigma_j \eta_{m,j} * LVL_{m,j} = \Sigma_f \eta_{m,f} * INP_{m,f} \tag{11}$$

ENPRBAL_ $$\Sigma_j \rho_{m,j} * LVL_{m,j} = \Sigma_f \rho_{m,f} * INP_{m,f} \tag{12}$$

where

$\underline{AREA}_m$	=	Total (arable) area in Member State m
$LVL_{m,j}$	=	level of activity j $\in$ CACT in Member State m
$INP_{m,f}$	=	demand for feed input f $\in$ FEED in Member State m
$\eta_{m,s}$	=	energy requirement (s $\in$ AACT) or content (s $\in$ FEED) in Member State m
$\rho_{m,s}$	=	protein requirement (s $\in$ AACT) or content (s $\in$ FEED) in Member State m

Note that (11) and (12) do not guarantee that the requirements *will* be met for each animal activity, only that they *can* be met. In fact, as long as sufficiently reliable information on the allocation of feedstuffs across activities is not available, this allocation is considered unobservable and therefore not to be modelled. An explicit modelling of the feed allocation is beyond the scope of CAPSIM. Nonetheless, controlling aggregate balances on energy and protein are useful means to check the consistency of simulation results for animal production and feed demand which is ignored in traditional approaches relying on behavioural functions, in contrast to programming approaches (e.g. McKinzie, Paarlberg, Huerta 1986).

The essence of our approach is first to rewrite a restricted profit function which depends on fixed (nonjoint) factor quantities in an unrestricted form which depends on (shadow) resource prices and second to add explicit balances for these resources with fixed supply to determine these prices. In this approach scarcity of land (demand exceeding $\underline{AREA}_m$), for example, would translate itself into rising rental values of land, hence declining shadow revenues of crops and finally reduced levels of crop activities until the land balance is met. A similar response will be triggered by increased scarcity of nutrients: Increased resource costs for nutrients will first reduce net revenues and then activity levels of animal activities according to the parameters of the sectoral profit function. At the same time, the "residual prices" of feed will be reduced; leading to a complementary increase of feed demand which contributes to restore the balance on aggregate energy and protein.

In a (quantity dependent) restricted profit function framework these nutrients would be considered fixed factors with a zero endowment. Because this endowment is fixed, no parameters could be identified which capture explicitly the effects of nutrient scarcity. The existence of nutrient constraints would be incorporated in all other parameters of the profit function, hopefully. Implicitly, a traditional restricted profit function may be perfectly consistent with nutrient balances as well. However, the solution implemented in CAPSIM permits to check consistency, rather than hoping for it.

As an (ad hoc) safeguard against negative land prices, fallow land (usually also exogenous) may increase by up to 30% of arable land if the land price tends to drop below 10% of the base year value[4]:

FALL_

$$\begin{aligned} LVL_{m,FALL} &= \underline{LVL}_{m,FALL} \\ &+ 0.3\underline{AREA}_m \cdot 0.5\left(1-\frac{PLND_m}{0.1\beta_{PLND,m}}+\sqrt{\left(1-\frac{PLND_m}{0.1\beta_{PLND,m}}\right)^2+\varepsilon_F}\right) \end{aligned} \tag{13}$$

where

$\underline{AREA}_m$ = Allocatable (arable) area in Member State m

$LVL_{m,FALL}$ = simulated level of fallow land in Member State m

$\underline{LVL}_{m,FALL}$ = exogenous projection for fallow land in Member State m

$PLND_m$ = shadow rental price of land in Member State m

$\beta_{PLND,m}$ = base year rental price of land in Member State m

ε_F = small positive number (= 0.001)

Note that the large bracket evaluates to a small positive number as long as $PLND_m > 0.1\beta_{PLND,m}$ but approaches 2 as $PLND_m \to 0$. For nutrient prices a comparable slack outlet for energy or protein might be a "waste" activity, but this has not yet been implemented. Nonetheless nutrient prices have been usually positive in recent simulations.

[4] We owe this idea of a built in "safeguard" to a suggestion from the CAPSIM Reference Group (RG). However, the thresholds chosen are pure guesstimates.

Behavioural functions

In problem (9) the optimising agricultural sector takes net revenues and "residual" prices as given, such that behavioural functions for activity levels and input demands follow from the envelope theorem:

LVL_ $$LVL_{m,j} = \partial\pi_m / \partial NREV_{m,j} \quad (14)$$

INP_ $$INP_{m,i} = -\,\partial\pi_m / \partial NP_{m,I} \quad (15)$$

where

π_m	=	profit function in Member State m
$LVL_{m,j}$	=	level of activity j $\in$ PACT in Member State m
$NREV_{m,j}$	=	net revenue of activity j $\in$ PACT in Member State m,
$INP_{m,i}$	=	demand for input j $\in$ FEED $\cup$ NOFEED in Member State m
$NP_{m,i}$	=	net price for input i $\in$ FEED $\cup$ NOFEED in Member State m,

Functional form

The first step in the empirical implementation will be the choice of a suitable functional form. In this choice we restrict ourselves to flexible and globally well-behaved examples. The former property is necessary if we want to be able to incorporate any (theoretically consistent) information, which is available in the literature on elasticities. The latter is necessary if we want to maintain theoretical consistency during simulations (in contrast to the predecessor model MFSS99). The most frequently used forms with the above properties are the Normalised Quadratic, the Generalised Leontief and the Symmetric Generalised McFadden (see Oude Lansink, Thijssen 1998 for an empirical comparison). We will work with the Normalised Quadratic (NQ):

$$\pi_m(\mathbf{RN}_m) = \alpha_{m,0,0} + \Sigma_s\, \alpha_{m,s,0}\, RN_{m,s} + \Sigma_s \Sigma_t\, \alpha_{m,s,t}\, RN_{m,s}\, RN_{m,t} \quad (16)$$

where

$$\mathbf{RN}_m = (\mathbf{NREV}_m, \mathbf{PP}_{m,NOFEED}, \mathbf{NP}_{m,FEED})' / PP_{m,REST} \quad (17)$$

and

π_m	=	normalised profit function in Member State m
$\mathbf{RN}_m$	=	column vector of price variables s normalised by the general price index $PP_{m,REST}$ in Member State m
$\mathbf{NREV}_m$	=	column vector of net revenues $NREV_{m,j}$ of activity j $\in$ PACT in Member State m
$\mathbf{PP}_{m,NOFEED}$	=	column vector of producer prices $PP_{m,i}$ of input i $\in$ NOFEED (with $\eta_{m,i} = \rho_{m,i} = \lambda_{m,i} = 0$) in Member State m
$\mathbf{NP}_{m,FEED}$	=	column vector of net prices $RP_{m,i}$ of input i $\in$ FEED in Member State m
α_m	=	parameter matrix of the profit function in Member State m

This yields the following linear behavioural functions for netputs:

LVLNET_, INPNET_ $$NETP_{m,s}(\mathbf{RN}_m) = \partial\pi_m/\partial RN_{m,s} = \alpha_{m,s,0} + \Sigma_t \alpha_{m,s,t} RN_{m,t} \quad (18)$$

where

LVL_ $$NETP_{m,s} = LVL_{m,s} \text{ for } s \in PACT \quad (19)$$

INP_ $$NETP_{m,s} = -INP_{m,s} \text{ for } s \in INDINP \cup FEED \quad (20)$$

and other symbols as explained after (17).

Supply side elasticities $SEL_{m,s,t}$ with respect to price variables may be derived as

$$SEL_{m,s,t} = \frac{\partial NETP_{m,s}}{\partial RN_{m,t}} \cdot \frac{RN_{m,t}}{NETP_{m,s}} = \alpha_{m,s,t} \cdot \frac{RN_{m,t}}{NETP_{m,s}}, \quad t \neq REST \quad (21)$$

$$SEL_{m,s,REST} = \frac{\partial NETP_{m,s}}{\partial RN_{m,REST}} \cdot \frac{RN_{m,REST}}{NETP_{m,s}} = -\sum_{t \neq REST} \alpha_{m,s,t} \cdot \frac{RN_{m,t}}{NETP_{m,s}} \quad (22)$$

For our purposes the Normalised Quadratic has a number of advantages. Compared to the Symmetric Generalised McFadden, it is much simpler. Compared to the Generalised Leontief form used earlier, the linear behavioural functions of the NQ may be less attractive but they certainly help to implement the innovative characteristic of CAPSIM: Balances on land, energy and protein are incorporated through the definition of net revenues and net feed prices which render $\mathbf{NREV}_m$ and $\mathbf{NP}_{m,FEED}$ endogenous due to the shadow prices for these constraints. As net revenues might become negative during simulations it is convenient to work with a functional form defined over the entire real line.

Homogeneity is built in through normalisation, symmetry helps to reduce the number of free parameters in α_m and convexity will be imposed during the calibration with the Cholesky decomposition. As is the case with the Generalised Leontief, the constants of the behavioural functions (parameters $\alpha_{m,s,0}$) may be translated over time to reflect technological change. No adjustments on other elements of $\boldsymbol{\alpha}_m$ are required to maintain microeconomic consistency. This property will be exploited in the reference run to conveniently implement exogenous forecasts (see Appendix II: User Manual).

2.1.2 Parameter specification

Accounting for heterogeneous land quality

As mentioned in the introduction, the parameters will be calibrated to reproduce a base year rather than to estimate it on a whole time series of observations. This base year situation is more complex than assumed so far because there is a significant regional variation of land quality, which may be captured by parameters $\lambda_{m,j}$ in equation (6). Consequently it is not assumed that the same absolute price of land applies to, say, vegetables as well as to cereals. However, it is still plausible that local land markets are sufficiently tied together to make for land prices of all qualities move together. It is assumed that relative land qualities $\lambda_{m,j}$ are related to gross revenues relative to the soft wheat gross revenue. This relationship was assumed to be somewhat less than proportional:

$$\lambda_{m,j} = (NREV_{m,j} / NREV_{m,SWHE})^{0.8} \quad (23)$$

The land price $PLND_m$ in equation (6)has been specified such that the smallest net revenue is 30% of the corresponding gross revenue, thus making sure that all crop net revenues are still positive in the base year. It may be obtained by solving the following for $PLND_m$:

$$NREV_{m,min} = 0.3 * REV_{m,min} = REV_{m,min} - \lambda_{m,j}\, PLND_m \quad (24)$$

where $REV_{m,min}$ is the smallest gross revenue observed in the Member State. Other issues related to the base year data are discussed in section 3.2.

Calibration problem

In the calibration problem we are minimising the deviations of the model's elasticities (21) and (22) with respect to price variables from plausible starting values to be discussed later. These deviations are measured by the cross entropy criterion, which provides the objective function for the calibration:

$$\text{Max } ENTS_m = -\Sigma_z \Sigma_s \Sigma_t PROB_{m,z,s,t} \ln(PROB_{m,z,s,t} / \theta_{m,z,s,t}) \quad (25)$$

and

$$SEL_{m,s,t} = \Sigma_z PROB_{m,z,s,t} \underline{SELS}_{m,z,s,t} \quad (26)$$

where

$ENTS_m$	=	cross entropy in supply side calibration for Member State m
$PROB_{m,z,s,t}$	=	final probability weight for support point z of elasticity of netput s wrt price variable t in Member State m
$\theta_{m,z,s,t}$	=	initial probability weight for support point z of elasticity of netput s wrt price variable t in Member State m
$SEL_{m,s,t}$	=	final supply side elasticity of netput s wrt price variable t in Member State m
$\underline{SELS}_{m,z,s,t}$	=	support point z of elasticity $SEL_{m,s,t}$ of netput s wrt price variable t in Member State m

We are working with three support points centred around our starting value (=$\underline{SELS}_{m,2,s,t}$) on which almost the total initial probability mass is concentrated ($\theta_{m,2,s,t}$ = 99,98%). This will strongly pull the elastiticities towards these starting values except for the case that they are incompatible with the constraints of the problem.

Among these constraints there is the Cholesky decomposition to impose convexity. Furthermore we explicitly precluded complementary and regressive relationships *for given prices of resources,* requiring $\alpha_{m,s,t} < 0$ for $s \neq t$. The main cause for these relationships is likely to be endogeneity of certain prices such that overall elasticities with adjustable prices may feature regressivity or complementarity. As an example consider a decrease in the price of manioc. In addition to an increase in demand for manioc this may cause an increase in the demand for protein rich feed to maintain the balance of protein and energy in the feed mix.

This kind of complementarity would be induced by an increase in the price of protein and it is not excluded at all by the constraint $\alpha_{m,s,t} < 0$ for $s \neq t$. However, complementarity and regressivity were excluded for given prices of resources, assuming that this constraint adds more in terms of plausibility than it costs in terms of generality.

In addition it was checked whether the resource balances and market clearing for the male and female calves might be maintained in a set of auxiliary simulations. In these auxiliary "price variable runs" the revenue $REV_{m,p}$ or price $PP_{m,p}$ are changed in such an amount that the corresponding net revenue $NREV_{m,p}$ or net price $NP_{m,p}$ would decrease by 30%, prior to the adjustment of resource prices. The simulated netputs in these auxiliary "price variable runs" are also used to compute arc elasticities. To show this we have to introduce a superscript for the price variable changed:

$$\underline{NETP}^{\circ}_{m,s} = \alpha_{m,s,0} + \Sigma_t \alpha_{m,s,t} RN^{\circ}_{m,t} \quad (27)$$

$$NETP^{p}_{m,s}(\mathbf{RN}^{p}_{m}) = \alpha_{m,s,0} + \Sigma_t \alpha_{m,s,t} RN^{p}_{m,s} \quad (28)$$

$$ELARC_{m,s,p} = [(NETP^{p}_{m,s}(\mathbf{RN}^{p}_{m}) - \underline{NETP}^{\circ}_{m,s}) / \underline{NETP}^{\circ}_{m,s}] / [(RN^{p}_{m,p} - RN^{\circ}_{m,p}) / RN^{\circ}_{m,p}] \quad (29)$$

where

$\underline{NETP}^{\circ}_{m,s}$ = quantity of netput $s \in PACT \cup INDINP \cup FEED$ in Member State m in the base year

$RN^{\circ}_{m,t}$ = price variable $t \in PACT \cup NOFEED \cup FEED$ in Member State m in the base year

$NETP^{p}_{m,s}$ = quantity of netput $s \in PACT \cup INDINP \cup FEED$ in Member State m in price variable run p

$RN^{p}_{m,t}$ = price variable $t \in PACT \cup NOFEED \cup FEED$ in Member State m in price variable run p

α_m = parameter matrix in Member State m

In contrast to the analytical supply side elasticities $SEL_{m,s,t}$ the arc elasticities $ELARC_{m,s,p}$ reflect endogenous adjustments of resource (and calves) prices. They are different therefore not only in their calculation but also in their interpretation. Note that the "parameters" and $\alpha_{m,s,t}$ are endogenous variables in the context of their calibration. Known parameters will be underlined in this section (only). Definitions (6), (7), and (17) apply accordingly:

$$\mathbf{RN}^{v}_{m} = (\mathbf{NREV}^{v}_{m}{}', \underline{\mathbf{PP}}^{v}_{m,NOFEED}{}', \mathbf{NP}^{v}_{m,FEED}{}')' / PP_{m,REST} \quad (30)$$

$$NREV^{v}_{m,t} = \underline{REV}^{v}_{m,t} - \underline{\lambda}_{m,t} * PLND^{v}_{m} - \underline{\eta}_{m,t} * PENE^{v}_{m} - \underline{\rho}_{m,t} * PPRT^{v}_{m} \quad (31)$$

$$NP^{v}_{m,t} = \underline{PP}^{v}_{m,t} - \underline{\eta}_{m,t} * PENE^{v}_{m} - \underline{\rho}_{m,t} * PPRT^{v}_{m} \quad (32)$$

where

$\mathbf{RN}^{v}_{m}$	=	column vector of price variables t $\in$ PACT $\cup$ INDINP $\cup$ FEED in Member State m in simulation v (v = o, p)
$NREV^{v}_{m,t}$	=	net shadow revenue of activity t $\in$ PACT in Member State m in simulation v (v = o, p)
$\underline{PP}^{v}_{m,t}$	=	producer price of item t $\in$ NOFEED $\cup$ FEED in Member State m in simulation v (v = o, p)
$NP^{v}_{m,t}$	=	net price of item t $\in$ NOFEED $\cup$ FEED in Member State m in simulation v (v = o, p)
$\underline{REV}^{v}_{m,t}$	=	gross revenue of activity t $\in$ PACT in Member State m in simulation v (v = o, p)
$PLND^{v}_{m}$	=	(shadow) rental price of land in Member State m in simulation v (v = o, p)
$PENE^{v}_{m}$	=	(shadow) price of energy in Member State m in simulation v (v = o, p)
$PPRT^{v}_{m}$	=	(shadow) price of protein in Member State m in simulation v (v = o, p)
$\underline{\lambda}_{t}$	=	land requirement of activity t (=1 for j$\in$ CACT, 0 otherwise)
$\underline{\eta}_{m,t}$	=	energy requirement (t $\in$ AACT) or content (t $\in$ FEED) in Member State m (= 0 for t $\in$ NOFEED $\cup$ CACT)
$\underline{\rho}_{m,t}$	=	protein requirement (t $\in$ AACT) or content (t $\in$ FEED) in Member State m (= 0 for t $\in$ NOFEED $\cup$ CACT)

Note that exogeneity has been indicated exclusively from the viewpoint of the calibration and that base year revenues are thus considered exogenous here (even though they are calculated elsewhere). Note also that the base year shadow prices of land, energy, and protein are exogenous, because they have been determined in a preparatory step while setting up the database (see section 3.2.4). In any other auxiliary simulation p, the resource prices and hence net prices and net revenues will be endogenous. In these simulations, the shadow prices have to adjust to render the complete system of netputs consistent with constraints (10), (11), (12). To ensure feasibility in subsequent policy simulations resource prices were not permitted to drop below 20% of their base year value, which indirectly constrains parameters in α_m.

Maximising objective (25) subject to the constraints will determine parameters α_m which imply elasticities $SEL_{m,s,t}$ as close as possible to the starting values while at the same time being consistent with explicit resource constraints. Schematically varying one argument after the other and checking for feasibility in rather wide bounds is certainly not a guarantee for feasibility and plausibility in later applications, but it is a cheap partial test.

Initialisation

Starting values for supply side elasticities $SEL_{m,s,t}$ have been taken as available so far. Unfortunately empirical estimates of supply side elasticities for EU Member States are quite rare and they differ a lot in the underlying methodology[5]. The attempt to base the initial values on published estimates had to be abandoned therefore. Given available resources it was

5 See Boyle, O'Neill (1990), Guyomard, Baudry, Carpentier (1996), Higgins (1986), Jensen (1996), Khatri, Thirtle, (1996), Mergos, Yotopoulos, (1988), Peeters, Surry (1993), (1997), (2000), Schokai, Moro (1996), Surry, (1990), Tiffin, Renwick, (1996)

impossible at the same time to undertake an estimation of parameters α_m for 14 EU Member States as well.

The only solution in this situation was to rely on systematic guesstimates supported by judgement and theoretical reasoning. Significant simplification may be achieved if homothetic separability can be assumed for the technology T_m (Chambers 1988:115). This appears almost unavoidable given that we have up to 60 netputs and price variables in a Member State. This would require to specify 60*(60-1)/2 = 1770 independent elasticities, with symmetry and homogeneity already exploited. Consequently we assume that the profit function has the following structure:

$$\pi_m(\mathbf{R}_m) = \max_{\boldsymbol{NETP}_m} \left\{ \mathbf{R}_m' \, \boldsymbol{NETP}_m : T_m(\boldsymbol{NETP}_m) = 0 \right\} =$$
$$\hat{\pi}_m(\hat{\mathbf{R}}_m) = \max_{\hat{\boldsymbol{NETP}}_m} \left\{ \hat{\mathbf{R}}_m' \, \hat{\boldsymbol{NETP}}_m : \hat{T}_m(\hat{\boldsymbol{NETP}}_m) = 0 \right\} \tag{33}$$

where

$$\hat{R}_{m,S}(\mathbf{R}_{m,S})\, \hat{NETP}_{m,S} = \pi_{m,S}(\mathbf{R}_{m,S}, \hat{NETP}_{m,S})$$
$$= \max_{\boldsymbol{NETP}_{m,S}} \left\{ \sum\nolimits_{s \in S} R_{m,s} \cdot NETP_{m,s} : F_{m,S}(\boldsymbol{NETP}_{m,S}) = \hat{NETP}_{m,S} \right\} \tag{34}$$

$$\mathbf{R}_m = (\mathbf{NREV}_m, \mathbf{PP}_{m,NOFEED}, \mathbf{NP}_{m,FEED})' \tag{35}$$

and

$\boldsymbol{NETP}_m$	=	column vector of netput quantities s $\in$ PACT $\cup$ NOFEED $\cup$ FEED in Member State m
$\mathbf{R}_m$	=	column vector of unnormalised prices variables for netput s $\in$ PACT $\cup$ NOFEED $\cup$ FEED in Member State m
$\hat{\boldsymbol{NETP}}_m$	=	column vector of aggregate netput quantities $\hat{NETP}_{m,S}$, S $\subset$ {PACT $\cup$ NOFEED $\cup$ FEED} in Member State m
$\hat{\mathbf{R}}_m$	=	column vector of aggregate netput prices $\hat{R}_{m,S}$, S $\subset$ {PACT $\cup$ NOFEED $\cup$ FEED}, in Member State m
$\boldsymbol{NETP}_{m,S}$	=	column vector of netput quantities $NETP_{m,s}$, s $\in$ S $\subset$ {PACT $\cup$ NOFEED $\cup$ FEED} in Member State m
$\mathbf{R}_{m,S}$	=	column vector of netput prices $R_{m,s}$ s $\in$ S $\subset$ {PACT $\cup$ NOFEED $\cup$ FEED} in Member State m

Homothetic separability permits the definition of aggregate prices and quantities, which may be used for two-stage decision making as indicated in (33). Two stage decision making means that the top-level maximisation defines a profit function $\hat{\pi}_m(.)$ itself, with aggregate elasticities. These aggregate elasticities may be combined with "within group" elasticities to obtain the integrated disaggregate elasticities:

$$SEL_{m,i,j} = SEL_{m,i,j\,|I} + SEL_{m,I,I}\,\underline{SHA}_{m,j}\,/\underline{SHA}_{m,I} \tag{36}$$

$$= \tau_{m,i,j\,|I}\,\underline{SHA}_{m,j}\,/\,\underline{SHA}_{m,I} + \tau_{m,I,I}\,\underline{SHA}_{m,j}\;(i,j \in I)$$

$$SEL_{m,i,j} = SEL_{m,I,J}\,\underline{SHA}_{m,j}\,/\underline{SHA}_{m,J} \tag{37}$$

$$= \tau_{m,I,J}\,\underline{SHA}_{m,j}\;(i\in I, j \in J, I \neq J)$$

where

$SEL_{m,i,j}$	=	supply side elasticity of netput i wrt netput price j in Member State m
$SEL_{m,i,j\,\|I}$	=	supply side elasticity of netput i wrt netput price j within netput aggregate I in Member State m
$SEL_{m,I,J}$	=	supply side elasticity of netput aggregate I wrt aggregate J in Member State m
$\tau_{m,i,j\,\|I}$	=	Allen elasticity of transformation of netput i wrt netput j within aggregate I in Member State m
$\tau_{m,I,J}$	=	Allen elasticity of transformation of aggregate I wrt aggregate J in Member State m
$\underline{SHA}_{m,i}$	=	$R_{m,i}\,NETP_{m,i}/\pi_m$ = (base year) share of netput i in total profit of agriculture in Member State m
$\underline{SHA}_{m,I}$	=	$\hat{R}_{m,I}\,\hat{NETP}_{m,I}/\pi_m$ = (base year) share of netput aggregate I in total profit of agriculture in Member State m

The number of within group elasticities is rather small (one per aggregate) if the aggregator functions $F_{m,I}$ may be assumed to be of CES type. With 21 netput aggregates we have to specify 21*20/2 = 210 independent between aggregate elasticities. However, a lot of these may be assumed to be close to zero. Finally it is assumed that the Member State specific characteristics are largely incorporated in the shares such that the Allen elasticities of transformation ($\tau_{m,I,J} = \tau_{EU,I,J}$) will be assumed uniform across EU Member States (apart from some cases with clearly special circumstances). The full elasticity matrix is thus mainly resulting from assumptions on a sparsely populated matrix of “between group” transformation elasticities and a single column of “within group” transformation elasticities (Table 2.1-1).

Table 2.1-1: Allen elasticities of transformation between netput aggregates in CAPSIM

	OIPU	OANS	PERE	OFMA	SUGB	COWS	BUHF	CALF	SHEO	PIPE	IPLG	IGEG	RESG	FEED	FPRO	FENE	FMIL	FOTH	FMAI	FGRA	FOFO	within
CERS	-0.03	-0.01	-0.002	-0.02	-0.2						0.06	0.01	0.05									-0.3
OIPU		-0.02	-0.002	-0.01	-0.2						0.04	0.01	0.06									-0.3
OANS			-0.002	-0.01	-0.2						0.02	0.01	0.15									-0.3
PERE				-0.001	-0.002						0.01	0.01	0.15									-0.3
OFMA					-0.1						0.04	0.01	0.02									-0.3
SUGB											0.04	0.01	0.1									
COWS							-0.01		-0.01			0.05	0.05	0.07								-0.3
BUHF								-0.01	-0.01			0.05	0.05	0.1								-1.2
CALF												0.05	0.05	0.2								-1.5
SHEO												0.05	0.05	0.07								-0.3
PIPE												0.05	0.05	0.2								-0.4
IPLG												-0.05	-0.05									
IGEG													-0.05									
RESG																						
FCER															-0.5	-0.5		-0.2	-0.2	-0.05	-0.2	0.6
FPRO																-0.5	-0.05	-0.1	-0.2	-0.05	-0.2	0.8
FENE																		-0.1	-0.2	-0.05	-0.2	0.8
FMIL																						0.8
FOTH																			-0.2	-0.05	-0.2	1.0
FMAI																				-0.5	-0.5	
FGRA																					-0.5	
FOFO																						0.5

Note: OIPU = oilseeds plus pulses, SUGB = sugar beet as group, OANS = other non perennial arable crops but no sugar beet, PERE = fruits and other perennials, CERS = cereals and set aside, OFMA = fodder maize and other fodder, CALF = fattening of calves, BUHF = fattening of bulls or heifers, COWS = cows, SHEO = sheep and other animals, PIPE = pigs & poultry & eggs, IPLG = plant related inputs, IGEG = general inputs, RESG = residual factors, FEED = aggregate feed, FCER = feed: cereals, FPRO = feed: rich protein, FENE = feed: rich energy, FMIL = feed: milk and milk products, FOTH = feed: other, FMAI = fodder maize, FGRA = Gras fodder, FOFO = Other fodder, Overall, these transformation elasticities may appear quite small, for example compared to a Cobb Douglas transformation function between a few outputs. However the first thing to note is that the resulting price variable elasticities are defined with respect to a *net* price or quantity. If we expect an ordinary price elasticity of, say, 0.2 and the resource cost are 50% of gross revenue the corresponding elasticity would be 0.1. Note furthermore that the "shares" may be quite large because the profit in the denominator (= revenues – cost) can be smaller than the revenue or cost from single aggregates. When moving to elasticities with respect to the revenue of cereals ($SEL_{m,I,J} = \tau_{m,I,J} * \underline{SHA}_{m,J}$) the relevant share ($\underline{SHA}_{m,CERS}$) is close to or greater than 1 in 6 Member States. Finally it may be concluded from (36) that the between group effect is only a part of the total response and usually it will be the smaller part, if substitution is stronger within than between groups. Because no within group response will be added in case of single item groups (SUGB, FMAI, FGRA, FOFO), the relevant transformation elasticities are set somewhat higher in these columns. An attempt has been made to differentiate the entries according to expected substitution possibilities but nonetheless this specification should be considered preliminary.

The reader may have recognised that Table 2.1-1 includes an aggregate transformation elasticities between animal activities and total feed, but no elasticities between (groups of) animal activities and groups of feedstuffs. It may be expected that these relationships can be quite specific, depending on the typical feed mix in a Member State. Unfortunately this feed allocation is unobserved which was precisely the reason why CAPSIM imposes only overall (rather than animal specific) nutrient balances. However in this case more reliable estimates have been compiled elsewhere, namely to set up the base year for the CAPRI modelling framework[6]. Table 2.1-2 reproduces the feed allocation for broad groups on the EU level but this kind of estimates has been used for all Member States to initialise the feed livestock transformation elasticities, as will be explained below.

Table 2.1-2: Estimated allocation of groups of feedstuffs to groups of animal activities in EU 15

	CALF	BUHF	COWS	SHEO	PIPE
FCER	0.30%	5.50%	24.50%	9.70%	59.90%
FPRO	2.60%	19.40%	24.30%	0.40%	53.30%
FENE	0.00%	0.03%	11.00%	47.50%	41.50%
FMIL	2.40%	11.20%	5.70%	2.50%	78.20%
FOTH	0.00%	1.40%	1.10%	1.90%	95.60%
FMAI	0.30%	10.40%	82.90%	6.50%	0.00%
FGRA	0.70%	13.90%	68.60%	16.80%	0.00%
FOFO	1.20%	11.20%	72.10%	15.50%	0.00%

Source: Aggregated CAPRI estimates for the base year. Codes as explained under Table 2.1-1.

These shares reflect both the importance of certain animal activities as well as the feed use per head.

To link the estimated feed allocation to the current framework consider the special case of the technology constraint $\hat{T}_m$ being separable into a general operating capacity constraint $\hat{T}_{m1}$ and a feed technology $\hat{T}_{m2}$ describing solely the links between animal activities and feedstuffs beyond the energy and protein constraint. Maximum profit then implies minimisation of feed cost given levels of animal activities:

6 See http://www.agp.uni-bonn.de/agpo/rsrch/capstr/capstr_e.htm

$$\hat{\pi}_m(\hat{\mathbf{R}}_m) = \max_{\hat{\boldsymbol{NETP}}_m} \left\{ \hat{\mathbf{R}}_m' \hat{\boldsymbol{NETP}}_m : \hat{T}_m(\hat{\boldsymbol{NETP}}_m) = 0 \right\}$$

$$\begin{aligned} = \max_{\hat{\boldsymbol{NETP}}_m} \Big\{ & \hat{\mathbf{R}}_{m,CACT}' \hat{\boldsymbol{NETP}}_{m,CACT} + \hat{\mathbf{R}}_{m,AACT}' \hat{\boldsymbol{NETP}}_{m,AACT} \\ & - \hat{\mathbf{R}}_{m,NOFEED}' \hat{\boldsymbol{NETP}}_{m,NOFEED} \\ & - C_m(\hat{\mathbf{R}}_{m,FEED}, \hat{\boldsymbol{NETP}}_{m,AACT}) : \\ & \hat{T}_{m1}(\hat{\boldsymbol{NETP}}_{m,CACT}, \hat{\boldsymbol{NETP}}_{m,AACT}, \hat{\boldsymbol{NETP}}_{m,NOFEED}) = 0 \Big\} \end{aligned} \tag{38}$$

where

$$C_m(\hat{\mathbf{R}}_{m,FEED}, \hat{\boldsymbol{NETP}}_{m,AACT}) = \min_{\hat{\boldsymbol{NETP}}_{m,FEED}} \left\{ \hat{\mathbf{R}}_{m,FEED}' \hat{\boldsymbol{NETP}}_{m,FEED} : T_{m2}(\hat{\boldsymbol{NETP}}_{m,FEED}, \hat{\boldsymbol{NETP}}_{m,AACT}) = 0 \right\} \tag{39}$$

and

$\hat{\boldsymbol{NETP}}_{m,GRP}$ = column vector of aggregate netput quantities $\hat{NETP}_{m,I}$, $I \subset GRP$, GRP = CACT, AACT, NOFEED, FEED in Member State m

$\hat{\mathbf{R}}_{m,GRP}$ = column vector of aggregate netput prices $\hat{R}_{m,I}$, $I \subset GRP$, GRP = CACT, AACT, NOFEED, FEED in Member State m

Now assume that $C_m(.)$ is the cost function of a nonjoint and constant returns feed technology (see also Peeters, Surry 1993: 113):

$$C_m(\hat{\mathbf{R}}_{m,FEED}, \hat{\boldsymbol{NETP}}_{m,AACT}) = \sum_{A \in AACT} C_{m,A}(\hat{\mathbf{R}}_{m,FEED}) \cdot \hat{NETP}_{m,A} \tag{40}$$

In this case total feed demand is the sum of feed intake per activity:

$$\frac{\partial C_m}{\partial \hat{R}_{m,F}} = \hat{NETP}_{m,F} = \tag{41}$$

$$\sum_{A \in AACT} \frac{\partial C_{m,A}}{\partial \hat{R}_{m,F}} \cdot \hat{NETP}_{m,A} = \sum_{A \in AACT} \left[\frac{\hat{NETP}_{m,F,A}}{\hat{NETP}_{m,A}} \right] \cdot \hat{NETP}_{m,A}$$

where

$\hat{NETP}_{m,F}$ = aggregate feed quantity $F \subset FEED$ in Member State m

$\hat{NETP}_{m,A}$ = aggregate animal activity $A \subset AACT$ in Member State m

$\hat{NETP}_{m,A,F}$ = aggregate use of feed item F in activity A in Member State m

$C_{m,A}(.)$ = feed cost function per head of activity $A \subset AACT$ in Member State m

The input coefficients in brackets do not depend on activity levels such that the elasticities of feed use with respect to net revenues of animal activities may be derived from the reallocation among animals together with the shares of particular animals in total feed use:

$$\frac{\partial \hat{NETP}_{m,F}}{\partial \hat{R}_{m,\tilde{A}}} = \sum_{A\in AACT} \frac{\partial C_A}{\partial \hat{R}_{m,F}} \cdot \frac{\partial \hat{NETP}_{m,A}}{\partial \hat{R}_{m,\tilde{A}}}$$

$$= \sum_{A\in AACT} \left[\frac{\hat{NETP}_{m,F,A}}{\hat{NETP}_{m,A}} \right] \cdot \frac{\partial \hat{NETP}_{m,A}}{\partial \hat{R}_{m,\tilde{A}}}$$

$$\Rightarrow \frac{\partial \hat{NETP}_{m,F}}{\partial \hat{R}_{m,\tilde{A}}} \frac{\hat{R}_{m,\tilde{A}}}{\hat{NETP}_{m,F}} = SEL_{m,F,\tilde{A}} \tag{42}$$

$$= \sum_{A\in AACT} \frac{\hat{NETP}_{m,F,A}}{\hat{NETP}_{m,F}} \cdot \frac{\partial \hat{NETP}_{m,A}}{\partial \hat{R}_{m,\tilde{A}}} \frac{\hat{R}_{m,\tilde{A}}}{\hat{NETP}_{m,A}}$$

$$= \sum_{A\in AACT} \underline{FSH}_{m,A,F} \cdot SEL_{m,A,\tilde{A}}$$

where in addition to symbols explained under (41)

$\hat{R}_{m,\tilde{A}}$	=	net revenue of aggregate animal activity Ã ⊂ AACT in Member State m
$SEL_{m,F,\tilde{A}}$	=	elasticity of feed quantity F with respect to net revenue of animal activity Ã in Member State m
$SEL_{m,A,\tilde{A}}$	=	elasticity of animal activity A with respect to net revenue of animal activity Ã in Member State m
$\underline{FSH}_{m,A,F}$	=	(base year) share of animal activity A in total use of feed quantity F in Member State m

Equation (42) shows how to translate the information from an estimated feed allocation into feed - animal elasticities. The required elasticities $SEL_{m,A,\tilde{A}}$ follow from the transformation elasticities in Table 2.1-1 after multiplication with the shares $\underline{SHA}_{m,\tilde{A}}$. The own revenue elasticity may be derived from homogeneity but for that purpose it was necessary to make an assumption on the aggregate transformation elasticity of animal activities to total feed $\sigma_{m,A,FEED}$ (because single animal feed elasticities were still to be computed) which is also reproduced in Table 2.1-1 above. For consistency with this assumption it was finally necessary to scale the elasticities estimated according to (42). This gives finally the equation to compute the required Allen elasticities of transformation between animals and feed:

$$SEL_{m,\tilde{A},F} = SEL_{m,F,\tilde{A}} \left(\underline{SHA}_{m,F} / \underline{SHA}_{m,\tilde{A}} \right)$$

$$= \sum_{A\in AACT} \underline{FSH}_{m,A,F}\, SEL_{m,A,\tilde{A}} \frac{\underline{SHA}_{m,F}}{\underline{SHA}_{m,\tilde{A}}} \frac{SEL_{m,\tilde{A},FEED}}{\sum_{G\in FEED} \sum_{A\in AACT} \underline{FSH}_{m,A,G}\, SEL_{m,A,\tilde{A}} \frac{\underline{SHA}_{m,G}}{\underline{SHA}_{m,\tilde{A}}}}$$

$$\Leftrightarrow \tau_{m,\tilde{A},F} = SEL_{m,\tilde{A},F} / \underline{SHA}_{m,F}$$

$$= \sum_{A \in AACT} \underline{FSH}_{m,A,F} \, \tau_{m,A,\tilde{A}} \frac{\tau_{m,\tilde{A},FEED} \cdot \underline{SHA}_{m,FEED}}{\sum\limits_{G \in FEED} \sum\limits_{A \in AACT} \underline{FSH}_{m,A,G} \, \tau_{m,A,\tilde{A}} \, \underline{SHA}_{m,G}} \qquad (43)$$

where

$SEL_{m,\tilde{A},F}$	=	elasticity of animal activity Ã wrt net price F ⊂ FEED in Member State m
$\underline{SHA}_{m,J}$	=	profit share of netput J in Member State m
$\underline{FSH}_{m,A,G}$	=	(base year) share of animal activity A in total use of feed quantity G ⊂ FEED in Member State m
$\tau_{m,I,J}$	=	Allen elasticity of transformation of netput aggregate I wrt aggregate J in Member State m
$\underline{SHA}_{m,FEED}$	=	profit share of total feed in Member State m
$\tau_{m,\tilde{A},FEED}$	=	Allen elasticity of transformation of animal aggregate Ã wrt total feed in Member State m

Equation (43) has been used with earlier equations (36) and (37) to compute the starting values for the elasticities and the 3 support points used in the calibration. However it should be noted that neither the hierarchical separability structure nor nonjointness of the feed technology have been maintained during the calibration. The only purpose of these auxiliary assumptions was to generate starting values for the full matrix of elasticities based on a rather small set of assumed basic parameters (which may be reconsidered in the light of empirical evidence).

2.1.3 Illustrative results from the calibration

The full set of matrices of elasticities with tens of thousands of numbers is available in electronic form but this set is not very useful for presentation here. However, it will be illuminating to look at certain elasticities with respect to three typical price variable changes which will be the net revenue of soft wheat (SWHE), the net price of fodder maize (FMAIF) and the net revenue of bulls fattening (BULF), see Table 2.1-3. In addition to the initial (column INI) and final (column FIN) values of conventional supply side elasticities $SEL_{m,s,t}$ the arc elasticities $ELARC_{m,s,p}$ with adjustable prices are also shown (column ARC). Finally the table gives the lower (column "1") and upper (column "3") support values. The central support value is calculated according to (26) to give an expected value equal to the initial value $SEL_{m,s,t}$ but given the high probability of 0.998 attached to it, this boils down to a central support value almost equal to the initial value. This also justifies omitting the central support point from the table. The outer support values are specified relative to the initial elasticity but with minimum and maximum bounds attached to it. The lower support point for cross revenue elasticities between crops, for example, is 10 * the initial value, but at least –1.0 and at most –0.1. This rule is also visible in the table and it should both permit a minimal feasible region for all cross revenue elasticities and incorporate the expectation that strongly negative elasticities would be less surprising if the initial value is already nonnegligible[7].

[7] A suggestion from the CAPSIM Reference Group (RG) to work entirely with uniform outer supports apparently increased the time for convergence and was abandoned therefore.

Table 2.1-3: Initial values, supports, final standard elasticities and "total" arc elasticities

	1	3	INI	FIN	ARC
SWHE .SWHE	0.130	0.496	0.261	0.261	0.297
BARL .SWHE	-0.598	0.050	-0.060	-0.068	-0.166
MAIZ .SWHE	-0.598	0.050	-0.060	-0.059	-0.145
SUGB .SWHE	-0.914	0.050	-0.091	-0.091	-0.050
RAPE .SWHE	-0.137	0.014	-0.014	-0.014	-0.079
SUNF .SWHE	-0.137	0.014	-0.014	-0.014	-0.086
TIND .SWHE	-0.100	0.005	-0.005	-0.006	-0.104
VEGE .SWHE	-0.100	0.005	-0.005	-0.005	-0.042
MAIF .SWHE	-0.100	0.009	-0.009	-0.009	-0.051
OFOD .SWHE	-0.100	0.009	-0.009	-0.010	-0.085
SETA .SWHE	-0.598	0.050	-0.060	-0.067	-0.106
IGEN .SWHE	-0.005	0.046	0.005	0.005	-0.005
IPLA .SWHE	-0.027	0.274	0.027	0.027	0.000
DCOW .FMAIF	-0.030	0.001	-0.005	-0.005	-0.003
SCOW .FMAIF	-0.030	0.001	-0.005	-0.005	-0.022
SHEE .FMAIF	-0.030	0.001	-0.002	-0.002	-0.176
FSWHE.FMAIF	-0.004	0.039	0.008	0.008	0.284
FBARL.FMAIF	-0.004	0.039	0.008	0.008	0.132
FMAIZ.FMAIF	-0.004	0.039	0.008	0.008	0.270
FPULS.FMAIF	-0.004	0.039	0.008	0.008	-0.159
FRAPE.FMAIF	-0.004	0.039	0.008	0.008	0.112
FSUNF.FMAIF	-0.004	0.039	0.008	0.008	0.020
FSOTH.FMAIF	-0.004	0.039	0.008	0.008	-0.256
FMAIF.FMAIF	-0.267	-1.015	-0.534	-0.534	-0.551
FOFOD.FMAIF	-0.010	0.096	0.019	0.020	0.022
FRAPC.FMAIF	-0.004	0.039	0.008	0.008	-0.185
FSUNC.FMAIF	-0.004	0.039	0.008	0.008	-0.767
FSOYC.FMAIF	-0.004	0.039	0.008	0.008	-0.094
DCOW .BULF	-0.030	0.001	-0.003	-0.003	0.000
SCOW .BULF	-0.030	0.001	-0.003	-0.003	0.072
BULF .BULF	0.237	0.902	0.475	0.579	0.544
HEIF .BULF	-2.000	0.050	-0.740	-0.989	-0.864
CAMF .BULF	-0.030	0.001	-0.003	-0.003	-0.597
CAFF .BULF	-0.030	0.001	-0.003	-0.003	0.821
FSWHE.BULF	-0.002	0.082	0.016	0.016	-0.027
FBARL.BULF	-0.002	0.082	0.016	0.016	0.007
FMAIZ.BULF	-0.002	0.082	0.016	0.017	-0.007
FPULS.BULF	-0.006	0.288	0.058	0.064	-0.219
FRAPE.BULF	-0.001	0.030	0.002	0.002	-0.024
FSUNF.BULF	-0.001	0.030	0.002	0.002	0.018
FSOTH.BULF	-0.001	0.030	0.002	0.002	-0.139
FMAIF.BULF	-0.002	0.115	0.023	0.023	0.029
FOFOD.BULF	-0.003	0.137	0.027	0.027	0.033
FRAPC.BULF	-0.006	0.288	0.058	0.061	-0.014
FSUNC.BULF	-0.006	0.288	0.058	0.068	-0.243
FSOYC.BULF	-0.006	0.288	0.058	0.058	0.035

It may also be seen in the table that complementarity and regressivity is not foreseen in any initial value as it is ruled out by a constraint. It might be conceivable to set the upper support value for cross revenue elasticities between crops to zero to preclude complementarity but some experiments with this idea resulted in less stable or more time consuming solution behaviour such that the corresponding supports were finally set slightly beyond the permissible region.

Looking in more detail now at the initial values it is possible to see the consequence of the separability assumptions built into the initial values: According to (37) cross revenue elasticities will be uniform for substitution with all crops belonging to another group J (=> $SEL_{FR,TIND,SWHE} = SEL_{FR,VEGE,SWHE}$, for example) and according to (36), they will also be the same for netputs belonging to the same group as the netput in question, if within group substitution has also be assumed uniform ($\tau_{m,r,s} = 0.3$ for r, s $\in$ CERS, see column "within" in Table 2.1-1, => $SEL_{FR,BARL,SWHE} = SEL_{FR,MAIZ,SWHE}$). However, the column with the final elasticities also shows that these restrictions are not maintained during the calibration. The comparison of initial and final values reveals them to be very close together in general. This is both a consequence of the high probability weight attached to the central support point as well as to a careful initialisation with few violations of microeconomic consistency (which speeds up convergence).

Most interesting to understand the functionality of the supply side specification is the comparison of (final) elasticities $SEL_{m,s,t}$, assuming exogenous prices, with the arc elasticities $ELARC_{m,s,p}$ incorporating price adjustments. In the case of soft wheat an adjustment mainly occurs on the price of land, which clearly moves in parallel to the revenue of soft wheat, because this is an example of an important crop. The adjusting price of land imposes a fixed arable crop area and tends to increase cross revenue elasticities because an increase in soft wheat area has to be matched by a decrease in some other areas. This may be observed for substitution with almost all crops. In cases such as textiles and industrial crops (TIND) or vegetables (VEGE) the strength of this effect may appear somewhat exaggerated. Technically it is determined mainly by the own revenue elasticity (perhaps too high here) and by the assumed pattern of land requirements (see equation (23)). However, the case of sugar beet[8] shows that adjusting land prices can impede a straightforward interpretation because sugar beet are not only responding to the change in the soft wheat net revenue and to the triggered change in the own net revenue. In addition, all other crop net revenues are modified, according to the respective share of land cost in net revenue, and the sugar beet area will also respond to these changes according to the cross revenue elasticities of sugar beet to other crops. To analyse a certain arc elasticity in detail therefore requires to trace back the netput response to all changing price variables which may be done for questionable cases but certainly not for all arc elasticities.

Finally it is interesting to look at the response of general (IGEN) and plant related (IPLA) inputs to a change in the soft wheat net revenue. Whereas the (final) elasticities $SEL_{FR,s,SWHE}$ indicate a "normal" positive response, this response is reduced to about zero for IPLA and even becomes regressive for IGEN. This illustrates the earlier proposition that regressivity may show up in the arc elasticities $ELARC_{m,s,SWHE}$, even though this is precluded by a constraint for the ordinary elasticities $SEL_{FR,s,SWHE}$, thus supporting the view that the supply side specification is quite general in spite of these constraints. The negative response of general

8 Note that the calibration considers the hypothetical case of free adjustments irrespective of the quota regime, as is the case for dairy cows.

inputs to the soft wheat net revenue will be due to the fact that some of the crops replaced by soft wheat require more general inputs than soft wheat.

The next example shown in Table 2.1-3 is a change in the net revenue of fodder maize[9]. An increase in the price of fodder maize is associated with some increase in the price of energy and a slight decrease in the price of protein, because fodder maize is relatively rich in energy. On balance this sums up to a certain increase in nutrient cost and to a decrease in net revenues of dairy cows, suckler cows, and sheep. However the response of these activities is very diverse because the share of nutrient cost in the base period revenue is 23% for dairy, 47% for suckler cows and 77% for sheep, at least according to the present estimates, see section 3.2.4. With comparable own revenue elasticities for these activities this implies a markedly pronounced sensitivity of sheep to the price of fodder maize compared to the cows activities. This is not to argue that these differences in the elasticities are plausible but that they can be explained. Addressing these questionable consequences is most straightforward when revising the current estimates of nutrient requirements and contents. A revision should probably increase the weight for the share of energy and protein cost in gross revenue to obtain more "balanced" net revenues from the cross entropy problem in section 3.2.4, but this has to be earmarked for the future.

For the response of other feedstuffs to an increase in the price of fodder maize it should be explained first that it is due to the assumed transformation elasticities in Table 2.1-1, column FMAI, that most cross price elasticities $SEL_{FR,s,FMAIF}$ to equal 0.008. The separability structure would have permitted to differentiate these elasticities somewhat, but this option has not been used. The nutrient balances tend to increase substitution, at least among feedstuffs with a similar ratio of energy to protein contents. This is visible in the case of cereals, for example. However, the table also reveals certain cases of complementarity to protein rich feedstuffs. Of course, the example of fodder maize has been selected precisely to illustrate the basic functionality of the imposed nutrient balances and these effects of adjusting nutrient prices are only discernible for a few major feedstuffs. However plausible in general, the differences among the different cakes are again surprising. It may be traced back both to a high own price elasticity for sunflower cake ($SEL_{FR,FSUNC,FSUNC}$ = -1.16, $SEL_{FR,FSOYC,FSOYC}$ = -0.65) as well as to a high share of the nutrient value in the gross price (= 85% for FSUNF, 53% for FSOYC), analogous to the problem of sheep discussed previously. These troublesome relationships should be kept in mind for the next opportunity of an update. The differences between the seeds rape (FRAPE), sunflower (FSUNF), and soya beans (FSOTH) is more convincing because soya beans contain about twice as much protein per unit of energy as the other oilseeds. Hence it is possible that complementarity prevails for soya beans whereas rape and sunflower seed are still substitutes for fodder maize. Finally we see at the example of other fodder on arable land, FOFOD, (e.g. fodder beet) that the combined effect of adjustments in energy and protein cost may also net out to zero, as ordinary and arc elasticities are almost equal to each other.

The last example is the most complex one as an increase in the revenue for fattening of bulls is accompanied with an marked increase in the price of male calves, a smaller decrease in the price of female calves, some decrease in the price of protein and almost no response in the energy price. Overall the changes in calves prices increase the profitability of suckler cows which induces a complementary relationship to bulls fattening. This effect is negligible for dairy cows because the main output is milk here. Fattening of heifers would be reduced

[9] Fodder maize is treated as any other feedstuff even though it will be handled as a nontradable item in CAPSIM. However, during the calibration the endogeneity of producer prices of fodder maize in later simulations is neglected, for the time being.

strongly because these activities are evidently highly substitutable. Fattening of male calves is strongly reduced due to the scarcity of male young calves. On the contrary, female calves are amply available because supply is increasing (SCOW) whereas demand is reduced (HEIF). This will spur an increase in fattening of female calves and thus motivate another complementarity to the fattening of bulls activity. It will be evident that the current specification is able to capture the basic relationships in the cattle sector with endogenous price adjustments in spite of the ordinary revenue elasticities precluding complementarity.

The effects on feed use are small and not very surprising in many cases but a markedly regressive relationship is visible to protein rich feed. Technically this is due to a decrease in the price of protein which is reflecting the importance of energy in the requirements of fattening of bulls. However, the strongly negative response of sunflower cake and the positive response of soya cake have to be explained. The strong response of sunflower cake is again due to the high own price elasticity for sunflower cake as well as to the high share of the nutrient value in the gross price. This explanation from above also applies here. It may be less evident, however, that the increase in the demand for soya cake will be strongly influenced by substitution within the protein rich feed group, because this substitution is stronger than substitution between groups.

Summing up for the three selected examples we may say that theoretically expected properties indeed work out in the empirical results. Unexpected results may be explained, but this explanation turned out quite complex with several prices changing at the same time. Finally, the detailed look at selected elasticities has helped to identify ideas for further improvements in the details of the implementation, which would increase the persuasiveness of the revised supply side specification.

2.1.4 Illustrative simulation results

Because the nutrient balances are the most innovative features of CAPSIM it may be useful to investigate what a difference they make to the simulation behaviour. A model version of CAPSIM which is comparable to the present version but still does not impose the nutrient balances may be obtained if we fix the nutrient prices to their base year values and transform the balance measured in percent of the base year requirements to a free variable. This is not really a “conventional” CAPSIM version because it is still driven by net revenues, only that the cost component of these net revenues or net prices would be constant. A truly “conventional” model version would be expressed in terms of gross revenues and gross feed prices[10] with gross elasticities calibrated to assume values “equivalent” to those in the present version. However, the calibration of a new “equivalent” set of elasticities would be time consuming and perhaps even impossible if an “equivalent set of gross elasticities would violate some microeconomic constraint, say convexity, which is fulfilled in the “net version”. Consequently the following comparison may be somewhat biased if we consider a net version of CAPSIM with non constraining nutrient balances to be an inferior to a conventional supply side specification.

Nonetheless it will be illuminating to see the differences between active and switched off nutrient constraints and the narrow scope of differences between the model versions may help

[10] See the brief description in Witzke 2003.

to correctly interpret the results. The test simulation will be akin to the reference run in the recent MTR simulation with CAPSIM[11].

Table 2.1-4: Simulation results on nutrient balances [in % of total base year requirements] with and without adjustable nutrient prices

	with	without
	adjustable nutrient prices	
BL000.ENNE	0.00%	-7.84%
BL000.CRPR	0.00%	-10.63%
DK000.ENNE	-0.02%	3.15%
DK000.CRPR	0.00%	-6.45%
DE000.ENNE	0.00%	1.76%
DE000.CRPR	-0.02%	-8.78%
EL000.ENNE	-0.01%	11.48%
EL000.CRPR	0.01%	14.09%
ES000.ENNE	0.00%	20.02%
ES000.CRPR	0.00%	12.31%
FR000.ENNE	0.00%	5.27%
FR000.CRPR	-0.02%	-1.29%
IR000.ENNE	-0.01%	0.06%
IR000.CRPR	0.01%	-1.50%
IT000.ENNE	0.00%	-0.85%
IT000.CRPR	0.00%	-4.44%
NL000.ENNE	0.00%	-32.05%
NL000.CRPR	0.00%	-38.20%
AT000.ENNE	0.00%	14.76%
AT000.CRPR	0.00%	3.97%
PT000.ENNE	0.00%	1.10%
PT000.CRPR	0.00%	-14.40%
FI000.ENNE	2.00%	4.41%
FI000.CRPR	2.06%	5.47%
SE000.ENNE	0.00%	34.85%
SE000.CRPR	0.00%	1.63%
UK000.ENNE	-0.02%	-0.02%
UK000.CRPR	0.01%	-10.80%

Table 2.1-4 shows the overall nutrient balances in EU countries in percent of the total base year requirements. Contrary to equations (11) and (12) these are not always zero, even in the current version with maintained nutrient balances. The reason is that feasibility problems in certain member states suggested incorporating these constraints with a penalty in the objective function rather than as strict equality constraints. In Finland there remains a small (about 2%) supply of energy and protein beyond the requirements, because the drop in the nutrient prices was constrained to be at most 99% of their base period value. In the other countries the excess demand did not exceed 0.02% of the base period requirements. On the contrary, the right column shows that this desirable result does not follow automatically. In a few cases excess demand or supply of a nutrient is less than 1% without adjustable nutrient prices but in several cases it exceeds 30%. The corresponding simulation results would be considered infeasible technically. Note that conventional models would not reveal this infeasibility, because nutrient balances would not be checked. As these results are very heterogeneous across Member States it is difficult to summarise them but we may state that excess consumption of

[11] See the explanation on exogenous input and policy specification in the report on the MTR analysis Witzke 2003. Some details in the specification of exogenous inputs have been different there, however.

energy frequently exceeds that of protein and in many cases there is even a deficit in terms of protein.

Next we look at the results on the overall market balances for a number of interesting items. For an appropriate interpretation it would be useful to know some details on the specification of a reference run (see Section 2.5.2) but important aspects may be explained easily. The most frequent specification of the trade regime in the reference run relies on exogenous border prices and net trade being calculated as a residual variable from supply minus demand. Exceptions are net trade of pork and poultry, which is exogenous and hence equal in the top and bottom part of Table 2.1-5. However, the similarity of simulation results with and without adjustable prices extends to the beef market, which also has net trade being a free residual variable.

Table 2.1-5: Simulation results on EU markets [1000 t] for CAPSIM versions with and without adjustable nutrient prices

	Supply		Demand		Net trade	
	Base year 1998	Reference 2009	Base year 1998	Reference 2009	Base year 1998	Reference 2009
	Specification with adjustable nutrient prices imposing nutrient balances					
SWHE	91806	101875	77112	77707	14694	24167
BARL	52372	51762	42557	50129	9816	1633
MAIZ	37644	44274	38259	38015	-615	6260
PULS	5718	6148	7205	7612	-1487	-1464
BEEF	7020	6909	6508	6718	512	192
PORK	17318	18478	15977	17303	1341	1175
POUM	8746	9373	8010	9415	736	-42
RAPC	4838	5239	5474	4172	-636	1067
SUNC	2845	2991	4782	285	-1937	2706
SOYC	11992	13084	23854	24130	-11862	-11045
	Specification with fixed nutrient prices and free nutrient balances					
SWHE	91806	101714	77112	84378	14694	17336
BARL	52372	51712	42557	57500	9816	-5788
MAIZ	37644	44209	38259	42329	-615	1879
PULS	5718	6138	7205	4609	-1487	1529
BEEF	7020	6901	6508	6718	512	183
PORK	17318	18478	15977	17303	1341	1175
POUM	8746	9410	8010	9452	736	-42
RAPC	4838	5239	5474	1901	-636	3338
SUNC	2845	2991	4782	93	-1937	2898
SOYC	11992	13084	23854	19432	-11862	-6348

The main differences occur in feed demand. Without nutrient balances imposed, demand for important cereals is increasing more in the bottom than in the top part of Table 2.1-5. On the contrary demand for important sources of protein such as pulses and soya cake is even decreasing. This is the origin of different signs of the nutrient balance in the previous table.

The bottom results are evidently implausible also because the changes on the demand side appear less balanced and somewhat exaggerated. Adjustable nutrient prices apparently do a good job to moderate these simulation results. However, as mentioned above, this comparison may appear somewhat biased by construction therefore it shall not be pursued here to derive further support for the chosen specification.

However, one conclusion appears to be quite evident: nutrient balances matter for modelling and they may be a useful safeguard against unreasonable projections.

2.2 Consumer demand

2.2.1 Conceptual framework

Whereas the supply side specification included some innovative characteristics the microeconomic framework for the demand side will be a standard utility maximisation set up which does not require detailed exposition here. Straightforward interpretation of simulation results is guaranteed if microeconomic consistency is maintained globally. To achieve global regularity we have to select an appropriate functional form, taking into account other requirements. Among these is local flexibility because we require the possibility to translate any consistent set of elasticities into parameters. Furthermore we appreciate simplicity and plausibility.

Local flexibility discards the Translog form because imposing globally correct curvature would destroy flexibility (Diewert, Wales 1987). The Normalised Quadratic (or "Symmetric Generalised McFadden") expenditure function (Diewert, Wales 1988) can be rendered globally well behaved without loss of flexibility, but at the cost of a fairly complex structure.

The Generalised Leontief form may be rendered globally regular using a very simple parameter restriction without loss of flexibility, if we only consider substitutes. In empirical analysis it is sometimes undesirable to exclude net complementary relationships among goods. These are conceivable on a very disaggregated level, say between sausage (from pork) and (dark) bread, but implausible for moderately aggregated items such as those in CAPSIM, for example pork and soft wheat products. Here it is more convincing to assume a (weak) substitutionary relationship such that the GL form will be chosen.

When working on food demand plausibility requires the ability to reflect Engel's law. This may be achieved with quadratic or linear Engel curves, in the latter case provided they need not pass through the origin, as in the linear expenditure system. Ryan and Wales have shown (1996) that theoretically consistent demand systems with linear Engel curves will stem from an indirect utility function of the following form:

$$V_m(\mathbf{CP}_m, \underline{EX}_m^{HD}) = - G_m / (\underline{EX}_m^{HD} - F_m) \tag{44}$$

where

$\mathbf{CP}_m$ = consumer prices $\mathbf{CP}_m$ in Member State m

$\underline{EX}_m^{HD}$ = consumer expenditure per head in Member State m

G_m, F_m = linear homogenous functions of consumer prices $\mathbf{CP}_m$ in Member State m

V_m = indirect utility function in Member State m

Roy's identity gives demand functions of the form:

$$CNS^{HD}_{m,i} = -\frac{\partial V_m}{\partial CP_{m,i}} \Big/ \frac{\partial V_m}{\partial \underline{EX}^{HD}_m} = \frac{G_{m,i}}{G_m}\left(\underline{EX}^{HD}_m - F_m\right) + F_{m,i} \tag{45}$$

where

$CNS^{HD}_{m,i}$	=	per capita demand quantity of item i ∈ ITEM in Member State m
$CP_{m,i}$	=	consumer price of item i ∈ ITEM in Member State m
$G_{m,i}$	=	$\partial G_m/\partial CP_{m,i}$
$F_{m,i}$	=	$\partial F_m/\partial CP_{m,i}$

Note the similarity to the linear expenditure system: F_m may be viewed as committed expenditure, ($\underline{EX}^{HD}_m$ -F_m) is noncommitted expenditure, $CP_{m,i} \cdot G_{m,i}/G_m$ is marginal expenditure for item i out of noncommitted expenditure and $CP_{m,i} \cdot F_{m,i}$ is committed expenditure on item i. In view of later calibration Marshallian price elasticities $MEL_{m,u,v}$ are of interest:

$$MEL_{m,u,v} = \left[\left(\frac{G_{m,u,v}}{G_m} - \frac{G_{m,u}G_{m,v}}{G_m^{\ 2}}\right)\left(EX^{HD}_m - F_m\right) - \frac{G_{m,u}}{G_m}F_{m,v}\right]\frac{CP_{m,v}}{CNS^{HD}_{m,u}} \tag{46}$$

where $G_{m,u,v} = \partial^2 G_m/\partial CP_{m,v}\partial CP_{m,u}$.

Expenditure elasticities are

$$MEL_{m,i,E} = \frac{G_{m,i}}{G_m}\frac{EX^{HD}_m}{CNS^{HD}_{m,i}} \tag{47}$$

As is well known Marshallian elasticities $MEL_{m,u,v}$ are related to Hicksian elasticities $HEL_{m,u,v}$ through the Slutzky equation:

$$HEL_{m,u,v} = MEL_{m,u,v} + SHB_{m,v}\,MEL_{m,u,E} \tag{48}$$

where

$HEL_{m,u,v}$	=	Hicksian price elasticity of item u ∈ ITEM wrt consumer price of item v ∈ ITEM in Member State m
$MEL_{m,u,v}$	=	Marshallian price elasticity of item u ∈ ITEM wrt consumer price of item v ∈ ITEM in Member State m
$SHB_{m,v}$	=	$CP_{m,v} \cdot CNS^{HD}_{m,v}$ / $\underline{EX}^{HD}_m$ = budget share of product v in Member State m
$MEL_{m,u,E}$	=	Expenditure elasticity of item u ∈ ITEM in Member State m

Using (45), (46) and (47) the Hicksian elasticities $HEL_{m,u,v}$ may be shown to have a simpler structure which will be help later:

$$\mathrm{HEL}_{m,u,v} = \left[\left(\frac{G_{m,u,v}}{G_m} - \frac{G_{m,u}G_{m,v}}{{G_m}^2}\right)\left(\mathrm{EX}_m^{HD} - F_m\right) - \frac{G_{m,u}}{G_m}F_{m,v} + \frac{G_{m,u}}{G_m}\mathrm{CNS}_{m,v}^{HD}\right]\frac{\mathrm{CP}_{m,v}}{CNS_{m,u}^{HD}} \qquad (49)$$
$$= \frac{G_{m,u,v}}{G_m}\left(\mathrm{EX}_m^{HD} - F_m\right)\frac{\mathrm{CP}_{m,v}}{CNS_{m,u}^{HD}}$$

As justified above, we will use the Generalised Leontief form for function G_m:

$$G_m(\mathbf{CP}_m) = \sum_u \sum_v \chi_{m,u,v} {\mathrm{CP}_{m,u}}^{0.5} {\mathrm{CP}_{m,v}}^{0.5} \qquad (50)$$

where

$$\chi_{m,u,v} = \chi_{m,v,u} \qquad (51)$$

and

$$\chi_{m,u,v} > 0 \qquad (\forall\ u \neq v) \qquad (52)$$

to impose global concavity in consumer prices. Function F_m will be taken to be linear in prices:

$$F_m(\mathbf{CP}_m) = \sum_u \delta_{m,u}\mathrm{CP}_{m,u} \qquad (53)$$

Even though not indicated in equation (53), committed consumption may be shifted over time to reflect trends in consumption, for example away from beef and in favour of poultry. It will turn out helpful for the implementation of a reference run that any changes in the commitments will not interfere with theoretical consistency of the demand system.

Based on our choice for functions F_m and G_m, Marshallian per capita demand will be

CNS_HD__

$$CNS_{m,i}^{HD} = {\mathrm{CP}_{m,i}}^{-1}\frac{\sum_v \chi_{m,i,v}{\mathrm{CP}_{m,i}}^{0.5}{\mathrm{CP}_{m,v}}^{0.5}}{\sum_u\sum_v \chi_{m,u,v}{\mathrm{CP}_{m,u}}^{0.5}{\mathrm{CP}_{m,v}}^{0.5}}\left(\mathrm{EX}_m^{HD} - \sum_u \delta_{m,u}\mathrm{CP}_{m,u}\right) + \delta_{m,i} \qquad (54)$$

The fraction may be recognised to be the marginal budget shares for item i. These marginal budget shares add up to one by construction such that adding up need not be imposed as a separate restriction. The marginal budget shares reappear in the income elasticities:

$$\mathrm{MEL}_{m,i,E} = {\mathrm{CP}_{m,i}}^{-1}\frac{\sum_v \chi_{m,i,v}{\mathrm{CP}_{m,i}}^{0.5}{\mathrm{CP}_{m,v}}^{0.5}}{\sum_u\sum_v \chi_{m,u,v}{\mathrm{CP}_{m,u}}^{0.5}{\mathrm{CP}_{m,v}}^{0.5}}\frac{\mathrm{EX}_m^{HD}}{CNS_{m,i}^{HD}} \qquad (55)$$

As to price elasticities, given their simpler structure we will use the Hicksian elasticities during the calibration:

$$\mathrm{HEL}_{m,i,w} = \frac{1}{2\mathrm{CP}_{m,i}} \frac{\chi_{m,i,w}\mathrm{CP}_{m,i}^{0.5}\mathrm{CP}_{m,w}^{-0.5}}{\sum_u\sum_v \chi_{m,u,v}\mathrm{CP}_{m,u}^{0.5}\mathrm{CP}_{m,v}^{0.5}} \left(\mathrm{EX}_m^{HD} - \sum_u \delta_{m,u}\mathrm{CP}_{m,u}\right)\frac{\mathrm{CP}_{m,w}}{CNS_{m,i}^{HD}} \quad (56)$$

$$= \frac{\chi_{m,i,w}\mathrm{CP}_{m,i}^{0.5}\mathrm{CP}_{m,w}^{0.5}}{\sum_u\sum_v \chi_{m,u,v}\mathrm{CP}_{m,u}^{0.5}\mathrm{CP}_{m,v}^{0.5}} \frac{\left(\mathrm{EX}_m^{HD} - \sum_u \delta_{m,u}\mathrm{CP}_{m,u}\right)}{2\mathrm{CP}_{m,i}\, CNS_{m,i}^{HD}}$$

$$= \frac{\chi_{m,i,w}\mathrm{CP}_{m,w}^{0.5}}{\sum_u \chi_{m,i,u}\mathrm{CP}_{m,u}^{0.5}} \frac{\left(CNS_{m,i}^{HD} - \delta_{m,i}\right)}{2\mathrm{CP}_{m,i}}$$

where the last equality in (56) follows when (54) is used to substitute for noncommitted expenditure ($\underline{\mathrm{EX}}_m^{HD}$ - $\Sigma_u\ \delta_{m,u}\ \mathrm{CP}_{m,u}$).

Finally note that total consumption follows from per capita consumption times inhabitants:

CNS_

$$\mathrm{CNS}_{m,i} = CNS_{m,i}^{HD} \cdot \underline{\mathrm{INHA}}_m \quad (57)$$

where

$CNS_{m,i}^{HD}$ = per capita demand quantity of item i ∈ ITEM in Member State m

$\mathrm{CNS}_{m,i}$ = total demand quantity of item i ∈ ITEM in Member State m

$\underline{\mathrm{INHA}}_m$ = inhabitants in Member State m

2.2.2 Parameter specification

The parameter specification will rely on calibration techniques rather than on a full econometric estimation. This calibration may be based on a set of given uncalibrated elasticities (see the earlier description in Witzke, Britz 1998). The calibration chooses parameters $\chi_{m,u,v}$ and $\delta_{m,u}$ to minimise deviations from the starting points according to the cross entropy objective (Golan, Judge, Miller 1996) and constraints derived from consumer theory and plausibility considerations.

The calibration problem is

$$\mathrm{Max\ ENTD}_m = -\Sigma_z\,\Sigma_u\,\Sigma_v\,\mathrm{PROB}_{m,z,u,v}\ \ln(\mathrm{PROB}_{m,z,u,v} / \theta_{m,z,u,v}) \quad (58)$$

$$-\Sigma_z\,\Sigma_u\,\mathrm{PROB}_{m,z,u,E}\ \ln(\mathrm{PROB}_{m,z,u,E} / \theta_{m,z,u,E})$$

with a number of constraints (apart from adding up of probabilities). The first of these is the definition of price and expenditure elasticities from (four) support points:

$$\mathrm{HEL}_{m,u,v} = \Sigma_z\,\mathrm{PROB}_{m,z,u,v}\ \underline{\mathrm{HELS}}_{m,z,u,v} \quad \forall\ u,v \quad (59)$$

$$\mathrm{MEL}_{m,u,E} = \Sigma_z\,\mathrm{PROB}_{m,z,u,E}\ \underline{\mathrm{MELS}}_{m,z,u,E} \quad \forall\ u$$

where

ENTD_m = cross entropy in demand side calibration for Member State m

$\mathrm{PROB}_{m,z,u,v}$ = final probability weight for support point z of elasticity of consumer demand u wrt price of item v in Member State m

$\theta_{m,z,u,v}$ = initial probability weight for support point z of elasticity of consumer demand u wrt price of item v in Member State m (= 0.499 for z = 2,3)

$HEL_{m,u,v}$ = Hicksian demand elasticity of consumer demand u wrt price of item v in Member State m

$\underline{HELS}_{m,z,u,v}$ = support point z of elasticity $HEL_{m,u,v}$ of consumer demand u wrt price of item v in Member State m

$PROB_{m,z,u,E}$ = final probability weight for support point z of elasticity of consumer demand u wrt expenditure in Member State m

$\theta_{m,z,u,E}$ = initial probability weight for support point z of elasticity of consumer demand u wrt expenditure in Member State m

$MEL_{m,u,E}$ = (Marshallian) demand elasticity of consumer demand u wrt expenditure in Member State m

$\underline{MELS}_{m,z,u,E}$ = support point z of elasticity $HEL_{m,u,E}$ of consumer demand u wrt expenditure in Member State m

Furthermore we use the homogeneity property to compute the Hicksian own price elasticity:

$$\Sigma_v\ HEL_{m,u,v} = 0 \qquad \forall\ u \tag{60}$$

In addition we require (51), (52), (54), (55), and (56) from section 2.2.1. In a consistent set of elasticities, that is taking care of symmetry, homogeneity, and adding up we have n(n-1)/2 + n-1 free elasticities (Deaton Muellbauer 1980: 64). In our system the symmetry restrictions (51) have reduced the number of free $\chi_{m,u,v}$ and δ_u parameters to n(n-1)/2 + n, that is one more than needed. There is thus a need for normalisation. This may also be concluded from the marginal budget shares being homogenous of degree zero in the χ. Whereas Ryan, Wales 1996 suggested to set the sum of the diagonal elements to 1 ($\Sigma_u\ \chi_{m,u,u} = 1$) we will simply use $\chi_{m,REST,REST} = 0.1 * CNS_{m,REST}$, that is equal to 10% of the base period consumption, because this turned out to yield a reasonable scaling and some comparability of parameters across MS.

Initialisation

As on the supply side it would appear almost impossible to specify starting values for the complete set of elasticities (or parameters) without using separability assumptions even though they will not be maintained during the calibration. At the same time it is typical in the empirical literature that researchers have estimated either complete but more aggregated demand systems or systems for groups of food item, for example the meats. To make use of this information we will assume again that the demand system may be approximated by a hierarchical demand system susceptible to two stage budgeting. In this system, demand functions are conditioned on group expenditures:

$$\begin{aligned} \mathbf{CNS}_{m,1} &= \mathbf{D}_{m|1}(\mathbf{CP}_{m,1}, EX_{m,1}) \\ &\vdots \\ \mathbf{CNS}_{m,N} &= \mathbf{D}_{m|N}(\mathbf{CP}_{m,N}, EX_{m,N}) \end{aligned} \tag{61}$$

where group expenditures are determined in an upper level demand system:

$$EX_{m,1} = \hat{CP}_{m,1} \cdot \hat{CNS}_{m,1} = \hat{CP}_{m,1} \cdot \hat{D}_{m,1}(\hat{\mathbf{CP}}_m, \underline{EX}_m) \quad (62)$$

$$\vdots$$

$$EX_{m,N} = \hat{CP}_{m,N} \cdot \hat{CNS}_{m,N} = \hat{CP}_{m,N} \cdot \hat{D}_{m,N}(\hat{\mathbf{CP}}_m, \underline{EX}_m)$$

and

$\mathbf{CNS}_{m,I}$	=	column vector of consumption quantities $i \in I \subset$ ITEM (I = 1, …, N) in Member State m
$\mathbf{CP}_{m,I}$	=	column vector of consumer prices $CP_{m,i}$, $i \in I \subset$ ITEM in Member State m
$EX_{m,I}$	=	expenditure on group $I \subset$ ITEM in Member State m
$\mathbf{D}_{m\,\|I}$	=	column vector of demand functions $D_{m,i\,\|I}$, $i \in I \subset$ ITEM conditional on group expenditure $EX_{m,I}$ in Member State m
$\hat{CNS}_{m,I}$	=	aggregate consumption quantity I in Member State m
$\hat{\mathbf{CP}}_m$	=	column vector of aggregate consumer prices $\hat{CP}_{m,I}$ in Member State m
$\hat{D}_{m,I}$	=	aggregate demand function I in Member State m
$\underline{EX}_m$	=	$\Sigma_I\, EX_{m,I}$ = total expenditure in Member State m

In this type of hierarchical system, the overall or "integrated" (Hicksian) elasticities $HEL_{m,i,w}$ may be derived from the lower level elasticities $HEL_{m,i,w\,|I}$ and $MEL_{m,i,I}$ and the top level elasticities $\hat{HEL}_{m,I,W}$ and $\hat{MEL}_{m,I,E}$ as follows, first for the income elasticities:

$$\begin{aligned} MEL_{m,i,E} &= \frac{\partial CNS_{m,i}}{\partial EX_m}\frac{EX_m}{CNS_{m,i}} = \frac{\partial D_{m,i|I}}{\partial EX_{m,I}}\frac{EX_{m,I}}{D_{m,i|I}}\frac{\partial EX_{m,I}}{\partial EX_m}\frac{EX_m}{EX_{m,I}} \\ &= \frac{\partial D_{m,i\,|I}}{\partial EX_{m,I}}\frac{EX_{m,I}}{D_{m,i|I}}\hat{CP}_{m,I}\frac{\partial \hat{D}_{m,I}}{\partial EX_m}\frac{EX_m}{\hat{D}_{m,I}}\frac{1}{\hat{CP}_{m,I}} \\ &= MEL_{m,i,I} \cdot \hat{MEL}_{m,I,E} \end{aligned} \quad (63)$$

where

$MEL_{m,i,E}$	=	elasticity of good $i \in I$ wrt. total expenditure in Member State m
$MEL_{m,i,I}$	=	elasticity of good $i \in I$ wrt. group expenditure in Member State m
$\hat{MEL}_{m,I,E}$	=	elasticity of group I consumption wrt. total expenditure in Member State m

For the Hicksian price elasticities the following relationship (comp. de Haen, Murty, Tangermann 1982, eq. 22 or Egderton et al. 1996, eq. 20) holds:

$$\begin{aligned} HEL_{m,u,v} &= HEL_{m,u,v\,|U} + MEL_{m,u,U}\, \hat{HEL}_{m,U,U}\, \underline{SHB}_{m,v} / \underline{SHB}_{m,V} \\ &= \sigma_{m,u,v\,|U}\, \underline{SHB}_{m,u} / \underline{SHB}_{m,U} + MEL_{m,u,U}\, \sigma_{m,U,U}\, \underline{SHB}_{m,v} \end{aligned} \quad (64)$$

$(u,v \in U=V)$

$$HEL_{m,u,v} = MEL_{m,u,U}\ \hat{HEL}_{m,U,V}\ \underline{SHB}_{m,v} / \underline{SHB}_{m,V}$$

$$= MEL_{m,u,U}\ \sigma_{m,U,V}\ \underline{SHB}_{m,v} \qquad (65)$$

$$(u \in U,\ v \in V,\ U \neq V)$$

where symbols other than the expenditure elasticities are

$HEL_{m,u,v}$	=	Hicksian price elasticity of item u wrt price of item v in Member State m
$HEL_{m,u,v\|U}$	=	Hicksian price elasticity of item u wrt price of item v (u,v ∈ U) given expenditure on group U ("within group elasticity") in Member State m
$\hat{HEL}_{m,U,V}$	=	Hicksian price elasticity of aggregate item U wrt price of aggregate item V in Member State m
$\sigma_{m,u,v\|U}$	=	Allen elasticity of substitution of item u wrt item v within aggregate U in Member State m
$\sigma_{m,U,V}$	=	Allen elasticity of substitution of aggregate U wrt aggregate V in Member State m
$\underline{SHB}_{m,v}$	=	$CP_{m,v}\ CNS_{m,v} / EX_m$ = (base year) budget share of item v in Member State m
$\underline{SHB}_{m,V}$	=	$\hat{CP}_{m,V}\hat{CNS}_{m,V}/EX_m$ = (base year) budget share of aggregate item V in Member State m

Note that the above separability structure has not been imposed during the calibration. Its only purpose was to facilitate the derivation of *starting* values for a detailed and completely filled elasticity matrix given sparse information on elasticities. For aggregate food group elasticities $\hat{HEL}_{m,U,V}$ there is a certain number of thorough European estimations available, usually based on one or the other variety of the AIDS system: Fulponi 1989 (France); Mergos, Donatos 1989 (Greece); Michalek, Henning 1992 (Germany); Molina 1994 (Spain); Edgerton et al. 1996 (Denmark, Sweden, Finland); Tiffin 1999 (UK); Wildner 2001(Germany); Nichele 2002 (France); Moro, Schokai 2000 (Italy); Mazocchi 2002 (Italy). Furthermore, 'group' price elasticities may rely on Michalek, Keyzer 1990, even though their elasticities are all very close to zero and fairly old. Information on within group elasticities is usually not available for all food items from a single study, exceptions being Tiffin, Tiffin 1996 and Nichele 2002. With only sketchy information, we have to rely on reasonable assumptions. A reasonable benchmark for group expenditure elasticities $MEL_{m,i,I}$ is certainly the assumption of homothetic aggregates or $MEL_{m,i,I} = 1\ \forall\ i \in I$. This has been applied except in those cases where anecdotal evidence suggests something else. For example, it has been assumed that butter has a below average expenditure elasticity (0,9) compared to oils. As a default solution, we assumed a uniform elasticity of substitution for the intra group substitution which was set to $\sigma_{m,u,v|U} = 0.5$ except for meats and oils for which we assumed a higher value of 1.0. However, given that some of the above studies gave surprising results in terms of certain elasticities (example: $MEL_{DE,BEEF,BEEF} = -2.2$ in Wildner 2001) it was considered useful to introduce the a priori expectation of "standard" elasticities as another support point, apart from the literature derived one[12]. Both the standard and the literature based support points were associated with a priori probability of .499 whereas two outer support points were ensuring feasibility. In this way the evidence from the literature could contribute member state specific patterns of elasticities but the standard set was always pulling the calibrated

[12] Again, this idea was picked up from a discussion in the CAPSIM Reference Group.

elasticities towards "conventional" values. The standard set of support points for between group substitution was derived from the Allen elasticities of substitution in Table 2.1-1. These substitution elasticities may appear quite high but this fact only reflects the small budget shares for food. Combined with shares these substitution elasticities have been used to obtain starting values for "between group" Hicksian elasticities which are considered "standard". To obtain the integrated elasticities we used the default assumptions on within group substitution from above. In the next section we will look at illustrative results for Germany.

Table 2.2-1: Standard aggregate Allen elasticities of substitution to derive starting values for Hicksian elasticities in EU 15

	MEAT	FRVG	MICE	OILS	POTG	SUGG	RESG
BRCE	2	4	2	2	6	1	0.1
MEAT		2	10	4	2	0.5	0.1
FRVG			2	2	4	1	0.1
MICE				4	2	0.5	0.1
OILS					2	0.5	0.1
POTG						1	0.1
SUGG							0.1

Note: BRCE = Bread and cereals, MEAT = meat, FRVG = fruit & vegetables group, MICE = milk, cheese and eggs, OILS = oils, fat and butter, POTG = potatoes, SUGG = sugar containing items, RESG = nonfood consumption. Source: own assumptions

2.2.3 Illustrative results from the calibration

Germany is an interesting example to look at because some findings from the German study Wildner 2001 have been considered suspect. Table 2.2-2 shows how the information derived from standard assumptions and the available evidence from earlier estimations has been merged. The final Hicksian elasticities frequently turn out to lie close to the unweighted mean of the initial "standard" and "literature based" elasticities (see the own price elasticities of POUM, RAPO, SUNO), which is not very surprising given the initial probability weights of 0.499 for the respective supports[13]. This moved the beef own price elasticity from -2.27 to about -1.44 and thus into a more plausible region (even though still surprisingly high). The "correction" is considered a reasonable compromise between the incorporation of recent empirical evidence from the EU Member States and some reserves against entirely new "findings".

The elasticities of pork and butter are examples to show that the result may also deviate from the unweighted average of two supports because it takes into account the constraints imposed by microeconomic theory. Because elasticities from the literature which have been estimated on another database than ours are likely to violate these constraints when combined with our shares, the "standard" elasticities tend to prevail in case of marked differences. It is also possible to see the impacts of the separability structure used to specify the initial elasticities. According to equation (65) the Hicksian elasticities $HEL_{m,u,v}$ between, say POUM, and different members of the OILS set (RAPO, SUNO, BUTT) will be the same as long as the income elasticities of these items are identical. Because the income elasticity for butter has been set somewhat lower (0.9) than for other oils (1.0), so will be the corresponding Hicksian cross

[13] The outer supports ("1" and "4") were chosen to reflect a "medium" spread based on earlier experience: For the income elasticities we set: "1" = .01* starting value; "4" = 2.0. For the own price Hicksians we set : "1" = 0.5* starting value; "4" = 1.5* starting value. For the cross price Hicksians we set: "1" = max(-0.2, -2*starting value); "4" = min(2.0, 25*starting value).

price elasticity but those of rape oil and sunflower oil are the same. Again we may see in the same lines (RAPO.POUM, SUNO.POUM) that these implications of two stage budgeting are not imposed during the calibration such that the final elasticity matrix may have a more general structure than the initial values. Again, these full elasticity matrices are better screened in electronic form in a spreadsheet rather than in this documentation.

Table 2.2-2: Selected standard (STD) and literature based (LIT) central support points and final (FIN) Hicksian and Marshallian elasticities (MAR) for Germany

	STD	LIT	FIN	MAR
BEEF.BEEF	**-0.855**	**-2.267**	**-1.444**	**-1.445**
PORK.BEEF	0.11	0.823	0.319	0.318
POUM.BEEF	0.136	0.111	0.133	0.132
RAPO.BEEF	0.026		0.007	0.007
SUNO.BEEF	0.026		0.007	0.006
BUTT.BEEF	0.02	-0.001	0.008	0.007
BEEF.PORK	0.417	1.175	0.974	0.972
PORK.PORK	**-0.656**	**-1.265**	**-0.79**	**-0.793**
RAPO.PORK	0.078	0.004	0.028	0.027
SUNO.PORK	0.078	0.004	0.028	0.027
BUTT.PORK	0.062	0.003	0.025	0.024
BEEF.POUM	0.105	0.093	0.103	0.102
PORK.POUM	0.085	0.007	0.07	0.069
POUM.POUM	**-0.886**	**-0.805**	**-0.843**	**-0.844**
RAPO.POUM	0.02	-0.001	0.005	0.005
SUNO.POUM	0.02	-0.001	0.004	0.004
BUTT.POUM	0.016	-0.002	0.007	0.006
BEEF.RAPO	0.003	-0.001	0.001	
PORK.RAPO	0.004		0.001	0.001
POUM.RAPO	0.003	-0.001	0.001	
RAPO.RAPO	**-0.588**	**-0.51**	**-0.558**	**-0.558**
SUNO.RAPO	0.131	0.206	0.141	0.141
SOYO.RAPO	0.131	0.206	0.141	0.141
BUTT.RAPO	0.037	0.096	0.036	0.036
BEEF.SUNO	0.001	-0.002		
PORK.SUNO	0.002	-0.002		
POUM.SUNO	0.001	-0.002		
RAPO.SUNO	0.056	0.087	0.06	0.06
SUNO.SUNO	**-0.663**	**-0.629**	**-0.649**	**-0.649**
BUTT.SUNO	0.016	0.039	0.015	0.015
BEEF.BUTT	0.007	0.002	0.003	0.003
PORK.BUTT	0.01	0.003	0.003	0.003
POUM.BUTT	0.007	0.002	0.003	0.003
RAPO.BUTT	0.043	0.234	0.089	0.089
SUNO.BUTT	0.043	0.234	0.084	0.084
BUTT.BUTT	**-0.409**	**-0.254**	**-0.361**	**-0.361**

Note: BEEF = Beef, PORK = pork, POUM = poultry meat, RAPO = rape oil, SUNO = sunflower oil, BUTT = butter.

2.3 Processing

At least a part of total agricultural production is first processed before being consumed or traded. The required processing cost generates a margin between producer prices for raw products and prices of users which has to be incorporated. Furthermore in some cases the market balances differentiate between processing and immediate consumption, which both permits and requires to explicitly modeling this component of demand.

2.3.1 Standard case: Exogenous margins

In the standard case the difference between the EU price at producer level and national consumer prices is held constant:

PTD_ $$CP_{m,i} = EP_i + UMA_{c,m,i} \quad (66)$$

where

$$UMA_{C,m,i} = (\beta_{CP,m,i} - \beta_{EP,i})* UMA_{c,EU,i} / \beta_{UMAC,EU,i} \quad (67)$$

and

$CP_{m,i}$ = consumer price of item i in Member State m

$UMA_{c,reg,i}$ = unit margin to consumer level of item i in region reg (reg = m, EU)

$\beta_{UMAC,EU,i}$ = base year unit margin to consumer level of item i in EU

$\beta_{CP,m,i}$ = base year consumer price of item i in Member State m

EP_i = EU price of item i

$\beta_{EP,i}$ = base year EU price of item i

The Member State margins were tied to EU trends because Member State trends for margins appeared to be unreliable given the resulting heterogeneity across items and Member States. Unit margins on the EU level were constrained to be nondecreasing over time.

While the exogenous specification of margins is not very satisfying it is difficult to replace with something else which is also operational. In earlier specifications consumer prices were linked to national producer prices. This was abandoned because food items are increasingly independent from national raw products. Theory suggests that imperfect competition in the food industry, when combined with increasing returns to scale may even lead to higher price transmission than the standard constant returns, perfect competition case (McCorriston, Morgan, Rayner 2001). A major empirical price transmission study for food products is underway, but is not yet available.

2.3.2 Explicit behavioural functions

In some cases, e.g. for oilseeds, the market balances give information on the quantities processed. In these cases processing is conceived as a behavioural function of the processing margin (= derived revenues minus raw product costs), the general price index and the state of technology. Whereas technological progress is captured, however imperfectly, on the agricultural supply side through the trending yields it would be difficult to find an empirical proxy for the rate of technological progress in processing. To acknowledge its existence at least we assume technological change exactly compensates the cost increasing effects of general inflation, such that processing will depend on net revenues only. The functional form will be linear, corresponding to a normalised quadratic profit function in the processing industry:

PRC_ $$PRC_{m,r} = \psi_{m,r,0} + \psi_{m,r,r}\, UMA_{p,m,r} \quad (68)$$

where

MARG_ $$UMA_{p,m,r} = (\Sigma_h\, \gamma_{m,r,h}\, PP_{m,h}) - PP_{m,r} \quad (69)$$

where

$PRC_{m,r}$	=	total processing of raw product r ∈ {other cereals, potatoes, rape, sunflower, soya, olives} in Member State m
$\psi_{m,r,0}$	=	constant in processing function of raw product r in Member State m
$\psi_{m,r,r}$	=	slope in processing function of raw product r in Member State m
$\gamma_{m,r,h}$	=	processing coefficient: tons of processed output h per ton of raw product r
$UMA_{p,m,r}$	=	unit margin in processing of item r in Member State m
$PP_{m,r}$ ($PP_{m,h}$)	=	producer price of item r (item h) in Member state m

The slope parameter has been usually specified based on an assumed processing elasticity with respect to the margin of 0.5. The raw product for production of rice is (currently) "other cereals" in CAPSIM, lumping together rye, oats, other cereals and paddy. Because the share of paddy in this aggregate is likely to change with a changed profitability of rice production , this elasticity has been set higher (=3.0) to reflect the possibility of a variable composition of this aggregate on the demand side. However, an appropriate treatment of rice would require disaggregating this heterogeneous aggregate[14].

Production of secondary products is derived from processed raw products with coefficients $\gamma_{m,r,h}$ from above:

PRD_PRC_ $$PRD_{m,h} = \Sigma_r\, \gamma_{m,r,h}\, PRC_{m,r} \quad (70)$$

where

$PRD_{m,h}$	=	production of secondary product h ∈ SECO in Member state m
$PRC_{m,r}$	=	processing of raw product r in Member state m
$\gamma_{m,r,h}$	=	processing coefficient: tons of processed output h per ton of raw product r

2.3.3 Special case: milk

The first special case relates to milk products. Similar to the case for the feed technology it is considered useful to explicitly control the balances on milk fat and protein (see also Bouamra, Requillard 2000):

[14] A few years ago, when the product list of the predecessor model MFSS99 was decided, rice and rye have not been at the focus of policy interest and it was assumed that some effort could be saved here. This unfortunate decision will be revised at the next opportunity.

MLKBAL_ $$\sum_{i \in SECMLK} \gamma_{m,i,c}\, PRD_{m,i} = \sum_{h \in RAWMLK} \gamma_{m,h,c}\, PRC_{m,h} \quad (71)$$

where

$PRD_{m,i}$	=	production of secondary milk product i ∈ SECMLK in Member state m
$PRC_{m,h}$	=	processing of raw milk type h in Member state m dairy
$\gamma_{m,i,c}$	=	content of item c ∈ {FAT, PRT} in item i in Member state m

Production of secondary milk products responds to processing margins of secondary milk products (i ∈ SECMLK) with linear behavioural functions, which are conceptually derived from a normalised quadratic profit function for the dairy industry:

PRDM_ $$PRD_{m,d} = \psi_{m,d,0} + \Sigma_j \psi_{m,d,h}\, UMA_{p,m,h} \quad (72)$$

where the margins are defined net of protein and energy cost, which also applies to the two types of raw milk:

MARGM_ $$UMA_{p,m,i} = PP_{m,i} - \Sigma_c\, \gamma_{m,i,c}\, PP_{m,c} \quad (73)$$

and

$PP_{m,i}$	=	price of milk item i ∈ ALLMLK in Member state m
$PP_{m,c}$	=	price of milk content c in Member state m
$\gamma_{m,i,c}$	=	content of item c ∈ {FAT, PRT} in item i ∈ ALLMLK
$UMA_{p,m,i}$	=	unit margin in production/processing of milk item i ∈ ALLMLK (h ∈ SECMLK)

As has been argued above a normalisation with the residual (general) price index is omitted to account for technological progress in the processing industry, which more or less compensates the prices of other inputs rising with inflation. The slopes in equation (72) reflect an assumed own margin elasticity of +1.0 and -0.2 off the diagonal.

The margins for raw milk are usually negative because the dairies pay somewhat less to farmers for the raw milk than the value of the contents. However these negative margins may be used just as good as positive margins in the linear processing equation (68) which therefore also applies to raw milk. The processing elasticity has been set to 3.0 for cow milk and 1.0 for sheep and goats milk. The high margin elasticity for cow milk will render the margin for cow milk fairly stable such that the value of cow milk will closely follow the values of milk fat and protein. The margin of sheep and goat milk is more flexible due to a lower elasticity, otherwise some changes relevant for cow milk which drive up or down the value of fat and protein would generate large swings in the price of sheep milk.

2.3.4 Special case: sugar

The second special case relates to sugar. Modelling the quantity of processing is quite easy here because it can be assumed that essentially the total production of beet is also processed, apart from a few minor outlets for beet (exogenous industrial use, exogenous trade in beet, almost negligible feed use). However, the price linkage of beet and sugar prices is rather complex, also due to the sugar CMO. It is more convenient therefore to address this special case later in the context of the sugar regime (section 2.4.6).

2.4 Prices, revenues, and policy

This section explains the links between revenues, prices at different levels and policy instruments, including quantity control measures as they are represented in CAPSIM.

2.4.1 Revenues and premiums

Gross revenues in net revenue definition (6) stem from market revenues and three different types of subsidies:

REV_

$$REV_{m,j} = \Sigma_i \left[(PP_{m,i} + \underline{PAYT}_{m,i}) * \underline{YLD}_{m,i,j}\right] + \underline{HIST}_{m,j} * \underline{PRET}_{m,j} * PRETFAC_{m,j} + \underline{PREM}_{m,j} * PREMFAC_{m,j} \quad (74)$$

where

$REV_{m,j}$	=	gross revenue of activity j in Member State m
$PP_{m,i}$	=	producer price of item i in Member State m
$\underline{PAYT}_{m,i}$	=	Payment per ton of item i in Member State m
$\underline{YLD}_{m,i,j}$	=	(exogenous) yield of activity j in terms of item i in Member State m
$\underline{HIST}_{m,j}$	=	historical yield of main product in activity j in Member State m
$\underline{PRET}_{m,j}$	=	premiums per unit of historical yield in activity j in Member State m
$PRETFAC_{m,j}$	=	scaling factor to enforce ceilings on common premiums PRET for activities j in Member State m
$\underline{PREM}_{m,j}$	=	specific premiums per unit of activity j in Member State m
$PREMFAC_{m,j}$	=	scaling factor to enforce ceilings on specific premiums for activities j in Member State m

The first subsidy type is a straightforward payment per ton of actual yield. The only example is currently the dairy premium introduced in the Agenda 2000 decisions. The second type of subsidies is more relevant (see second line in the equation): the premiums per activity unit are the product of policy instruments $\underline{HIST}_{m,j}$ ("historical" yields, subject to political renegotiations) and $\underline{PRET}_{m,j}$ (premiums per ton, currently uniform in all EU member states). Evident examples for this first type are the premiums for CAP Grandes Cultures. A third type of premiums per activity unit $\underline{PREM}_{m,j}$ is plainly specified as such and captures premiums specific for individual activities (durum wheat, suckler cow, special male premium). Because yields are exogenous it is irrelevant for the results in CAPSIM whether a subsidy is granted as a payment per ton or an equivalent area payment. In case that any ceilings for the premiums $\underline{CEIL}_{m,j}$ are exceeded, the respective scaling factors $PRETFAC_{m,j}$ and $PREMFAC_{m,j}$ will assume values smaller one.

2.4.2 Set aside

Set aside is formally endogenous, though it may be considered an essentially exogenous activity in the current specification, as it is derived in a single equation from exogenous policy variables and certain parameters, regardless of prices or any other variables:

SET_ $$LVL_{m,SETA} = \Sigma_{j \in COP} LVL_{m,j} * \phi_{SET,m} * \underline{SETR}_m^{\varepsilon_{SETR,m}} \quad (75)$$

where

$LVL_{m,j}$ = level of activity j $\in$ COP (= cereals oilseeds, pulses) in Member State m

$\underline{SETR}_m$ = obligatory set aside rate in Member State m

$\phi_{SET,m}$ = constant set aside parameter for Member State m

$\varepsilon_{SETR,m}$ = elasticity of actual set aside to the obligatory set aside rate in Member State m

The set aside elasticity $\varepsilon_{SETR,m}$ has been set to 0.4 for all member states initially. It ought to capture the opposite change in voluntary set aside which usually accompanies an increase in the obligatory set aside rate. Parameter $\phi_{SET,m}$ (constant factor) has been derived to reproduce the DG Agri forecast on the growth of set aside from the June 2002 “Prospects” (p. 82).

An equally simple specification was chosen for non-food production on set aside area. This is assumed to remain constant in proportion to set aside:

NONF__ $$LVL_{m,NONF} = LVL_{m,SETA} * \beta_{LVL,m,NONF} / \beta_{LVL,m,SETA} \quad (76)$$

where

$LVL_{m,j}$ = level of activity j (= SETA, NONF) in Member State m

$\beta_{LVL,j,m}$ = base year level of activity j (= SETA, NONF) in Member State m

Proposal for future specification

This specification is evidently unsatisfactory, because it is difficult to introduce explicit assumptions on voluntary and obligatory set aside and because set aside is completely unresponsive to prices and revenues. To prepare a revision of this specification it is useful to look at the farm level decision problem, more precisely at the associated Lagrangian expression. To simplify, we neglect animal activities, purchased inputs and the choice between the small and professional producer scheme:

$$
\begin{aligned}
&\widetilde{L}_f\left(\mathbf{LVL}_f, PLND_f, PSETLO_f, PSETUP_f, PT_f\right) \\
&= \mathbf{REV}_{f,NOSET}{}'\,\mathbf{LVL}_{f,NOSET} + REV_{f,SETA}\ LVL_{f,SETA} \\
&+ PLND_f \cdot \left(\underline{AREA}_f - \sum_{j\in NOSET} LVL_{f,j} - LVL_{f,SETA} \right) \\
&+ PSETLO_f \cdot \left(LVL_{f,SETA} - \sum_{j\in NOSET} \xi_j LVL_{f,j} \right) \\
&+ PSETUP_f \cdot \left(\underline{UPSETA}_f - LVL_{f,SETA} \right) \\
&+ PT_f \cdot T_f\left(\mathbf{LVL}_{f,NOSET}, LVL_{f,SETA}\right)
\end{aligned}
\tag{77}
$$

where

$\mathbf{REV}_{f,NOSET}$	=	column vector of revenues $REV_{f,j}$ of crop activity j $\neq$ set aside on farm f
$\mathbf{LVL}_{f,NOSET}$	=	column vector of crop areas $LVL_{f,j}$ of crop activity j $\neq$ set aside on farm f
$REV_{f,SETA}$	=	revenue of set aside on farm f
$LVL_{f,SETA}$	=	area of set aside on farm f
$\underline{AREA}_f$	=	Total area in farm f (exogenous)
ξ_j	=	set aside requirement of 1 ha of crop j
T_f	=	operating capacity constraint on farm f
$PLND_f$	=	shadow rental price of land in farm f
$PSETLO_f$	=	shadow price of set aside lower bound on farm f
$PSETUP_f$	=	shadow price of set aside upper bound on farm f
PT_f	=	shadow price of operating capacity constraint T_f on farm f

The first order conditions for crop levels other than set aside are

$$REV_{f,j} - PLND_f - PSETLO_f\, \xi_j = -PT_f\, T_{f,j} \tag{78}$$

Crop revenue net of land costs and the cost of additional set aside should equal the operating capacity cost which may stem from scarce labour and capital or from rotational limitations. The corresponding condition for set aside is:

$$REV_{f,SETA} - PLND_f - PSETUP_f + PSETLO_f = -PT_f\, T_{f,SETA} \tag{79}$$

Here the set aside lower bound may introduce a virtual revenue stemming from the fulfilment of the set aside requirement whereas the upper bound may give rise to an additional shadow cost component. The shadow price of the set aside lower bound will be zero on a farm voluntarily exceeding the set aside requirement:

$$PSETLO_f \geq 0 \quad \perp \quad LVL_{f,SETA} \geq \sum\nolimits_{j\in NOSET} \xi_j LVL_{f,j} \tag{80}$$

On the other hand the shadow price of the upper bound may also zero if it is not binding:

$$PSETUP_f \geq 0 \quad \perp \quad UPSETA_f \geq LVL_{f,SETA} \tag{81}$$

Usually a farm will operate in one of three regimes: (1) It may set aside exactly an required area corresponding to the lower bound and responds to changes in the obligatory set aside rate, but not to marginal changes in the set aside payment. (2) The farm may be unconstrained by the upper and lower bounds and it will only respond to marginal changes in the set aside payment in this case. (3) The farm might wish to extend its voluntary set aside but feel constrained by the upper bound.

Unfortunately this simple behaviour will not hold in the aggregate, because farm heterogeneity implies that we always have a total farm population made up of all three farm types. Because farms with voluntary set aside or even farms with a positive shadow price for the upper bound will usually operate with lower productivity, for example due to unfavourable natural conditions, we might consider to distinguish three farm types in CAPSIM. However the empirical problems appear to be insurmountable probably in a sector model which operates on the Member State level.

A shortcut could be to treat unpaid fallow land, voluntary and obligatory set aside as three different activities. If unpaid fallow land is due to various circumstances, including the upper bound on voluntary set aside, it may be wise to keep it exogenous and assume PSETUP = 0 for modelling purposes. Furthermore we may take unconstrained voluntary set aside as one of the elements of set NOSET and let index SETA refer to obligatory set aside only.

Equation (79) may be used then to substitute $PSETLO_f$ in (78) and to obtain:

$$REV_{f,j} + \xi_j REV_{f,SETA} - (1+\xi_j) PLND_f = -PT_f (T_{f,j} + \xi_j T_{f,SETA}) \tag{82}$$

The left hand side may be considered the total net revenue of 1 ha of crop j, including the associated loss due to an obligatory ξ_j ha of set aside. This offers a straightforward possibility to include both the set aside payments and set aside rate in a coherent way into CAPSIM, once the set aside activity has been disaggregated. Note however, that (82) does not yet lead to behavioural functions for activity levels solely in terms of net revenue ($\mathbf{LVL}_f = g(\mathbf{NREV})$) as the set aside requirements ξ_j are still part of the right hand side and consequently the behavioural functions would directly depend on ξ_j ($\mathbf{LVL}_f = g(\mathbf{REV}, \boldsymbol{\xi})$). Simplification is only possible if it may be assumed that any operating capacity cost in terms of labour and capital demand and rotational benefits of set aside exactly cancel such that $T_{f,SETA} = 0$. While this has been done before (implicitly in Moro, Schokai 1999), it represents nonetheless a fairly strong assumption. However, compared to the current specification (75) equation (82) would definitely represent a considerable gain in economic content.

2.4.3 Milk quotas

The milk quota regime is handled in a standard way: Production is fixed which indirectly also fixes the herd size due to exogenous yields. This requires a shadow revenue for the behavioural function and to initialise the model, an estimate of the base year percentage quota rent. We assumed the quota rent (=difference between market derived net and shadow net revenues) to be 20% in the base year for France. Other Member States have been initialised according to results by Barkaoui, Butault, Guyomard 1997 for the marginal cost per ton of milk and to the yield differences to the reference country France.

Table 2.4-1: Estimated quota rents for the base period in EU Member states (relative to the market revenue)

BL	0.342
DK	0.391
DE	0.175
EL	0.171
ES	0.173
FR	0.200
IR	0.356
IT	0.207
NL	0.448
AT	3.770451E-4
PT	0.018
FI	0.088
SE	0.323
UK	0.373

For quota abolition simulations the quotas would be increased iteratively until shadow revenues were close to market revenues and dropped from that point onwards. Simulation results on milk market reform options are strongly dependent on the estimated quota rents. The above estimates imply, for example, that a hypothetical 10 percent price drop in the market derived net revenue would lead to some decline in production only in AT, PT and FI. Because CAPSIM has not been applied in extensive modelling efforts for the milk sector, the above specification should be considered preliminary.

2.4.4 International price transmission

International prices (border prices) are linked to EU prices using a price transmission equation based on the law of one price. Without border measures, these international prices would directly apply to EU markets. Price policy instruments are tariffs or, until tariffication is complete, administered prices with associated flexible levies or export subsidies. Export quantities are constrained by WTO restrictions, possibly requiring public intervention.

PTE_ $$EP_i = WP_i * (1+ \underline{TARR}_i) + \underline{TARA}_i + FLEV_i \tag{83}$$

where

EP_i = EU level market price of product i

WP_i = EU border price

$TARR_i$	=	ad valorem tariff
$TARA_i$	=	specific tariff (fixed amount per t)
$FLEV_i$	=	flexible levy / export restitution, = 0 for $i \notin INTERV \subset ITEM$

and

FLEV_ $$FLEV_i = WP_i * (1+ \underline{TARR_i}) + \underline{TARA_i} - \underline{PADM_i} \quad (84)$$

where

$PADM_i$	=	Administered EU price

This specification may be simplified representation of actual EU market management, which includes storage aid and heavily relies on various bidding procedures for export subsidies. Nonetheless it is assumed that the whole package of policy instruments is handled in a coherent way to move EU market prices consistent with any movement in official support prices, say the intervention price of sugar. In the case of sugar the market management includes an adjustment of quotas to avoid intervention purchases, which is handled by appropriate exogenous adjustments of quotas.

The above international price transmission is switched off for items with exogenous price forecasts ($i \in FXPTE$), for items without central EU price ($i \in MSBAL$) or in the reference run in trade regime No. 6 see section 2.5.

2.4.5 Intra-EU price transmission

Producer price changes in Member States are usually assumed to equal those on the EU level in relative terms:

PTP__ $$PP_{m,i} = EP_i * \beta_{PP,m,i} / \beta_{EP,i} \quad (85)$$

where

$PP_{m,i}$	=	producer price of product $i \in ITEM \setminus MSBAL$ in Member State m
$\beta_{PP,m,i}$	=	base period producer price of product i in Member State m
$\beta_{EP,i}$	=	base period EU level market price of product i

The proportional differences between Member State prices and EU prices reflect differences in composition and in quality of the products involved, taken to be constant in simulation runs. This strict proportional linkage of all MS prices need not hold for a set with MS level price determination ($i \in MSBAL$)

Prices for feed use of items may differ from the selling prices of farmers due to marketing and processing within or outside of agriculture. The mark up is specified in the base period to be consistent with the EAA information on total feed costs. Strictly speaking the distinction of producer prices and feed use prices should have been introduced already earlier in equations (2), (3), (5), (7), (32) and (69), but this was postponed to avoid some clutter at least up to this point. This is justified because percentage feed price changes in Member States are assumed to equal those of producer prices if they exist, otherwise those of EU prices:

PTF_ $$FP_{m,f} = I_{PP,f} * PP_{m,f} * \beta_{FP,m,f} / \beta_{PP,m,f} + (1- I_{PP,f})\, EP_f * \beta_{FP,m,f} / \beta_{EP,f} \quad (86)$$

where

$FP_{m,f}$ = feed price of item f in Member State m

$I_{PP,f}$ = 1 if $\beta_{PP,m,i}$ exists, 0 otherwise

2.4.6 Sugar regime

CAPSIM has been used in an extensive study of the EU sugar market. As a consequence several characteristics specific to the sugar Common Market Organisation (CMO) have been introduced. The most important elements of this “sugar heritage” are described in the following[15].

Price linkage between sugar beet and sugar

Specific features in the sugar sector first relate to price formation. For sugar prices we apply the proportional linkage of national prices according to equation (85) to a central EU price which is defined to be the intervention price in the sugar sector. The base period pattern of national prices is preserved therefore in the simulations. For national sugar prices we used the average of the CAOBISCO[16] national prices in Linde et al. 2000, p. 71 and the intervention price, to reflect the possibility that the CAOBISCO sample might exaggerate the difference of market prices to the intervention price.

Prices for beets, on the contrary, are specified on the Member state level, starting from information in the Economic Accounts on Agriculture, which provides the framework for all sectoral data in CAPSIM. The price linkage of sugar beet prices and derived products reflect the self-financing character of the levy system. It assumes that a constant share of market revenues net of variable processing costs (for example for energy…) is passed on to growers of beet. Prices of C sugar beet are a certain percentage of derived (international[17]) revenues net of variable processing costs:

PTSC_

$$PP_{m,SUBC} = (1-\omega_{m,IND})* (\gamma_{m,SUGB,SUGA}\, WP_{SUGA} + \gamma_{m,SUGB,MOLA,}\, EP_{MOLA} - \gamma_{m,SUGB,PRC}) \quad (87)$$

where

EP_{MOLA} = EU level market price of molasses

$PP_{m,SUBC}$ = producer price of SUBC (= C sugar beet) in Member state m

WP_{SUGA} = border price of sugar

$\gamma_{m,SUGB,h}$ = processing coefficient: tons of processed output h $\in$ {SUGA, MOLA} per ton of sugar beet

$\gamma_{m,SUGB,PRC}$ = variable cost per ton of processed sugar beet

$\omega_{m,IND}$ = share of net revenue for sugar industry fixed cost and profit

---

15 To remove clutter from the code and this description several useful output and input facilities which were part of the “sugar version” of CAPSIM have been removed from the “standard version”. If necessary they may be activated again at the cost of additional complexity of handling CAPSIM.

16 CAOBISCO = Association des Industries de la Chocolaterie, Biscuiterie et Confiserie de l'UE.

17 For simplicity and due to its minor importance we use domestic prices of molasses rather than international prices.

The combined relative/absolute specification for fixed cost and profit tends to cushion any fluctuations in international prices and will render prices of C beet positive under most circumstances. Prices of A or B sugar beet (X = A,B) are determined in an analogous manner but have to reflect the levies:

PTSA_,
PTSB_

$$PP_{m,SUBX} = (1 - \omega_{m,IND})^* \quad (88)$$

$$(\gamma_{m,SUGB,SUGA}[EP_{SUGA} - ALEVY\ \omega_{m,SUBX} - BLEVY\ (1 - \omega_{m,SUBX})] + \gamma_{m,SUGB,MOLA}\ EP_{MOLA} - \gamma_{m,SUGB,PRC})$$

where

EP_i	=	EU level market price of item i ∈ { SUGA, MOLA }
$PP_{m,SUBX}$	=	producer price of SUBX ∈ { SUBA = A beet, SUBB = B beet } in Member state m
$\omega_{m,SUBX}$	=	weight of A levies in price determination of SUBX (X = A, B) in Member state m
ALEVY	=	levy on A sugar
BLEVY	=	levy on B sugar

In Member states implementing a classical A, B, C system the weight of A levies in the price determination of A beet weight ($\omega_{m,SUBA}$) equals 1. However, in countries implementing a pool price system the weight will be equal to the share of the A quota in the combined A+B quota, because the average levy will be applied both to A and to B beet.

The share parameters $\omega_{m,IND}$ and constant parameter $\gamma_{m,SUGB,PRC}$ of the price linkage equation have been determined to reflect the observed beet prices in Member State m in the base year. The following table shows the base year prices and parameters for EU Member states. The constant term in the price linkage equation is high, if the C-beet price was rather low compared to the A-beet price (e.g. in DE, IR, AT) and vice versa. The share parameter has to adjust in line with the average (total) beet price according to the Economic Accounts on Agriculture. B- and C-beet prices in EL and PT are included only for technical reasons, because these countries do not fully use their A quota, only the A price matters and other prices are estimates. For the relative differences between the beets of different types in EU Member States information from a survey in the sugar industry has been used. Processing yields are usually derived from Eurostat market balances, as mentioned above. The processing margins follow from the quota sugar valued at the given Member State sugar price plus C sugar revenues less levies and beet costs.

Table 2.4-2: Sugar relevant base year data for EU Member States in CAPSIM

	A-beet price [€/t]	B-beet price [€/t]	C-beet price [€/t]	total beet price [€/t]	MS sugar price [€/t]	processing margin [€/t]	processing yield	share parameter	constant
BL	53	53	18	48	686	259	0.153	0.39	5.55
DK	55	40	18	44	669	245	0.161	0.43	5.84
DE	58	41	16	48	675	237	0.156	0.33	11.42
EL	49	36	17	49	676	221	0.111	0.28	4.02
ES	48	48	17	47	702	278	0.122	0.35	4.42
FR	42	30	13	34	699	342	0.161	0.55	8.10
IR	54	54	13	52	690	290	0.152	0.31	16.62
IT	49	49	17	47	679	240	0.127	0.34	4.58
NL	50	50	17	48	678	266	0.145	0.40	5.26
AT	55	39	15	44	683	257	0.154	0.36	12.66
PT	46	34	16	46	697	308	0.122	0.39	4.42
FI	51	37	17	49	686	271	0.133	0.36	4.80
SE	52	38	17	48	690	328	0.163	0.47	5.90
UK	56	56	19	47	716	273	0.160	0.40	5.80

A-levies are bounded at 2% of the sugar price if that is insufficient to cover the budgetary cost per ton of sugar due to the surplus of A+B sugar,

ALEVY_

$$ALEVY = \min(0.02*EP_{SUGA}, (EP_{SUGA} - WP_{SUGA}) \cdot (NETTRD_{SUGA} - \Sigma_m \gamma_{m,SUGB,SUGA} PRC_{m,SUBC} + \Sigma_m IND_{m,SUGA}) / \Sigma_m (\gamma_{m,SUGB,SUGA} PRC_{m,SUBA} + \gamma_{m,SUGB,SUGA} PRC_{m,SUBB}) \quad (89)$$

while B-levies have to finance any remaining cost of surplus disposal:

BLEVY_

$$BLEVY = [(EP_{SUGA} - WP_{SUGA}) \cdot (NETTRD_{SUGA} - \Sigma_m \gamma_{m,SUGB,SUGA} PRC_{m,SUBC} + \Sigma_m IND_{m,SUGA}) - ALEVY * \Sigma_m \gamma_{m,SUGB,SUGA} PRC_{m,SUBA}] / \Sigma_m \gamma_{m,SUGB,SUGA} PRC_{m,SUBB} \quad (90)$$

Determination of activity levels for different beet types

Even though an analysis of FADN data shows that quotas are not fully used in a small part of the farm population, we rarely observed an underuse of the quota at the Member State level if the Member State produces C Sugar. This may have different reasons:

- It is known that some sugar enterprises are permitting some quota transfer between “their” farms already in the current framework, precisely to make for a rather complete use of quotas and processing capacity. This transfer is also likely to occur in an informal way directly between farmers.
- The carry forward possibility of the sugar CMO permits “C sugar” produced in a given year to be used as quota sugar in the next year. This implies that C sugar may be used to

fill “deficits” of quota sugar production, albeit at a (storage) cost. Because the enterprises always carry forward certain quantities they may be able to secure a complete use of quotas as long as there is a sufficient production of C sugar.

We assume that these and other mechanisms are making sure that the quotas are filled if the Member State is producing a sufficient amount of C sugar. As a consequence, we are modelling the total area of sugar beet in the first place. Given the total area of sugar beet activity levels of A, B, and C sugar beet may be derived as follows:

LVLA_ $$LVL_{m,SUBA} = \min(LVL_{m,SUGB}, QTL_{m,SUBA}) \quad (91)$$

where

$LVL_{m,SUGB}$ = aggregate activity level of sugar beet in Member State m

$LVL_{m,SUBA}$ = activity level of A beet in Member State m

$QTL_{m,SUBA}$ = A quota in Member State m, converted into beet area

LVLB_ $$LVL_{m,SUBB} = \min(LVL_{m,SUGB} - LVL_{m,SUBA}, QTL_{m,SUBB}) \quad (92)$$

where

$QTL_{m,SUBB}$ = B quota in Member State m, converted into beet area

LVLC_ $$LVL_{m,SUBC} = LVL_{m,SUGB} - LVL_{m,SUBA} - LVL_{m,SUBB} \quad (93)$$

Conversion of the sugar quota into a beet area quota relies on the base period conversion coefficient from sugar beet to sugar (= base period sugar production / base period beet processing according to Eurostat data) and the sugar beet yield projected for the simulation year.

Incentive revenue solution for total sugar beet area

Total sugar beet area, in turn, follows from a usual activity level equation (14) but to reflect the quota system, the net revenue for total sugar beet used in the activity level equation is not simply the average of net revenues for A-, B- and C-beet. Instead we use an “incentive revenue”, a kind of shadow revenue which steers the level of beet production. This incentive revenue is determined in turn as a function of the revenues of A-, B- and C- beet and of the sugar quota in area form:

INCENTIV_ $$\begin{aligned} NREV_{m,SUGB} = \phi_{m,0,1} &- \phi_{m,SUBA,1} EXP(\phi_{m,SUBA,2} NREV_{m,SUBA}) \\ &- \phi_{m,SUBB,1} EXP(\phi_{m,SUBB,2} NREV_{m,SUBB}) \\ &+ \phi_{m,SUBC,1} NREV_{m,SUBC}^{\phi_{m,SUBC,2}} \\ &+ \phi_{m,QTL,1} QTL_m + \phi_{m,QTL,2} QTL_m^2 \end{aligned} \quad (94)$$

where

$NREV_{m,j}$ = net revenue of activity $j \in \{SUGB, SUBA, SUBB, SUBC\}$ in Member State m

QTL_m = $QTL_{m,SUBA} + QTL_{m,SUBB}$ = aggregate area quota in Member State m

This functional form has been chosen in view of a priori expectations. A strong curvature with respect to net revenues of quota beets makes sure that the incentive revenue and hence total sugar beet area will not rise significantly if net revenues of quota beets rise but the quotas are unchanged. The parameters have been chosen to minimise the deviations of the CAPSIM supply response of sugar beet to the CAPRI supply response in a series of auxiliary calibration runs. These auxiliary simulations (base year, quota beet prices ± 30%, quota beet prices down to C level, C prices ± 40%, quotas – 25%, – 50%, and the reference run) were chosen to cover the spectrum of conceivable simulations in the sugar project. Because increases in sugar quotas have not been considered in the auxiliary simulations, the incentive function is not suitable for increases of quota endowments. However, it is highly unlikely that this would become a relevant simulation in the future. Quota cuts, on the contrary, would be translated into corresponding cuts of the incentive revenue, which subsequently triggers a decline in total sugar beet area. This decline will reflect a partly substitution of C beet for former quota beet as is to be expected.

As a consequence, the supply response of CAPSIM approximates by construction that of CAPRI, though not perfectly because we used only 9 parameters per Member State. The CAPSIM approach to modelling sugar beet supply may thus pick up other objectives of farmers than simple profit maximisation, even though in an ad hoc way. Earlier attempts to tackle the sugar sector in a rigorous profit maximisation framework[18] have been abandoned therefore.

2.5 Market clearing

2.5.1 Market balances

Market clearing requires definitions of supply,

SUP_ $$SUP_{m,i} = PRD_{m,i} \tag{95}$$

where

$SUP_{m,i}$ = supply of item i in Member State m,

and demand,

DEM_ $$DEM_{m,i} = INP_{m,i} + CNS_{m,i} + LNK_{m,i} + IND_{m,i} + PRC_{m,i} \tag{96}$$

where

$DEM_{m,i}$ = total domestic private demand of item i in Member State m

$LNK_{m,i}$ = use of item i linked to production in Member State m

$IND_{m,i}$ = industrial use of item i in Member State m, exogenous

Input demand $INP_{m,i}$ has been covered in section 2.1, consumer demand $CNS_{m,i}$ in section 2.2, and processing $PRC_{m,i}$ in section 2.3. The two demand components not mentioned so far are industrial use $IND_{m,i}$ and demand linked to production $LNK_{m,i}$. Industrial use is an exogenous

[18] Witzke, H.P., Heckelei, T. (2002a), (2002b).

component of demand. It is an important component mainly for barley where industrial use is 16% in the base period due to the brewery industry, but also for sugar. Lacking more detailed information (prices, product balance on, say, beer) we chose to project industrial uses by trend extrapolations.

Demand linked to production $LNK_{m,i}$ refers to certain positions of minor importance (seed use + losses) which are estimated using the base period percentage to production:

LNK_ $$LNK_{m,i} = PRD_{m,i} * \beta_{LNK,m,i} / \beta_{PRD,m,i} \quad (97)$$

where

$LNK_{m,i}$	=	use of item i linked to production (seed use + losses) in Member State m
$\beta_{PRD,m,i}$	=	base period production of item i in Member State m
$\beta_{LNK,m,i}$	=	base period use of item i linked to production (seed use + losses on farm + consumption on farm) in Member State m

The balance of domestic supply and (private) demand is excess supply, which usually equals net exports but may also flow into intervention for certain products, $i \in$ INTERV, if WTO limits are attained. For products without an official administered price an excessive support may lead to a violation of WTO limits which is simply assigned to a variable indicating (if positive) that the policy scenario is incompatible with the WTO:

MBAL_ $$NETTRD_i + ITS_i + XQTVIO_i = \Sigma_m (SUP_{m,i} - DEM_{m,i}) \quad (98)$$

where

$NETTRD_i$	=	net exports of item i from the EU
ITS_i	=	intervention sales of item $i \in$ INTERV to the EU
$XQTVIO_i$	=	violation of WTO limits for item $i \notin$ INTERV to the EU

2.5.2 Regimes for market clearing

Market clearance may occur in various regimes. In the standard regime net trade is a linear function of EU border prices WP_i:

NETEU_ $$NETTRD_i = \phi_{NETTRD,i,0} - \phi_{NETTRD,i,1} WP_i \quad (99)$$

With a slope parameter $0 < \phi_{NETTRD,i,1} < \infty$ this represents a situation where neither EU net trade nor EU border prices are exogenously fixed. The majority of slopes is derived from the results of auxiliary simulations with the redesigned trade model WATSIM (Kuhn 2003) where the EU border price change was calculated which results from a hypothetical X% exogenous cut in EU supply in the base year. For some products exogenous assumptions were used, see the following table. The table also gives the implied net trade elasticities from the WATSIM simulations, calculated for a 2009 reference situation (Agenda 2000). The constants have been calculated to reproduce the reference run, see section 3.5.

Table 2.5-1: Parameters of the net trade function in CAPSIM, elasticities with respect to EU border prices and reference run net trade

	Constant	Slope	Elasticity	NETTRD
SWHE	247924	2000.64	9.33	24009
DWHE	12468	64.90	*5.00*	2078
BARL	62251	591.70	44.11	1380
MAIZ	1056006	8885.02	176.89	5936
OCER			∞	3459
PULS	55073	410.01	38.29	-1477
POTA	594	2.12	*1.00*	297
SUBA			*0.00*	-332
SUBB			*0.00*	-11
SUBC			*0.00*	-5
RAPE	29386	148.57	60.55	477
SUNF	27412	132.89	12.24	-2438
SOTH	150811	2190.85	8.79	-19359
OLIV			*0.00*	0
TIND			n.a.	3710
VEGE		19.30	*1.00*	-5999
FRUI	-16832	0.54	*0.01*	-17002
WINE			n.a.	-2304
OCRO			n.a.	0
OANI			n.a.	0
MAIF			*0.00*	0
OFOD			*0.00*	0
GRAS			*0.00*	
COMI			*0.00*	0
BEEF	28126	12.03	146.11	191
VEAL	30	0.02	*5.00*	-7
PORK	21954	14.93	17.68	1175
SGMI			*0.00*	0
SGMT	3070	0.98	11.51	-292
EGGS	11292	11.45	*100.00*	112
POUM	11431	10.53	272.87	-42
YCAM			*0.00*	0
YCAF			*0.00*	0
RICE	213436	172.33	*1000.00*	-214
MOLA	11652	160.84	*12.00*	-1059
STAR	26324	15.00	*100.00*	261
SUGA	58394	241.67	10.80	4948
RAPO	5488	4.81	4.63	974
SUNO	2683	2.78	18.63	-152
SOYO	16113	18.69	13.09	1144
OLIO			n.a.	145
RAPC	9902	39.14	8.32	1062
SUNC	5553	13.33	1.05	2708
SOYC	54129	203.50	5.90	-11048
BUTT	739	0.28	13.23	52
SMIP	1385	0.81	38.73	-37
CHES			*0.00*	0
OMPR			*0.00*	0

Note: See the list at the end of this documentation for the meaning of the item codes in CAPSIM.

The elasticity assumptions determine the variability of border prices and net trade in simulations. Most frequently, the elasticities are in the range between 5 and 50 which will trigger only moderate responses of border prices to changes in net trade or, viewed from another angle, will permit rather strong variations in net trade with only minor adjustments in border prices. The very small (0.01) net trade elasticity for fruits (FRUI) will almost fix net trade. This assumption goes back to the first explorations with the endogenous trade component and might be reconsidered. For a number of items net trade has been fixed exogenously, implying a zero elasticity of net trade with respect to the EU border price[19]. In a similar way the very high trade elasticity for rice comes close to a fixed border price which has been imposed for "other cereals" as well. The "n.a." entry indicates that the EU price has been fixed exogenously and net trade is a residual variable for these items unrelated to a EU border price which is essentially unknown. Table 2.5-1 illustrates already that we have to watch for a number of different cases in the description of net trade, which will be explained, with the help of the following Table 2.5-2.

Table 2.5-2: Summary on trade regimes in CAPSIM

No	Main Groups	Net trade	Border price	EU price	Tariff	MTR run	Reference run
1	Endogenous border price and net trade	Endogenous	Endogenous	Endogenous	Exogenous	RICE, MOLA, STAR, RAPO, SUNO, SOYO, RAPC, SUNC, SOYC, PULS, POTA, RAPE, SUNF, SOTH, VEGE, FRUI, BEEF, VEAL, PORK, SGMT, EGGS, POUM	
2		Endogenous	Endogenous	Exogenous	Endogenous	SWHE, DWHE, BARL, MAIZ, SUGA, SMIP, BUTT	
3	Exogenous net trade	Exogenous	Exogenous	Endogenous	Implicit	OCER	
4		Exogenous	Exogenous	Endogenous	Exogenous		POTA, VEAL, PORK, POUM
5		Exogenous	Implicit	Endogenous	Exogenous		VEGE, FRUI, STAR, SGMT, EGGS, STAR
6		Exogenous	No	Free on MS level	No	OFOD, GRAS, MAIF, SUBA, SUBB, SUBC, OLIV, COMI, SGMI, YCAM, YCAF	OFOD, GRAS, MAIF, SUBA, SUBB, SUBC, OLIV, COMI, SGMI, YCAM, YCAF
7		Exogenous	Exogenous	Free on MS level	Implicit	CHES, OMPR	CHES, OMPR
8	Unconstrained net trade	Free	Exogenous	Endogenous	Exogenous		RICE, MOLA, RAPO, SUNO, SOYO, RAPC, SUNC, SOYC, PULS, RAPE, SUNF, SOTH
9		Free	Exogenous	Exogenous	Endogenous		SWHE, DWHE, BARL, MAIZ, OCER, SUGA, BEEF, SMIP, BUTT
10		No	Exogenous	Endogenous	Exogenous	FPRI, FENI	FPRI, FENI
11		Free	Implicit	Exogenous	Exogenous	OANI, TIND, WINE, OCRO, OLIO, OLIC, OOUT, IPLA, IGEN, REST	OANI, TIND, WINE, OCRO, OLIO, OLIC, OOUT, IPLA, IGEN, REST

[19] This is unsatisfactory for "other milk products" and especially for cheese. Ultimately it is due to the fact that we put these items have been put into a group with more flexible price movements than according to eq. (85), see further down in the text.

Table 2.5-2 gives these and all other trade regimes, which will be explained subsequently, including the members of these regimes in the reference run and in the MTR simulation performed for testing purposes. In the standard regime we have to distinguish whether there is an administered price (Regime no 2) or not (Regime no. 1). With an administered price, such as for cereals, the difference of the EU market price and the border price has to be variable (flexible levy / export subsidy), at least if the administered price becomes effective. Without an administrative price the border protection (tariff) may be exogenous if the EU market price can adjust.

The "fixed trade regime" could have been handled technically with a slope parameter $\phi_{NETTRD,i,1} = 0$, but we may save variables and equations if we simply switch off equation (99), once there is an exogenous projection available for net trade. With exogenous net trade we have to distinguish again various cases. Regimes 3 and 4 have both the border price as well as net trade fixed which definitely requires to switch off the net trade equation. These are rather exceptional cases. The case of "other cereals" (Regime 3) is an ad hoc way to introduce some plausibility into the MTR projection for this item in spite of the high aggregation level of "other cereals" (including, rye, oats, paddy and other minor cereals). The latter precludes a serious analysis of the MTR reforms on the rye and rice markets. In regime 3 not only equation (99) but also equation (83) is switched of. On the contrary Regime 4 has the EU price derived from an exogenous border price projection which is only possible with fixed net trade if some parameters of behavioural functions can adjust. In this case the activity level constant parameters have been rendered flexible to permit a reference run projection in line both with assumptions on net trade *and* with border prices. For products in regime 5 border price projections are not available. However, a certain border price is implied if we link the simulated EU prices to an exogenous estimate for the border protection, typically assuming a constant tariff.

All the previous regimes with fixed trade are mainly in use to handle exceptional cases or to design the reference run. Regime 6, on the other hand, is the standard treatment for items with limited tradability such as bulky fodder, raw materials or young animals. In this regime, market clearing occurs at the Member State level. This removes the proportionality of prices between Member States, which is imposed in the general case of equation (85). The definition of Member State net trade is simply

NETMS_ $$NETMS_{m,i} = SUP_{m,i} - DEM_{m,i} \tag{100}$$

where

$NETMS_{m,i}$ = net exports of item $i \in MSBAL$ from Member State m

and the Member State net trade is usually fixed to the base year level (with some exceptions for calves, for example). This imposes in essence that produced quantities of beet are also processed in the same Member State. The milk products cheese and "other milk products" are currently handled in essentially the same regime (No 7) because the flexibility of Member State prices facilitated the incorporation of balances on milk protein and fat on the Member State level. The concomitant exogenous treatment of net trade for these products is mainly due to the path dependent history of model development and should be reconsidered in the future.

Finally we may look at the last main group of trade regimes which are characterised by "unconstrained" net trade. In this group net trade is neither exogenously fixed nor linked to the border price through the net trade equation (99). The specification with exogenous border prices was standard in earlier versions of CAPSIM and it is still dominant in the reference run. As was the case with endogenous border prices, we have to distinguish whether there are administered EU prices (Regime 9) or not (Regime 8). For protein rich (fishmeal) and energy rich (cassava) foodstuffs the market balance equation (98) is switched off (Regime 10) because it was of no interest so far and the price assumptions are introduced via the border prices. In the final Regime 11 (with trade elasticities "n.a." in the previous table), the EU prices are determined directly by exogenous assumptions because this appeared most appropriate given the limited time devoted to products such as olive oil and wine so far. A border price could be recovered only with an additional assumption on the border protection, for example a constant tariff.

It is evident that a quite diverse set of regimes has been developed. This diversity is difficult to avoid if the available information for individual items can be quite different but is to be integrated in a flexible way both during the reference run and during the policy simulations (see Appendix II: User Manual).

2.5.3 Treatment of WTO limits and gross trade information

It was briefly mentioned above that WTO limits might force EU authorities to buy some quantities ITS_i in public intervention measures. Incorporating (quantity related) WTO limits on subsidised (gross) exports in a net trade model such as the current version of CAPSIM involves certain difficulties:

1. For products such as beef, with significant (preferential) imports, gross exports will exceed net trade such that the WTO limits $\underline{EXPQ}_i$ can be binding even though net trade is smaller than these limits
2. For products such as pork a significant part of exports occurs without export subsidies such that WTO limits $\underline{EXPQ}_i$ may not be binding even though net trade is larger than these limits
3. Official notifications to the WTO show that there is usually some slack in these constraints which might be reduced in some policy options, depending on the market management of EU authorities

A straightforward solution for the first problem would be to model gross rather than net trade, but this is beyond the current scope of CAPSIM. The second problem would suggest to abandon the simplified notion of homogenous agricultural commodities and to accommodate variable shares of subsidised and unsubsidised exports in the total. This has neither been possible given the simple structure of CAPSIM. The last point would not be a problem at all were it not for the fact that WTO notifications and Eurostat market balances need not build on the same definitions.

Having acknowledged that a rigorous solution of the above problems is impossible in the current framework we may move on to the ad hoc solution implemented in CAPSIM, for the three points above have to be addressed in some form. This solution involves to define adjusted WTO limits XQT_i ,

$$XQT_i = EXPQ_i - \beta_{EXPQ,i} + \beta_{NETTRD,i} + \beta_{SLACK,i} \qquad (101)$$

and to permit exogenous inputs for changing gross imports:

XQT_

$$NETTRD_i + IMPQ_i \leq XQT_i \qquad (102)$$

where

$\underline{EXPQ}_i$	=	official WTO limit for item i
$\beta_{EXPQ,i}$	=	official WTO limit for item i in base period
$\beta_{NETTRD,i}$	=	net trade of item i in base period
$\beta_{SLACK,i}$	=	original slack of WTO limit for item i in base period (= $\beta_{EXPQ,i} - \beta_{EUSE,i}$, with $\beta_{EUSE,i}$ = base period use of WTO limit)
$\underline{IMPQ}_i$	=	exogenous estimate for change in gross import quantity use of item i
$\underline{XQT}_i$	=	adjusted WTO limit for item i

The redefinition of WTO limits in (101) assumes that, apart from any base period slack $\beta_{SLACK,i}$ according to the official notifications, the quantity related WTO limits should be considered exactly binding in the base period to which any changes in these limits may be added. For an item such as beef with significant gross imports this implies an automatic downward correction ($XQT_{BEEF} < EXPQ_{BEEF}$) which mirrors these import quantities. In case that gross imports are expected to change this *change* may be entered via the exogenous (policy) variable $\underline{IMPQ}_i$ in (102). For products with significant unsubsidised exports (pork) it is assumed that the market potential for unsubsidised exports is exhausted and additional exports are only possible with subsidies. This case would imply an upward correction of official WTO limits ($XQT_{PORK} < EXPQ_{PORK}$). Apart from C sugar which is explicitly incorporated in CAPSIM (but neglected above) it has to be mentioned that an exogenous estimate may be supplied for the volume of unsubsidised exports. This detail may improve the derived estimate of refunds but should require explicit representation above.

A final detail to be added is the approach to estimate gross trade figures from net trade modelling results for output tables with the same structure as the input tables (see section 4.1). For that purpose we adopt the assumption that only the larger of exports or imports adjust according to the change in net trade and the smaller may be fixed at base year values.

The current treatment of gross trade and the implementation of WTO limits in CAPSIM are evidently ad hoc. Furthermore there are more issues to be addressed in the future. For example, may observers expect that in the EU it will usually be the quantity related limit which will be binding (Meijl, Tongeren 2002), but this need not hold for all items and in all policy simulations. It would be desirable (and quite straightforward) to incorporate the limits on export subsidy outlays as well. A substantially more difficult issue would be certainly to incorporate in some form the effect of the numerous Tariff Rate Quotas (TRQs) which spread after the Uruguay round and are likely to gain in importance, especially for an enlarged EU.

2.6 Welfare measures in CAPSIM

Apart from the immediate model results on area use and market balances more relevant outputs may be obtained in terms of welfare indicators for producers, consumers, the processing industry and the EU budget based on other variables which are already available after a simulation. This leads to an automatic complete welfare analysis for each policy simulation if these components are added.

2.6.1 Producer welfare

Producer income is simply computed on the basis of the EAA concepts rendered possible by the complete coverage of CAPSIM:

$$\begin{aligned} \text{EAAP.NVAF}_m = {} & \Sigma_{i\in \text{AGRO}} (\text{PRD}_{m,i} - \text{LNKF}_{m,i}) \cdot \text{PP}_{m,i} \\ & - \Sigma_{i\in \text{INDINP}} (\text{INP}_{m,i} \cdot \text{PP}_{m,i}) - \Sigma_{i\in \text{FEED}} (\text{INP}_{m,i} \cdot \text{FP}_{m,i}) \\ & + \text{EAAS.TOOU}_m - \text{EAAT.TOOU}_m \\ & - \text{EAAP.DEPM}_m - \text{EAAP.DEPB}_m \\ & + \text{EAAP.SUBO}_m - \text{EAAP.TAXO}_m \end{aligned} \qquad (103)$$

where

EAAP.NVAF_m = net value added at factor cost in Member State m

$\text{PRD}_{m,i}$ = gross production of item i Member State m

$\text{LNKF}_{m,i}$ = linked use of item i allocated to the farm sector in Member State m

$\text{PP}_{m,i}$ ($\text{FP}_{m,i}$) = producer (feed) price of item i in Member State m

EAAS.TOOU_m = allocated subsidies (calculated from premiums) in Member State m

EAAT.TOOU_m = allocated taxes (assumed constant) in Member State m

EAAP.DEPM_m = depreciation on machinery (trend extrapolated) in Member State m

EAAP.DEPB_m = depreciation on buildings (trend extrapolated) in Member State m

EAAP.SUBO_m = non allocated subsidies (assumed constant) in Member State m

EAAP.TAXO_m = non allocated taxes (assumed constant) in Member State m

The first two lines give the intermediate income concept of “gross value added at market prices”, EAAP.GVAD_m. Adding the third line yields a “gross value added at basic prices”, EAAB.GVAD_m. Considering fourth line finally results in “net value added at basic prices”, an income measure mentioned in the current EAA manual but which is not stored on a specific code in CAPSIM. Adding finally the difference of non allocated subsidies and taxes gives net value added at factor cost, EAAP.NVAF_m, which is the income concept calculated on the basis of the production account of the EAA.

Rents, interest and wages are also contained in the database, but without serious modelling of labour and capital, these components can only be forecasted in an exogenous way such that net entrepreneurial income is currently not included in the standard output of the system.

2.6.2 Consumer welfare

Consumer welfare is computed as the equivalent variation based on the consumer demand system included in CAPSIM:

$$\begin{aligned} EV_m^{HD} &= e_m(\mathbf{CP}_m^r, V_m^s) - \underline{EX}_m^{HD,r} \\ &= F_m^r - \frac{G_m^r}{V_m^s} - \underline{EX}_m^{HD,r} \end{aligned} \tag{104}$$

where

EV_m^{HD}	=	equivalent variation per head of moving from reference run to policy simulation
$e_m(.)$	=	expenditure function of Member State m
$\mathbf{CP}_m^r$	=	consumer price vector of Member State m in the reference run
V_m^s	=	indirect utility function in the policy simulation in Member State m
$\underline{EX}_m^{HD,r}$	=	consumer expenditure per head of Member State m in the reference run
F_m^r	=	function F_m evaluated at consumer prices $\mathbf{CP}_m^r$
G_m^r	=	function G_m evaluated at consumer prices $\mathbf{CP}_m^r$

The equivalent variation is the additional expenditure bringing the average consumer to the policy simulation utility even though prices were kept at their reference run values. It may be calculated from the expenditure function $e_m(.)$ which is obtained when solving the indirect utility function (44) for per capita expenditure. Substituting furthermore for V_m^s in (104) from (44) and converting to total values per Member State m gives finally:

$$EV_m = \underline{INHA}_m \cdot \left(\frac{G_m^r}{G_m^s} \left(\underline{EX}_m^{HD,s} - F_m^s \right) - \left(\underline{EX}_m^{HD,r} - F_m^r \right) \right) \tag{105}$$

where

EV_m	=	total equivalent variation of moving from reference run to policy simulation
$\underline{INHA}_m$	=	inhabitants in Member State m
$\underline{EX}_m^{HD,s}$	=	consumer expenditure per head of Member State m in the policy simulation
$\mathbf{CP}_m^s$	=	consumer price vector of Member State m in the policy simulation
F_m^s	=	function F_m evaluated at consumer prices $\mathbf{CP}_m^s$
G_m^s	=	function G_m evaluated at consumer prices $\mathbf{CP}_m^s$

Note that the equivalent variation is always defined relative to some reference point, which is by default the reference run situation.

2.6.3 Processing industry welfare

For items with fixed margins according to (66), for example soft wheat, it may be assumed that the fixed margin corresponds to fixed marginal cost such that the food industry profit is always zero ("normal" profits being remuneration for managerial capacity). This assumption has not been made, however, for those items covered by behavioural functions (68) and (72), for example oilseeds and milk products. Endogenous prices may change the processing industry margins (69) and (73) and thus processing industry profit which has to be incorporated in the welfare analysis. As the linear behavioural functions integrate back to a normalised quadratic profit function, it turns out straightforward to calculate the profit change in the processing industry:

$$\begin{aligned} &\nu_m(\mathbf{UMA}^s_m) - \nu_m(\mathbf{UMA}^r_m) \\ &\quad = \sum_u \psi_{m,u,0}(\mathrm{UMA}^s_{m,u} - \mathrm{UMA}^r_{m,u}) \\ &\quad + \tfrac{1}{2}\sum_u \sum_v \psi_{m,u,v}(\mathrm{UMA}^s_{m,u}\mathrm{UMA}^s_{m,v} - \mathrm{UMA}^r_{m,u}\mathrm{UMA}^r_{m,v}) \end{aligned} \tag{106}$$

where

$\mathbf{UMA}^s_m$ = unit processing margins in the policy simulation in Member State m

$\mathbf{UMA}^r_m$ = unit processing margins in the reference situation in Member State m

ν_m = processing industry profit function in Member State m

Note again that this is a profit *change*. To calculate absolute profit would require knowledge of the constant $\psi_{m,0,0}$ of this profit function or at least the base period profit in the processing industry which are both unknown. This corresponds perfectly to the welfare measure for consumers.

The sugar industry profit is calculated somewhat differently as derived sugar beet revenues minus levies minus processing cost minus payments to farmers. Given an estimated EU average for processing cost of 175 € / t based on the earlier mentioned sugar study, absolute profit of the sugar industry may be estimated as well. The change in sugar industry profit is automatically added to the result of equation (106).

2.6.4 Budgetary calculations

Simulations with CAPSIM permit to estimate budgetary impacts corresponding to the policy scenario, but these scenarios will only cover first pillar CAP measures and even those only in so far as these measures are explicitly incorporated. For other measures it is assumed that they are held constant and the corresponding expenditure is associated with "other output" (FEOG.OOUT).

At first sight it should be easy to calculate the outlays for **premiums** as activity levels, premiums per unit, "historical yields" and even the scaling factors to impose ceilings are all covered. However, the official premiums are not the only determinants of budgetary outlays, in addition there are many details not depicted in the model (in particular farm level ceilings). This fact and the incomplete match of budget years and calendar years creates a discrepancy of the "raw" model estimate and actual budget expenditure already in the base period which is used to calculate a conversion factor:

$$PRM_j = \Sigma_m \mathit{LVL}_{m,j} \cdot (\underline{HIST}_{m,j} \cdot \underline{PRET}_{m,j} \cdot PRETFAC_{m,j} + \underline{PREM}_{m,j} \cdot PREMFAC_{m,j}) \cdot \beta_{PRM,j} / (\Sigma_m \beta_{LVL,m,j} \cdot (\beta_{HIST,m,j} \cdot \beta_{PRET,m,j} + \beta_{PREM,m,j})) \quad (107)$$

where

PRM_j	=	EAGFF expenditure on activity j ∈ PACT in simulation year
$\mathit{LVL}_{m,j}$	=	simulated level of activity j ∈ PACT in Member State m
$\underline{HIST}_{m,j}$	=	historical yield of main product in activity j ∈ GCOP ∪ ACAT ∪ FCAL in Member State m
$\underline{PRET}_{m,j}$	=	premium per unit of historical yield in activity j ∈ GCOP ∪ ACAT ∪ FCAL in Member State m in the simulation year
$PRETFAC_{m,j}$	=	simulated scaling factor to enforce ceilings on common premiums PRET for activities j ∈ GCOP ∪ ACAT ∪ FCAL in Member State m
$\underline{PREM}_{m,j}$	=	specific premiums per unit of activity j ∈ PACT in Member State m in the simulation year
$PREMFAC_{m,j}$	=	simulated scaling factor to enforce ceilings on specific premiums for activities j ∈ PACT in Member State m
$\beta_{LVL,m,j}$	=	level of activity j ∈ PACT in Member State m in the base year
$\beta_{PRM,j}$	=	EAGFF expenditure on activity j ∈ PACT in base year
$\beta_{PRET,m,j}$	=	premiums per unit of historical yield in activity j ∈ GCOP ∪ ACAT ∪ FCAL in Member State m in the base period
$\beta_{PREM,m,j}$	=	specific premiums per unit of activity j ∈ PACT in Member State m in the base year

For the **refunds** we use a similar approach. The simulated refunds are a "raw" estimate multiplied by a conversion factor derived from base period data:

$$REFU_i = (EP_i - WP_i) * SUBX_i * \beta_{REFU,i} / (\beta_{EP,i} - \beta_{WP,i}) * \beta_{SUBX,i} \quad (108)$$

where

$REFU_i$	=	EAGFF expenditure on refunds for item i ∈ ITEM in simulation year
$SUBX_i$	=	estimated subsidised exports of item i ∈ ITEM from the EU
EP_i	=	EU market price of product i ∈ ITEM
WP_i	=	EU border price

$\beta_{REFU,i}$ = base period refunds on product i

$\beta_{WP,i}$ = base period EU border price of product i

$\beta_{EP,i}$ = base period EU market price of product i

$\beta_{SUBX,i}$ = base period subsidised exports of product i from the EU

The base period discrepancy implicit in the above conversion factor is partly due to the fact that the calculated price difference (based on FAO data) need not be a good estimate of true export refunds per unit. Furthermore we cannot account for heterogeneity of export refunds for a single product depending on quality, destinations and so forth. Explorations both with absolute and relative corrections suggested that the relative correction as above is likely to generate more reliable results. It prevents by construction nonzero estimates for refunds while exports are estimated to be zero. The weakest point in the above estimate is probably the quantity of subsidised exports. This can be estimated only in an ad hoc manner in a net trade model such as CAPSIM. Currently we use the following estimates:

$$SUBX_i = \begin{cases} 1.\ NETTRD_i + PPO1_i \\ 2.\ NETTRD_i + \beta_{SUBX,i} - \beta_{NETTRD,i} \\ 3.\ \sum_m EXPT_{m,i} \end{cases} \quad (109)$$

where

$NETTRD_i$ = net exports of item i from the EU

$PPO1_i$ = user supplied difference of subsidised exports and net trade

$\beta_{NETTRD,i}$ = base period net trade of product i from the EU

$EXPT_{m,i}$ = gross export estimate for Member State m

The sum of estimated Member State level gross exports is unsatisfactory because it relies on strong assumptions (only the larger of gross exports or imports changes see Table 4.3-5 below) and most of all because it will include the intra EU trade. With a base period estimate of subsidised exports we might rely on the difference to net trade in the base period and potentially the user may supply an even better estimate[20]. Given the inherent deficiencies of trade modelling with the current version of CAPSIM, the export refund estimate will be less precise than the above estimate of premiums.

Depreciation of intervention stocks is estimated using an additive correction term derived from the base period. We preferred an constant term for correction purposes because storage cost were nonzero in the database even without intervention purchases in some cases:

$$DEP_i = (EP_i - \underline{WP}_i) * (ITS_i + \beta_{INTP,i}) + \beta_{DEP,i} - (\beta_{EP,i} - \beta_{WP,i}) * \beta_{INTP,i} \quad (110)$$

[20] In addition to the above, the implementation in the GAMS code incorporates any estimate of base period unsubsidised exports, adds refunds to the sugar using chemical industry and deducts exports of C sugar.

where

DEP_i = EAGFF expenditure on depreciation of intervention stocks for item i $\in$ ITEM in simulation year

ITS_i = intervention sales of item i $\in$ INTERV to the EU

$\beta_{DEP,i}$ = base period depreciation on product i

$\beta_{INTP,i}$ = base period intervention purchases of product i in the EU

Note that in many cases the above estimate of depreciation will only reflect a change in the price difference of EU market and border prices because intervention sales ITS_i to the EU will usually be zero in sustainable policy simulations. Currently the model is simply calibrated with $ITS_i = 0$ for the base period even though there was nonzero intervention in some cases. However, the present structure of CAPSIM does not permit nonzero intervention if WTO limits are not yet filled, which was usually the case in the base period. This is another case for a more complex modelling of the trade regime than has been done so far.

Finally we have an estimate of **sugar levies** takes into account that these levies have to finance those subsidised exports in addition to re-exports of ACP imports plus the refunds for the chemical industry. ACP imports are automatically accounted for if the calculation starts from net trade. In spite of a quite detailed policy representation a conversion factor is necessary to match the budgetary information on sugar levies:

$$\begin{aligned} LEVY_{SUGA} = {} & (EP_{SUGA} - \underline{WP}_{SUGA}) * \\ & (NETTRD_{SUGA} - \beta_{UNSUBX,SUGA} \\ & + \Sigma_m (IND_{m,SUGA} - \gamma_{m,SUGB,SUGA} PRC_{m,SUBC}) \\ & * \beta_{LEVY,SUGA} \\ & / ([\beta_{EP,SUGA} - \beta_{WP,SUGA}] \\ & \quad * [\beta_{NETTRD,SUGA} - \beta_{UNSUBX,SUGA} \\ & \quad + \Sigma_m (\beta_{IND,m,SUGA} - \gamma_{m,SUGB,SUGA} \beta_{PRC,m,SUBC})]) \end{aligned} \tag{111}$$

where

$LEVY_{SUGA}$ = estimated levies on sugar in the EU

EP_{SUGA} = EU price of sugar

WP_{SUGA} = Border price of sugar

$NETTRD_{SUGA}$ = net trade of sugar from the EU

$IND_{m,SUGA}$ = industrial use of sugar in Member Sate m

$\gamma_{m,SUGB,SUGA}$ = processing coefficient of sugar in Member Sate m

$PRC_{m,SUBC}$ = processing of C sugar beet in Member Sate m

$\beta_{LEVY,SUGA}$ = base period levies on sugar

$\beta_{WP, SUGA}$ = base period world market price of sugar

$\beta_{EP,SUGA}$ = base period EU level market price of sugar

$\beta_{NETTRD, SUGA}$ = base period net trade of sugar

$\beta_{m,PRC,SUBC}$ = base period processing of C sugar beet in Member Sate m

$\beta_{m,IND,SUGA}$ = base period industrial use of sugar in Member Sate m

$\beta_{UNSUBX,SUGA}$ = unsubsidised exports of sugar (apart from C sugar)

The sum of outlays on premiums, refunds and depreciation on stocks is the estimated FEOGA budget. A net budget effect may be calculated by deducting the sugar levies. For the purpose of welfare calculations, FEOGA outlays are allocated to Member States using their shares in financing the total EU budget as available from the DG budget website, see section 3.2.6. Overall, we like to acknowledge that the current treatment of budget impacts in CAPSIM is still very simplified:

- Premiums are depicted quite accurately but farm level ceilings (currently applied for suckler cows, for example, but under discussion for all types of premiums) are neglected at the moment.
- Accounting of refunds suffers from incomplete match of databases and, unavoidably in CAPSIM, from aggregation errors and limitations of a net trade model.
- Depreciation of intervention stocks is calculated without accounting for permanent revaluation and devaluation of stocks. The base year situation in the model does not yet match DG Agri data on intervention activities.
- A number of policy instruments with sizeable budget impacts, for example consumption subsidies, are not yet incorporated in CAPSIM such that the corresponding outlays are simply fixed.
- The allocation of FEOGA to Members States assumes that changes in outlays lead to higher or lower contributions from Member States according to observed or estimated shares. In reality these shares may be changed or savings may be used for other, for example second pillar expenditure which would lead to other welfare impacts.

3. Model input

3.1 Overview on input options and requirements

This section will provide detailed information on various types of input data. Some of the following inputs require updates for each policy simulation, others will be required only for a new reference run and finally some are required only for a complete update of the model version:

1. Base year data for the initial situation
2. Parameters of behavioural functions (activity levels, set aside, processing, consumer demand, net trade)
3. Trend projections on several variables:
   - Yields
   - Exogenous activity levels
   - Exogenous prices

- Industrial use trends
- Population trends
- Exogenous EAA positions (depreciation, wages)
- Margins for consumer prices

4. Projections on EU border prices
5. Expert data may supplement or replace default trend projections:
   - Yields
   - Exogenous activity levels, input demands, consumer demands
   - Total final consumption expenditure and inflation
   - Set aside and non-food areas
   - Net trade quantities
6. Policy variables related to products and activities

The next section 3.2 will be about the content and properties of the *base year data*. Calibration of *parameters of behavioural functions* has been covered to a large extent in sections 2.1.2 (supply side functions), 2.2.2 (demand functions), 2.3 (processing industry), and 2.5.2 (net trade equation). They should be updated with each update of the database because the calibration will rely on the shares observed for this base period. There are some final parameter issues to be explained but this is best handled in section 3.6, expert data input. Exogenous *trend projections* are required on the above variables and the default procedure to obtain these forecasts is exclaimed in 3.2.6. *Border price projections* (see 3.5) are required if these border prices are handled exogenously. This will be frequent in the reference run but rare in an ordinary policy simulation. Regarding *expert data input* there will be more differences to be explained in section 3.6 between an ordinary policy simulation and the reference run. The input policy variables, explained in section 3.4, will be quite uniform both for the policy simulation and for the reference run.

A change in the base year data and in the parameters of behavioural functions will constitute a new model version, even if the model structure is maintained. A reference run is a particular simulation for a selected policy (usually the status quo) which serves as a yardstick for all other policy simulations to identify the "impacts" of alternative policy options. What is particular about the reference run is that different agencies (DG Agri, FAPRI, FAO, OECD) are working on projections for agricultural markets under status quo conditions. A CAPSIM reference run tries to incorporate some of this valuable information in a consistent way into its own projections. For this purpose the reference run involves various options to introduce exogenous information (trend and border price projections, expert data) beyond the policy variables. An ordinary policy simulation, on the contrary, is supposed to show the impacts of alternative policies, for example compared to the status quo. To identify the isolated effect of these policies all non-policy inputs should be maintained in general at their reference run levels. This holds in a straightforward way for yields, final consumption expenditure, and the inflation rate which are simply kept at the same value. In other cases, for example border price developments, projections for activity levels, input demands, consumer demands, set aside, non food areas and net trade quantities, exogenous projections for the reference run are translated into modified constants of behavioural functions which are kept fixed in subsequent policy simulations. However, this may be explained better in a discussion of specific exogenous inputs below rather than in this overview.

3.2 Consistent framework for physical and monetary database

The main data are organised in a consistent framework on the Member State level. It comprises data on farm and market balances, activity levels (hectares for crops and heads for animals), unit values and the EAA. This database is required at least for the starting point of the model that is for the base year (and all Member States). Technically it is stored as a set of two-dimensional matrices, one for each year, region, and more characteristics. The columns include activity levels and other information. The rows give the items and other information, see the Appendix sections 8.1 and 8.2 for a full listing, together with associated codes which will be used in this section extensively.

3.2.1 Consistency requirements

Simulation with a modelling system such as CAPSIM involves the solution of a set of equations, inequalities and perhaps an objective function. This implies that the simulated situation will always comply with this set of constraints. A policy "impact" is measured as the difference between the result of a policy simulation and a reference situation, which may also be the base year. If exogenous inputs take on those values observed in the base year a *calibrated* model should yield as model output exactly those values of endogenous variables, which have been observed historically. This calibration would be impossible if the base year data were inconsistent with any of those equations and inequalities forming the model, which would force the model to deviate from historical data. This would impede, in turn, to identify unambiguously the policy impacts and it would undermine confidence in the model's reliability. For this reason it is necessary to have a consistent database. The basic consistency relationships required in CAPSIM are the following:

- Linkage of physical production to production activities via physical output (or input) coefficients (yields or young animal coefficients).
- Linkage of monetary data from the Economic Accounts of Agriculture and farm balance data via "unit values".
- Adding up conditions for physical quantities by farm and market balances.

Because the following relationships always refer to the Member State level, we may omit the index m used above. As mentioned above the database has to be available at least for a base year, but if it covers a whole time series, it should hold in each year. The time index t may be omitted as well therefore, except for a relationship involving stock changes.

The first requirement is a consistent definition of output coefficients, which essentially reproduces equation (1), but here using the codes and scaling as currently stored in the database:

$$GROF_i = \Sigma_j \, LEVL_j \cdot DATA_{j,i} / 1000 \qquad (112)$$

where

$GROF_i$ = physical gross production [usually 1000 t] of item $i \in (AGRO \cup ICAL)$

$LEVL_j$ = activity level [usually 1000 ha or hd] of activity $j \in PACT$

$DATA_{j,i}$ = output (or input) coefficient of item $i \in (AGRO \cup ICAL)$ in activity $j \in PACT$

In contrast to the database, the model does not distinguish between young animals as inputs and as outputs. The yields in equation (1) are therefore defined to be net yields for young animals (calves) which are positive if the activity produces more than it requires (cows) and negative otherwise:

$$YLD_{y,j} = (DATA_{j,y} - DATA_{j,i})/ 1000 \qquad (113)$$

where

$YLD_{y,j}$	=	net yield of cattle activity j ∈ {CAMF, CAFF, DCOW, SCOW, BULF, HEIF} in terms of young animals y ∈ YCAL
$DATA_{j,i}$	=	input coefficient of cattle activity j ∈ {CAMF, CAFF, DCOW, SCOW, BULF, HEIF} in terms of young animal i ∈ ICAL
$DATA_{j,y}$	=	output coefficient of cattle activity j ∈ {CAMF, CAFF, DCOW, SCOW, BULF, HEIF} in terms of young animal y ∈ YCAL

Corresponding to (10) is the constraint that crop activity levels should add up to total area:

$$GROF.LEVL = \Sigma_j LEVL_j \qquad (114)$$

where

GROF.LEVL	=	total utilisable area [1000 ha]
$LEVL_j$	=	level [1000 ha] of land using activity j ∈ LANDUSE

A “farm balance” is splitting up gross production into the physical equivalent to the EAA output value NETF, and other uses not counting as output in the EAA:

$$GROF_i = NETF_i + SEDF_i + LOSF_i + INTF_i + I_{YCA} \cdot STCM_i \qquad (115)$$

where

$GROF_i$	=	gross output [usually 1000 t] of item i ∈ (AGRO ∪ ICAL)
$NETF_i$	=	(EAA valued) net output of item i ∈ (AGRO ∪ ICAL)
$SEDF_i$	=	seed use on farm of item i ∈ (AGRO ∪ ICAL)
$LOSF_i$	=	losses on farm of item i ∈ (AGRO ∪ ICAL)
$INTF_i$	=	internal use of item i ∈ (AGRO ∪ ICAL)
$STCM_i$	=	stock changes of item i ∈ (AGRO ∪ ICAL)
I_{YCA}	=	1 if i ∈ YCAL, 0 otherwise

Losses and seed use on farm are nonzero only for cereals due to data availability. For most items there is no distinction between losses and seed use on farm and on the market. Internal use is only relevant for young animals as inputs and output. In contrast to other items, stock changes for young animals are not valued in the EAA, hence the necessity to use an indicator variable I_{YCA} in (115). Internal use of young animals is identical in corresponding rows of outputs and inputs:

$$INTF.YCAM = INTF.ICAM, \qquad (116)$$

$$INTF.YCAF = INTF.ICAF$$

The EAA quantity NETF is disaggregated in the market balances. For secondary products there is no EAA quantity, but market balances disaggregate "marketable production" MAPR. As either NETF or MAPR is zero, they may be added in the following equation:

$$NETF_i + MAPR_i + IMPT_i = EXPT_i + EXPL_i + SEDM_i + LOSM_i + FEDM_i + INDM_i + PRCM_i + HCOM_i + (1-I_{YCA}) \cdot STCM_i \quad (117)$$

where

$NETF_i$	=	(EAA valued) net output [usually 1000 t] of item i ∈ (ITEM ∪ ICAL), = 0 for i ∈ (SECO ∪ SECMLK)
$MAPR_i$	=	marketable production of item i, = 0 for i ∉ (SECO ∪ SECMLK)
$IMPT_i$	=	(non life) import of item i
$EXPT_i$	=	(non life) export of item i
$EXPL_i$	=	net life animal export of item i
$SEDM_i$	=	seed use on market of item i
$LOSM_i$	=	losses on market of item i
$FEDM_i$	=	feed use of item i
$INDM_i$	=	industrial use of item i
$PRCM_i$	=	processing to secondary products of item i
$STCM_i$	=	stock changes of item i

Marketable production of secondary products $MAPR_i$, i ∈ SECO are linked to processing of raw products via the same processing coefficient $\gamma_{r,h}$ used in the definition of margins (69) above:

$$MAPR_h = \gamma_{r,h} PRCM_r \quad (118)$$

where

$MAPR_h$	=	marketable production of item h ∈ SECO
$PRCM_r$	=	processing to secondary products of item r ∈ AGRO
$\gamma_{r,h}$	=	processing coefficient: tons of secondary product h per ton of processed raw product r

The connection between the EAA valued position (column EAAP) and the market balance position NETF is provided by unit values UVAP, which will usually be used for the producer prices PP_i, for example in equation (74) and in the definition of farmers income (103) above:

$$EAAP_i = NETF_i \cdot UVAP_i /1000 \quad (119)$$

where

$EAAP_i$	=	monetary contribution of item i ∈ (ITEM ∪ INDINP) to EAA value at market prices [Mio €]
$UVAP_i$	=	unit value at producer prices [€/t]

As indicated above in the explanation of (86), feed is valued at feed prices, which incorporate some mark up over producer prices:

$$EAAP.FEED = \Sigma_{f \in FEED} FEDM_f \cdot UVAF_f / 1000 \quad (120)$$

where

EAAP.FEED	=	EAA value for feed cost at market prices [Mio €]
$UVAF_f$	=	unit value at feed prices [€/t]
$FEDM_f$	=	feed use of item f [1000 t]

More consistency requirements relate to the EAA data. In some cases the EAA is more aggregated than CAPSIM and a consistent disaggregation requires that the EAA value is the sum of the disaggregated values. This holds for cow and buffalo milk on the one hand and sheep and goats milk on the other:

$$EAAP.MILK = EAAP.COMI + EAAP.SGMI \quad (121)$$

where

EAAP.MILK	=	EAA value for total raw milk production [Mio €]
EAAP.COMI	=	EAA value for cow milk production [Mio €]
EAAP.SGMI	=	EAA value for sheep and goats milk production [Mio €]

A similar disaggregation is necessary for meat from “cattle” (-> BEEF, VEAL).

Stock changes should be consistent with time series on stock levels. Furthermore it would be implausible to obtain excessively changing or even negative stock levels.

$$STCM_{i,t} = STKM_{i,t} - STKM_{i,t-1} \quad (122)$$

where

$STCM_{i,t}$	=	stock change of item i ∈ ITEM \ YCAL in calendar year t [1000 t]
$STKM_{i,t}$	=	stock level of item i at end of calendar year t [1000 t]

Corresponding identities and plausibility requirements also hold for young animals, but they may be checked reasonably only at a more disaggregated level. This occurred currently in a preparatory step of data processing where relationships between herd sizes of different animal types, slaughterings, and trade have been used and imposed (Britz, Wieck, Jansson 2002). For example, the change in the stock of young bulls $STCM.YBUL_t$ should correspond with an increase in the activity level bulls fattening ($STCM.YBUL_t = BULF.LEVL_{t+1} - BULF.LEVL_t$). For young cows this relationship is more complicated but nonetheless the stock changes may be related to certain activity levels. Because CAPSIM does not explicitly model the raising activities, all female young cattle have been aggregated to YCAF and likewise for YCAM. The consistency of stock changes cannot be checked anymore in detail, but it is reassuring that the original database also reflected these intertemporal relationships.

All raising activities are vertically aggregated with the corresponding final use activities in CAPSIM to simplify its structure. For example the meat production from the activity pigs included the meat coming from old sows, assuming that an increase in the level of pigs would not cause a bottleneck in piglets if the base year relationship to sows production is maintained. Without disaggregation this cannot be checked but a lot is gained in terms of simplicity.

In the cattle sector the same aggregation occurs and integrates, for example, fattening of bulls BULF with raising of male calves (COCO code: CAMR). This vertical integration should be kept in mind when evaluating the current input and output coefficients. The input coefficient $DATA_{BULF,ICAM}$ is on the EU average 1966.9 because it includes the requirement of young calves for the integrated raising activity. However, the integrated fattening of bulls activity in CAPSIM also has an output coefficient of $DATA_{BULF,YCAM}$ = 966.9 for exactly the same reason. Netting out requirement and own production according to (113) shows that the activity BULF has a net requirement of $YLD_{YCAM,BULF} = -1$ which is exactly what intuition suggests, after taking care for the units.

3.2.2 Main data sources and technical implementation

Data for production and levels are available in Eurostat, NewCRONOS, domain ZPA1. Data for the farm positions are available in Eurostat NewCRONOS, domain ZPA1, for cereals, only. Data for the market positions are available in Eurostat NewCRONOS, domain ZPA1. Data for the EAA positions are available in Eurostat NewCRONOS, domain COSA. Pre-sets for prices are selected from Eurostat, NewCRONOS, domain PRAG.

The above consistency relationships are currently imposed in a data preparation step shared between CAPSIM and CAPRI teams which does not only impose consistency but also completeness on the required time series ("COCO"). The paper Britz, Wieck, Jansson 2002 gives a fairly recent description on how missing data are estimated, imposing consistency as defined by the described equations. In the appendix of this paper the current selection from NewCRONOS is also documented by a list of assignment statements (model code = NewCRONOS code).

Because the COCO step operates on a more differentiated product and activity list, a data aggregation step (CAPSIMDAT.GMS module, see section 5.2) is necessary to arrive at the aggregation level ultimately used in CAPSIM but this aggregation is quite straightforward[21].

3.2.3 Special issue: balances on milk fat and protein

The milk sector specification requires an initialisation for contents $\gamma_{m,h,c}$ of raw milks $h \in$ {COMI, SGMI} in terms of fat and protein (c = FAT, PRT), prices of fat and protein $PP_{m,c}$, and processing margins $MARG_{m,i}$ of milk products. For all of these it is possible to find plausible starting values, but these are not yet in line with the balances on milk fat and protein (71) and the linkage to observed prices of milk products (73).

A consistent initialisation is imposed through the following entropy problem:

$$\begin{aligned} \text{Max } ENTM_m = \; & -\Sigma_z \Sigma_h \Sigma_c PROB_{m,z,h,c} \ln(PROB_{m,z,h,c} / \theta_{m,z,h,c}) \\ & -\Sigma_z \Sigma_c PROB_{m,z,c,PP} \ln(PROB_{m,z,c,PP} / \theta_{m,z,c,PP}) \\ & -\Sigma_z \Sigma_i PROB_{m,z,i,UM} \ln(PROB_{m,z,i,UM} / \theta_{m,z,i,UM}) \end{aligned} \tag{123}$$

[21] The Details are explained in the comments of the associated GAMS file CAPSIMDAT

with the following definition of contents, prices of fat and protein, and margins from (three) supports:

$$\gamma_{m,h,c} = \Sigma_z PROB_{m,z,h,c} \underline{GS}_{m,z,h,c} \quad \forall\, c, h \in RAWMLK \qquad (124)$$

$$PP_{m,c} = \Sigma_z PROB_{m,z,c,PP} \underline{PPS}_{m,z,c} \quad \forall\, c$$

$$UMA_{p,m,i} = \Sigma_z PROB_{m,z,i,UM} \underline{UMAS}_{p,m,z,i} \quad \forall\, i \in ALLMLK$$

where

$ENTM_m$	=	cross entropy in milk data calibration for Member State m
$PROB_{m,z,h,c}$	=	final probability weight for support point z of raw milk's h content c in Member State m
$\theta_{m,z,hc}$	=	initial probability weight for support point z of milk's h content c in Member State m
$\gamma_{m,h,c}$	=	content of raw milk h n terms of c = PRT, FAT in Member State m
$\underline{GS}_{m,z,i,c}$	=	support point z of content of raw milk h in terms of c = PRT, FAT in Member State m
$PROB_{m,z,c,PP}$	=	final probability weight for support point z of producer price of milk content c in Member State m
$\theta_{m,z,c,PP}$	=	initial probability weight for support point z of producer price of milk content c in Member State m
$PP_{m,c}$	=	producer price of milk content c in Member State m
$\underline{PPS}_{m,z,c}$	=	support point z of producer price of milk content c in Member State m
$PROB_{m,z,i,UM}$	=	final probability weight for support point z of processing margin of milk item i in Member State m
$\theta_{m,z,i,UM}$	=	initial probability weight for support point z of processing margin of milk item i in Member State m
$UMA_{p,m,i}$	=	unit margin in production/processing of item i $\in$ ALLMLK in Member State m
$\underline{UMAS}_{p,m,z,i}$	=	support point z of processing margin of milk item i in Member State m

Furthermore we require consistent balances on milk fat and protein (71), consistency with observed prices (73) and, of course, adding up of probabilities. These constraints impose full consistency of the initialisation with the model's equations.

In the above problem we treat the base year values for processing of raw milk $PRC_{m,h}$ and production of secondary milk products $PRD_{m,i}$ (available from Eurostat) as fixed and known values. Starting values for $\gamma_{m,h,c}$ were rather easy to find ($\gamma_{m,COMI,FAT}$ = 4.1%, $\gamma_{m,COMI,PRT}$ = 3.3%, $\gamma_{m,SGMI,FAT}$ = 7.0%, $\gamma_{m,SGMI,PRT}$ = 5.5%) and contents of milk products are currently adopted as estimated for the COCO database. Fat (protein) prices have been initialised at 80% of the prices of butter (skimmed milk powder) per unit of fat (protein). Starting values for processing margins were derived from a German study (Wissenschaftlicher Beirat 2000).

3.2.4 Special issue: nutrient requirements and contents

For the feed sector we need contents of energy $\eta_{m,f}$ and protein $\rho_{m,f}$, and corresponding requirements of animal activities consistent with the balances (11) and (12). The prices of nutrients $PENE_m$ and $PPRT_m$ have to be initialised. Nutrient prices, contents and requirements should result, according to (6) and (7) in "reasonable" net revenues and net feed prices. Negative net revenues and net feed prices are permissible, but they would complicate the calibration of elasticities and have been ruled out for the time being. This initialisation is quite similar to the milk sector initialisation above but it involves more variables and equations at the same time. Nonetheless a corresponding entropy problem is suited to integrate and adjust all variables at the same time:

$$\begin{aligned} \text{Max } ENTF_m = & -\Sigma_z \Sigma_s \Sigma_c PROB_{m,z,s,c} \ln(PROB_{m,z,s,c} / \theta_{m,z,s,c}) \\ & -\Sigma_z \Sigma_c PROB_{m,z,c,PEP} \ln(PROB_{m,z,c,PEP} / \theta_{m,z,c,PEP}) \\ & -\Sigma_z \Sigma_i PROB_{m,z,s,RU} \ln(PROB_{m,z,s,RU} / \theta_{m,z,s,RU}) \end{aligned} \quad (125)$$

with the following definition of contents, prices of nutrients, and net revenues / net prices from (three) supports:

$$\begin{aligned} \zeta_{m,s,c} &= \Sigma_z PROB_{m,z,s,c} \underline{ZS}_{m,z,s,c} \quad \forall\, c, s \in AACT \cup FEED \\ PP_{m,c} &= \Sigma_z PROB_{m,z,c,PP} \underline{PPS}_{m,z,c} \quad \forall\, c \in \{ENNE, CRPR\} \\ RU_{m,s} &= \Sigma_z PROB_{m,z,s,RU} \underline{RUS}_{m,z,s} \quad \forall\, s \in AACT \cup FEED \end{aligned} \quad (126)$$

where

$ENTF_m$ = cross entropy in feed data calibration for Member State m

$PROB_{m,z,s,c}$ = final probability weight for support point z of content c in netput s in Member State m

$\theta_{m,z,s,c}$ = initial probability weight for support point z of content c in netput s in Member State m

$\zeta_{m,s,c}$ = content c in netput s in Member State m

$\zeta_{m,s}$ = $\{\zeta_{m,s,ENNE}, \zeta_{m,s,CRPR}\} = \{\eta_{m,s}, \rho_{m,s}\}$

$\underline{ZS}_{m,z,s,c}$ = support point z of c in netput s in Member State m

$PROB_{m,z,c,PP}$ = final probability weight for support point z of producer price of content c in Member State m

$\theta_{m,z,c,PP}$ = initial probability weight for support point z of producer price of content c in Member State m

$PP_{m,c}$ = producer price of content c in Member State m ($PP_{m,ENNE} = PENE_m$, $PP_{m,CRPR} = PPRT_m$)

$\underline{PPS}_{m,z,c}$ = support point z of producer price of content c in Member State m

$PROB_{m,z,s,RU}$ = final probability weight for support point z of unnormalised net revenue /net price of netput s in Member State m

$\theta_{m,z,s,RU}$	=	initial probability weight for support point z of unnormalised net revenue /net price of netput s in Member State m
$RU_{m,s}$	=	unnormalised net revenue /net price of netput s in Member State m
$\mathbf{RU}_m$	=	$\mathbf{RN}_m \cdot PP_{m,REST} = (\mathbf{NREV}_m, \mathbf{PP}_{m,NOFEED}, \mathbf{NP}_{m,FEED})'$
$\underline{RUS}_{m,z,i}$	=	support point z of unnormalised net revenue /net price of netput s in Member State m

Starting values for contents of feedstuffs and requirements of animals have been specified in line with the animal nutrition literature. Fortunately it was possible to draw heavily on earlier work in the CAPRI team. For feedstuffs it was expected that the contents might differ a lot across the EU because the quality of feedstuffs may be quite heterogeneous. On the contrary it was considered implausible to have vast differences in the requirements between EU Member States, after adjusting for different yields. Consequently a weight (= 10) has been introduced in the objective for requirements which pushed the requirements towards their starting values.

Starting values for energy and protein prices have been derived from a kind of hedonic regression where feed price variation for some 10 important feedstuffs over time and Member states had been explained with energy and protein contents[22].

Starting values for net revenues and net prices follow from gross revenues and gross prices after deducting energy and protein costs according to the starting values above. As mentioned above however, lower bounds have been imposed both for net revenues (= 10% of gross revenues) as well as for net prices (= 3% of gross prices).

Table 3.2-1 shows initial and final values for energy and crude protein requirements of dairy as an example activity, for contents in barley and for prices of nutrients. The first column shows some differences between Member States in the initial requirements (INI), mainly due to differing milk production per animal. The second column shows the changes brought about by calibration which are usually small, but sometimes larger (EL, UK). The next column reveals that the starting values for contents are uniform across the EU[23] but that the calibration may introduce heterogeneity. The largest changes occur again in EL and UK, where the calibration procedure is apparently correcting a severe shortage both of energy and protein. A more detailed analysis shows that this shortage is caused by a strong downward correction of the contents of grass in EL and UK, which is an important feedstuff. This downward correction is in turn due to very low gross grass prices in UK and EL, which do not tolerate high energy and protein values, if the net price is supposed to be positive. It may be worth further consideration how this dubious consequence of problems in the database may be avoided. Finally the last columns show initial and final values for energy and protein prices in EU Member States. These are again quite heterogeneous, already in the initial values. These differences ultimately go back to differences in the feed prices of the respective Member States because the starting values are regression results based on these feed prices. Some parameter constraints have been incorporated into this regression already but perhaps these constraints should be tightened even more[24]. Energy and protein prices are inversely related to each other: High energy prices usually go along with low protein prices (EL, ES,

[22] More details are explained in the comments of the responsible data aggregation program CAPSIMDAT.

[23] This holds at least on the disaggregated level of the COCO product list, but differing composition of aggregates at the CAPSIM level may lead to occasional differences between MS.

[24] Alternatively it is conceivable to allow negative net prices, after some adjustments in the calibration routine.

AT) and vice versa (FI, PT). The calibration does not appear to increase these differences in a sizeable amount.

Table 3.2-1: Energy and crude protein: requirements of dairy cows [GJ NEL/cow, t XP/cow], contents in barley [GJ NEL/t, t XP/t] and prices [€/GJ NEL, €/t XP] in EU Member States

	DCOW		BARL		Price	
	INI	FIN	INI	FIN	INI	FIN
			Energy (Net energy lactation, NEL)			
BL	36	36	7.2	7.3	6.8	1.6
DK	40	40	7.2	5.8	11.7	11.3
DE	36	36	7.2	7.1	9.2	9.3
EL	29	21	7.2	11.6	15.2	7.9
ES	31	30	7.2	6.7	13.8	13.5
FR	35	34	7.2	7.1	11.0	11.2
IR	29	28	7.2	8.2	6.6	3.4
IT	34	34	7.2	7.2	12.4	12.5
NL	40	40	7.2	7.3	7.7	3.2
AT	31	31	7.2	7.2	13.1	13.2
PT	32	32	7.2	7.3	5.9	4.8
FI	38	38	7.2	9.0	1.1	1.1
SE	41	41	7.2	7.1	8.0	8.0
UK	35	26	7.2	11.6	9.2	4.8
			Crude protein (XP)			
BL	0.82	0.72	0.10	0.11	298	519
DK	0.93	0.93	0.10	0.09	215	214
DE	0.82	0.82	0.10	0.10	284	281
EL	0.62	0.48	0.10	0.16	101	187
ES	0.68	0.68	0.10	0.08	95	95
FR	0.79	0.79	0.10	0.10	214	211
IR	0.62	0.54	0.10	0.12	242	314
IT	0.77	0.77	0.10	0.10	238	239
NL	0.94	0.75	0.10	0.10	278	528
AT	0.70	0.70	0.10	0.10	112	112
PT	0.72	0.71	0.10	0.10	583	465
FI	0.89	0.88	0.10	0.12	964	497
SE	0.95	0.95	0.10	0.10	328	326
UK	0.79	0.62	0.10	0.16	275	206

Summing up: the current procedure will ensure consistency of the feed system initialisation, but the resulting estimates are not entirely satisfying and should be considered a preliminary solution therefore.

3.2.5 Special issue: consumer prices

Given that consumer prices for food items were not offered in any Eurostat domain in sufficient detail and completeness they had to be derived in a procedure blending macroeconomic information on consumer expenditure from Eurostat or other sources with scattered information on consumer prices. The basic procedure was to use the macroeconomic data as an accounting framework and allocate all food expenditure in this framework to the items distinguished in the COCO product list with positive human consumption data. The allocation proceeds step by step, starting from the top (total final consumption) level, down to food groups and finally individual items.

Consumer prices are calculated on the product differentiation of the COCO database. They are aggregated for CAPSIM by the CAPSIMDAT.GMS module mentioned in section 3.2.2.

3.2.5.1 Available data sources

Total final consumption expenditure

The main source is domain BRKDOWNS, collection COICOP2 or COICOP3 (slight differences between the two). Here ESA95 definitions are applied, i.e. only direct expenditure by private households, without expenditure by public or private agencies (social security…) *for* private households.

Missing data in BRKDOWNS: No data prior to 1995 for BE, LU, GR, ES, NL, SE. In other MS no data prior to 1991 or earlier years. For LU only total expenditure 1995-99 are available.

Domain HIST (SEC2) has complete time series for final consumption expenditure 1985-1997. However, the definition of ESA87 at the base of SEC2 included a part of the expenditure for private households financed by other agencies, hence there is a conceptual difference to the BRKDOWNS data. Consequently, the HIST data on final consumption are only used to extrapolate the BRKDOWNS series into the past, where necessary. Regressions for this and other purposes are handled as explicit optimisations within the GAMS program "consumer.gms"

Total food expenditure

Main source is again domain BRKDOWNS, collection COICOP3.

However, missing data are more frequent than for total expenditure: No data at all in LU, SE. No data prior to 1995 for BL, GR, ES, NL. In other MS no data prior to 1991 or earlier years. No 1999 value in PT.

Domain HIST (SEC2) has data for 1985-97, but missing data after 1985 in ES, after 1991 in LU, 1995-97 in several MS. In general we use food expenditure *shares* calculated on HIST data to extrapolate the BRKDOWNS food expenditure shares in to the past with special treatments for SE, BL, EL and PT as visible in "consumer.gms".

Expenditure on food groups

Food expenditure on 8 food groups (bread & cereals, meat, fish, milk & cheese & eggs, oils & fats, fruits & vegetables, potatoes, sugar) is available in domain HIST (SEC2) for 1985-97. Gaps: No data at all on food groups in DE. No fruits & vegetables, potatoes, sugar, coffee & tea & cacao in LU. After 1985 in ES, after 1991 in LU nothing, 1995-97 gaps in several MS. The main problems are DE and ES.

For DEW we may use a breakdown of private consumption from RWI available for 1985-92. This breakdown seems to correspond quite well to SEC2 definitions except possibly for "sugar" where the RWI data evidently include data on sweets, chocolates and so forth. After 1992, the RWI data may be extrapolated to 1998 using OLS on expenditure shares of "typical" households in Germany from the German statistical office as published in the German statistical yearbook. This national series is also discontinued in 1998, but the HIST data end in 1997 at the latest in all MS such that the completed German series match those of the other MS.

For Spain, we have obtained detailed food expenditure data from the Anuario de Estadística Agroalimentaria (AEA) 1987-96 which have been aggregated to the HIST groups for further processing as in the other MS.

To extrapolate the above information of food expenditure to the recent past, we require a source, which is likely to have a future. Until there is more detailed information available in domain BRKDOWS the only option seems to be domain PRICE, collection HICP which offers weights (and corresponding disaggregated price indices) for the harmonised consumer price index series. These weights should come close to expenditure shares for years 1995-2000 and are given for 11 food expenditure groups: bread & cereals, meat, fish, milk & cheese & eggs, oils & fats, fruit, vegetables (including potatoes), sugar, coffee & tea & cacao, other food. After aggregation to the HIST grouping, we use these weights to obtain complete series for the allocation of expenditure on food groups from 1985 to 1999.

Absolute consumer prices on disaggregated food items

In Domain PRICE, collection PMNP there are absolute prices in national currency 1985-93 for 22 food items. However, the units are apparently different across countries. Because the series is discontinued and has missing data on several MS (completely for Luxembourg, Spain, Austria, Finland, and Sweden; gaps for specific items occur occasionally) we decided to discard this series completely.

Instead, the ILO offers data on consumer prices in national currency for 1985-99 for many food items, together with a description of the units (http://laborsta.ilo.org/). We use prices on 11 items: pulses, tomatoes, apples, oranges (for CITR), table grapes, table wine, rice, olive oil, table oil, butter, and cheese.

There are missing data scattered across items and member states: In FR: nothing prior to 93 and 1999 missing. DE only 1991-94. FI nothing before 1988. EL nothing after 97. LU without 1992, 94, 97. SE prior to 90. These gaps require completion of the ILO series before further use, which is mainly done using the percentage changes of an average (EU) consumer price, calculated on the basis of MS with complete ILO series for the specific item under investigation.

Producer prices and human consumption quantities on agricultural products

We use the columns UVAP, PRIC and HCOM in the COCO database, taking this information as given. This implies that the consumer prices will be calculated corresponding with and relying on the COCO information. Any odd properties of individual UVAP or HCOM series may thus trigger odd properties of one or several related consumer price series. If such properties have been detected, there was an additional check and reconsideration of the COCO procedures and results, but in principle the calculation of consumer and producer prices is done sequentially, without automatic feed back.

3.2.5.2 Methodological details

This section explains in more detail how the above information has been merged to obtain the consumer prices.

Step 1: expenditure framework for food groups

As mentioned above, the level of total final consumption expenditure and the share of food in total expenditure is taken from BRKDOWNS, COICOP3, if possible, as this series is likely to be continued in the future. In case of missing data (usually in the past), OLS projections based on the overlapping years with data from HIST (SEC2) have been used to fill the gaps.

The data from domain HIST have also been the first choice to calculate expenditure shares for broad food categories, in spite of their discontinuation in 1997. As mentioned above, similar national sources have been used for DE and ES. The consumer price index weights from domain PRICE, table HICP have only been used to complete the shares for 1995-2000. These weights are likely to be continued in the future but their definition is to some extent unclear. They are in general somewhat higher than HIST food expenditure shares but their relative sizes closely resemble those in HIST for most items. Consequently we based the projection of food expenditure shares on conversion factors a_i for share *ratios* r_{it} between HIST and PRICE calculated with meat (i = 1) as a numeraire:

$$
\begin{aligned}
\hat{s}_{1t}^{H} &= 1/\left(1+\sum\nolimits_{i\neq 1}\hat{r}_{it}^{H}\right)\\
\hat{s}_{it}^{H} &= \hat{r}_{it}^{H}\ \hat{s}_{1t}^{H}\\
\hat{r}_{it}^{H} &= a_i\ r_{it}^{P}\\
a_i &= \left(\frac{r_{i95}^{H}r_{i96}^{H}r_{i97}^{H}}{r_{i95}^{P}r_{i96}^{P}r_{i97}^{P}}\right)^{\frac{1}{3}}\\
r_{it}^{H} &= s_{it}^{H}/s_{1t}^{H}\ ,r_{it}^{P} = s_{it}^{P}/s_{1t}^{P}
\end{aligned}
\tag{127}
$$

where

s^{H}_{it} (s^{P}_{it}) = expenditure shares in domain HIST (PRICE)

This estimate guarantees that projected food expenditure shares add up to one.

Because potatoes are included in vegetables in the PRICE weights the above procedure only worked for the aggregate fruits + vegetables + potatoes share. To use the information in HIST on expenditure for potatoes, we undertook an OLS projection based on calculated potato shares computed as

$$\text{HCOM.POTA} * \text{PRIC.POTA}/\ \text{EXPE.CONS} \tag{128}$$

where EXPE.CONS is our completed series of total final consumption expenditures and HCOM.POTA and PRIC.POTA are variables on potatoes from COCO. This regression was preferred over shares calculated with producer prices UVAP or with consumer prices from the ILO based on a better fit. Expenditure on POTA was thus deducted from expenditure on fruits + vegetables + potatoes to yield an estimate of expenditure on fruits and vegetables FRVE.

Step 2: expenditure and absolute consumer prices for individual items

The allocation of food expenditure within the seven groups (BRCE, MEAT, FRVE, POTA, SUGA, OILS, MICE) was undertaken in a maximum entropy framework because it turned out that our prior information on single consumer prices and the estimated group expenditures was difficult to reconcile. A typical example is that in several countries expenditure on butter valued at wholesale prices (let alone consumer prices) exceeded the estimated expenditure on the whole fats and oils group OILS. This will be due to the group expenditure data ultimately going back to consumer survey information. Consumers will usually disregard their butter consumption hidden in bread, cakes, ice cream and so forth which is included in overall market balances. Consequently several expenditure groups, in particular BRCE, SUGA, OILS, and MICE are likely to have fuzzy boundaries and we therefore permitted expenditures on these groups to deviate from their starting values at moderate cost in terms of the entropy objective function. For POTA, MEAT, and FRVE, final group expenditures were pushed towards their starting values by a smaller range of support points. The only hard constraint was given by total food expenditure (without fish). To counteract the tendency of the solver to concentrate the adjustments on major expenditure items (which permits to keep most prices at their starting values) the entropy contributions of single prices and expenditure groups was weighted by expenditure shares:

$$\begin{aligned} \text{Max ENTC} = & -\Sigma_m \Sigma_z \Sigma_i \, PROB_{m,z,i,CP} \ln(PROB_{m,z,i,CP} / \theta_{m,z,i,CP}) \\ & \quad * (0.001 \underline{CPS}_{m,2,i} \, \underline{HCOM}_{m,i} / \underline{TOFO}_m \\ & -\Sigma_m \Sigma_z \Sigma_I \, PROB_{m,z,I,EX} \ln(PROB_{m,z,I,E} / \theta_{m,z,I,EX}) \\ & \quad * (\underline{EXS}_{m,2,I} / \underline{TOFO}_m) \end{aligned} \tag{129}$$

with constraints (apart from adding up of probabilities):

$$\begin{aligned} & CP_{m,i} = \Sigma_z \, PROB_{m,z,i,CP} \, \underline{CPS}_{m,z,i} \\ & EX_{m,I} = \Sigma_z \, PROB_{m,z,I,EX} \, \underline{EXS}_{m,z,I} \\ & EX_{m,I} = \Sigma_{i \in I} \, CP_{m,i} \, \underline{HCOM}_{m,i} \\ & \underline{TOFO}_m = \Sigma_I \, EX_{m,I} \end{aligned} \tag{130}$$

where

$ENTC_m$ = cross entropy in consumer price estimation

$PROB_{m,z,i,CP}$ = final probability weight for support point z of consumer price i in Member State m

$\theta_{m,z,i,CP}$ = initial probability weight for support point z of consumer price i in Member State m

$\underline{CPS}_{m,z,i}$ = support point z of item i in MS m

$\underline{EXS}_{m,z,I}$ = support point z of expenditure group I in MS m

$CP_{m,i}$ = final consumer price of item i in MS m [€/t]

$\underline{HCOM}_{m,i}$ = human consumption of item i in MS m [1000 t]

$EX_{m,I}$ = final expenditure on group I in MS m [mio €]

$\underline{TOFO}_m$ = total food expenditure in MS m [mio €]

The "central" of three support point for group expenditures (z = 2) was initialised with the estimate of group expenditures as explained above. Within the range of lower and upper support points (wider for less clearly defined groups) reallocation was possible but punished in the objective function. Additional lower bounds (for example: $EX_{m,I} > 0.5 * EXS_{m,2,I}$) and upper bounds provided additional safeguards. In an earlier version of our procedure we specified a minimal margin of 5% of the national producer price for processing and marketing services: $CP_{m,i} > 1.05 * \underline{UVAP}_{m,i}$. However this turned out unreasonable for some items of minor importance on the production side of a country, for example wine in Belgium or "other fruits" (OFRU) in Germany. In the latter country we observe high producer prices in the database for OFRU presumably stemming from other fruits than bananas which were quite cheap in Germany in the past and had a heavy weight in consumption. Unit values of items with minor importance on the production side also tend to be rather volatile while consumer prices will depend to a large degree on the price of imports, which provide the bulk of domestic consumption. Consequently we currently require a minimal margin of 5% relative to a domestic average raw product price of the item,

$$CP_{m,i} > 1.05 * \underline{AVP}_{m,i} \tag{131}$$

where the average price is defined as a weighted average of domestic and EU prices:

$$\underline{AVP}_{m,i} = WGT_{m,i}\, \underline{UVAP}_{m,i} + (1- WGT_{m,i})\, \underline{UVAP}_{EU,i} \tag{132}$$

and domestic weights are increasing with the ratio of domestic farm sales $NETF_{m,i}$ over domestic human consumption $HCOM_{m,i}$:

$$WGT_{m,i} = \frac{\underline{NETF}_{m,i}}{\underline{NETF}_{m,i} + \max(0, \underline{HCOM}_{m,i} - \underline{NETF}_{m,i})} \tag{133}$$

This modification eliminated most problems of volatile producer prices inducing implausible fluctuations in consumer prices. However some problems are still unresolved with the definitions above. One such example is tomatoes (TOMA) in BL which exports about half of total production, presumably in an "export quality" which commands a higher price than the average domestic consumption quality. Consumer prices exceeding $\underline{AVP}_{m,i}$ as defined above are thus conceivable in situations were the products at the producer and consumer level have a different composition. An appropriate treatment would require further disaggregation in these cases, which had not been feasible.

The main final point to be explained is where the initial values for the consumer prices, that is for the central support point $\underline{CPS}_{m,2,i}$ were coming from. This was specific for the different expenditure groups.

Cereals (BRCE) and meat (MEAT)

For cereals the starting values have been obtained in a way very similar to that in the times of the SPEL/BM:

$$\underline{CPS}_{m,2,i} = \underline{AVP}_{m,i} + MARC_{m,i} \tag{134}$$

where

$$MARC_{m,i} = (\underline{EXS}_{m,2,I} - - \Sigma_{i\in I}\, \underline{AVP}_{m,i}\, \underline{HCOM}_{m,i}) / \Sigma_{i\in I}\, \underline{HCOM}_{m,i} \tag{135}$$

Consumer prices were thus estimated assuming that the marketing margin above the average raw product price $\underline{AVP}_{m,i}$ was uniform in absolute terms for all cereals. This assumption is quite reasonable and will be used for the groups cereals and meats (I = BRCE, MEAT). A small modification is that ILO prices for rice have been used (given that a large part of rice will not processed further) and rice expenditure has been deducted before allocating the (large) residual to other cereals as explained above. A final detail to be explained is that all kinds products with margins probably similar to those of cereals and usually negligible consumption quantities, such as RAPE, SUNF, SOYA, OOIL, RAPC, SUNC, SOYC, OLIC, OTHC and STAR, have been included in the BRCE group as well.

Oils and fats (OILS)

The starting values were given by the completed ILO prices for butter, olive oil and table oil. Because no evidence was available to distinguish the prices of oil from rape, sunflowers, soya and other oilseeds, the price of table oil has been used for all of them.

Milk, cheese and eggs (MICE)

This group combines eggs, cheese and all other milk products except butter. ILO prices have been used as starting values for cheese and eggs. Starting values for other milk products have been estimated from PRAG wholesale prices for milk products, assuming that the percentage mark-up for all other milk products would equal the average mark-up for butter and cheese implied by the ILO prices. Before using them, PRAG prices have been completed (as the ILO prices), applying where necessary the percentage growth or the absolute level of an EU average price to MS with data gaps.

Sugar and potatoes (SUGA, POTA)

The starting value for these single item groups could be calculated simply as group expenditure / HCOM.

Fruit and vegetables (FRVE)

ILO prices were available for five items: TOMA, PULS (we used prices of white dried haricot beans), TAGR, APPL, CITR (we used prices of oranges). For the remaining items without further empirical information (TABO, OLIV, OVEG and OFRU) we assumed a 20% mark up over the average raw product prices AVP. Because the latter is a fairly crude estimate we applied a wide range of consumer price supports ($\underline{CPS}_{m,1,i}$ - $\underline{CPS}_{m,3,i}$ = 5 * $\underline{CPS}_{m,2,i}$) to these items to render deviations from these starting values cheap.

Wine (TWIN, OWIN)

ILO prices (for red table wine) have been applied to TWIN. Prices of other wine have been estimated assuming the same absolute margin as for table wine, again measured against the average raw product price AVP as defined above. Domain PRICE offers index weights for wine but these only date back to 1995 and have not been used so far.

3.2.6 Auxiliary data for the base year

DG Agri data

DG Agri data were used for crop ceilings, animal ceilings[25], areas/animals in receipt of premiums, the set aside areas (obligatory and voluntary), the non-food production on set aside, and national small producer shares. The monetary amounts spent are given in the yearly

---

[25] Data on **national ceilings** stem from the DG Agri web site http://europa.eu.int/comm/agriculture/agrista/2000/table_en/en361.htm. These national ceilings define the maximum premiums granted to grand cultures, bovine animals, suckler cows and sheep and goats. For modelling purposes, we also require the share of ceiling use to ceilings, because the ceilings have to be adjusted for definitional differences. This information was taken from the web-site above for the animals as well (as "number of animals in receipt of premiums"). In case of grand cultures we used the position 'area for which aid has been asked' from a file received by DG Agri.

FEOGA reports but it is gratefully acknowledged here that DG Agri provided an unofficial electronic compilation for the years 1990 - 2000. The FEOGA data for the base year were used for the specification of premiums (section 3.4.1), but also to calculate various correction factors or differences for the budget component in CAPSIM, see section 2.6.4. Shares of Member States in total Community finance are available on the DG Budget website[26] and have been used to allocate any FEOGA impacts from simulations to the Member states.

Sugar data

A recent study of reform options for the sugar CMO with contributions from CAPSIM and other modelling systems provided information on the yields of sugar beet in different types of farms (e.g. "C-beet producers") which was used to derive different average yields for A beet, B beet and C beet on the sectoral level, taking into account observed farm heterogeneity. These differences have been maintained in simulations. Furthermore the same study provided starting values on price differences between A-, B-, and C-beet in EU Member States which have been used to differentiate the average unit value of beet from the EAA. This information was needed to initialise the representation of the sugar CMO in CAPSIM, see section 2.4.6, including the parameters of the price transmission function.

Milk quota rents

The assumed milk quota rents have been addressed already in section 2.4.3.

WTO export limits

For export quotas and quantities of subsidised exports we used the notification documents by the EU as presented on the WTO website. Their use is explained in sections 2.5.3 and 3.4.2.

3.3 Default trends

Trend projections are required for a number of exogenous variables in CAPSIM:

- **Yields**

- **Exogenous activity levels**

Members of certain activity level sets are projected in an exogenous manner, at least during the reference run[27]: Set FXACT is always exogenous and REF_A_L0 is exogenous only in the reference run. The reason is usually that they turned out not very well suited for the standard treatment in CAPSIM. Because the membership in these sets[28] may be changed rather quickly it is convenient to have trend projections at hand for *all* activities.

[26] For the base year we used the 1998 shares from http://europa.eu.int/comm/budget/pdf/agenda2000/finue1998/en/an8.pdf. The recent 2002 data from http://europa.eu.int/comm/budget/pubfin/data/tabfinem_en.gif were assumed to apply to future simulations. Even though some shifts are predictable for the next future, official estimates have not been found. They may be introduced easily.

[27] See the user manual in the appendix for details on how to run the reference run as opposed to an ordinary policy simulation.

[28] Note that the set definition in the appendix is simplified in that it gives the most frequent membership across MS but in single MS one or two other activities may be included because the sets are MS specific.

- **Miscellaneous other exogenous positions:**
  - Exogenous sectoral aggregates: total area (GROF.LEVL), inhabitants (INHA.LEVL) for all MS
  - Industrial use (INDM) of the market balance for all inputs and outputs (set IO) and for all MS
  - Exogenous EU prices

    For products belonging to a set FXPTE = { TIND, WINE, OCRO, OANI, OLIO, OLIC, IPLA, IGEN, REST, OOUT} prices are currently specified exogenously because their endogenous modelling turned out difficult or because they are considered to be determined outside of agriculture. Membership in this set may be changed quickly if the corresponding trend projections are available.
  - EAA position for depreciation (DEPM, DEPB) and compensation of employees (WAGE) for all MS
  - EU-margins for consumer prices (column UMAC).

Most of the above projections will be maintained (automatically) at their reference run levels in an ordinary policy simulation. This is not (necessarily) the case for fixed activity levels. For members of the FXACT group, the user might have some knowledge that the area of grassland, for example, would decrease after a complete liberalisation of the CAP. Expert data would permit the user to overwrite the reference run trend conveniently (see section 3.6).

On the contrary, members of set REF_A_L0 = {DCOW, OCRO, OLIV, TIND, WINE } are handled endogenously in the policy simulation, but it appeared safer to perform the reference run projection based on activity level trends rather than based on given parameters and yield trends (on dairy see below). Fixing the activity level to this trend projection would render the activity level equation (18) infeasible. Some other variable, which is usually fixed, has to be rendered flexible to comply with the equation. For certain fixed activities (e.g. OANI) this adjustment may occur in the variable shadow revenue. If the activity has an ordinary net revenue specified elsewhere, our solution was to turn the constant $\alpha_{m,s,0}$ of the activity level equation into a variable for the reference run and fix it subsequently in policy simulations. In this way a strong upward trend for, say, olives area would translate itself into a higher constant $\alpha_{m,OLIV,0}$, reflecting technological or structural change which stimulates the cultivation of olives. In this way exogenous trends may be translated into revised parameters. Because the constants $\alpha_{m,s,0}$ are unrelated to homogeneity, symmetry or convexity of the functional form, this incorporation of exogenous inputs may occur without violating microeconomic consistency. In the policy simulations the revised constants are held fixed and the activity levels may respond to the policy change according to the calibrated parameters. The difference to the reference run may be attributed to the policy change then, because it has been checked that a repeated reference run without exogenous activity levels but with revised constants does indeed yield the same result. The constants are thus recalibrated to yield the exogenous trend projection as an endogenous model result.

In the case of dairy the constant was released in the same way to permit an exogenous projection for the shadow revenues (constant compared to base year). Otherwise the quota regime may have resulted in uncontrolled and perhaps implausible changes in shadow revenues.

The rest of this section describes the basic features[29] of the procedure to project trend values for the above group of variables. Strictly speaking the trend projections are only required only for the above variables. Nonetheless we chose to estimate trends on *all* exogenous and endogenous variables because this turned out easier in technical terms. The estimation procedure will be somewhat different in the above 3 cases. All these projections are to be considered default values. Sensitivity analysis or overwriting of default trends with better projections is possible if the user has better information[30].

3.3.1 Trend projections for yields

The difficulty with yield projections is to disentangle the systematic components from short run fluctuations due to the weather or statistical outliers (for example in case of tiny areas). With at most 14 observations (1986-1999), it was felt necessary to pool certain series and tie together certain parameters.

The first attempt was to tie together yield developments of "related" crops, for example cereals. However due to the difficulty to group all crops somewhere this approach has been abandoned. Instead we assume now that yields do not drift apart beyond any bounds *between EU member states*, because the technology is transferable to a significant degree among them. However to the extent that observed yield increases are due to Member State specific natural conditions or farm structure changes, it may be expected that yield trends can differ *somewhat* between member states. This idea has been implemented in the following constrained least squares[31] estimation approach:

$$\text{Min } \Sigma_{m,t}\, RES_{m,i,j,t}^{2} \cdot SHTO_{m,i} \tag{136}$$

s.t.

$$RES_{m,i,j,t} = (YLD_{m,i,j,t} - \mu_{m,i,j,0} - \mu_{m,i,j,1} \cdot AVYLD_{m,i,j} \cdot t) / AVYLD_{m,i,j} \tag{137}$$

$$ABS(\mu_{m,i,j,1} - \mu_{n,i,j,1}) \leq 0.01 \;\forall\; \mu_{m,i,j,1}\,,\, \mu_{n,i,j,1} > 0$$

$$\mu_{m,i,j,1} \geq 0 \;\forall\; m$$

where

$RES_{m,i,j,t}$	=	error in percent of average yield in Member State m and year t
$\mu_{m,i,j,0}$	=	constant term in trend for yield of i in activity j in Member State m
$\mu_{m,i,j,1}$	=	slope in trend for yield of i in activity j in Member State m
$AVYLD_{m,i,j}$	=	average yield over the years t in Member State m
$SHTO_{m,i}$	=	average share of the item in the total output value in Member State m

29 Details are visible and explained with further comments in the associated GAMS file CAPSIM_TRD.
30 These options to supply additional inputs are explained in more detail in the user manual in the Appendix.
31 Absolute deviations are frequently (e.g. in the Reference Group) considered more robust against outliers. In this problem however, we encountered convergence problems such that the gradient of the objective did not approach zero and the estimated parameters appeared to be very shaky if we replaced least squares with absolute deviations.

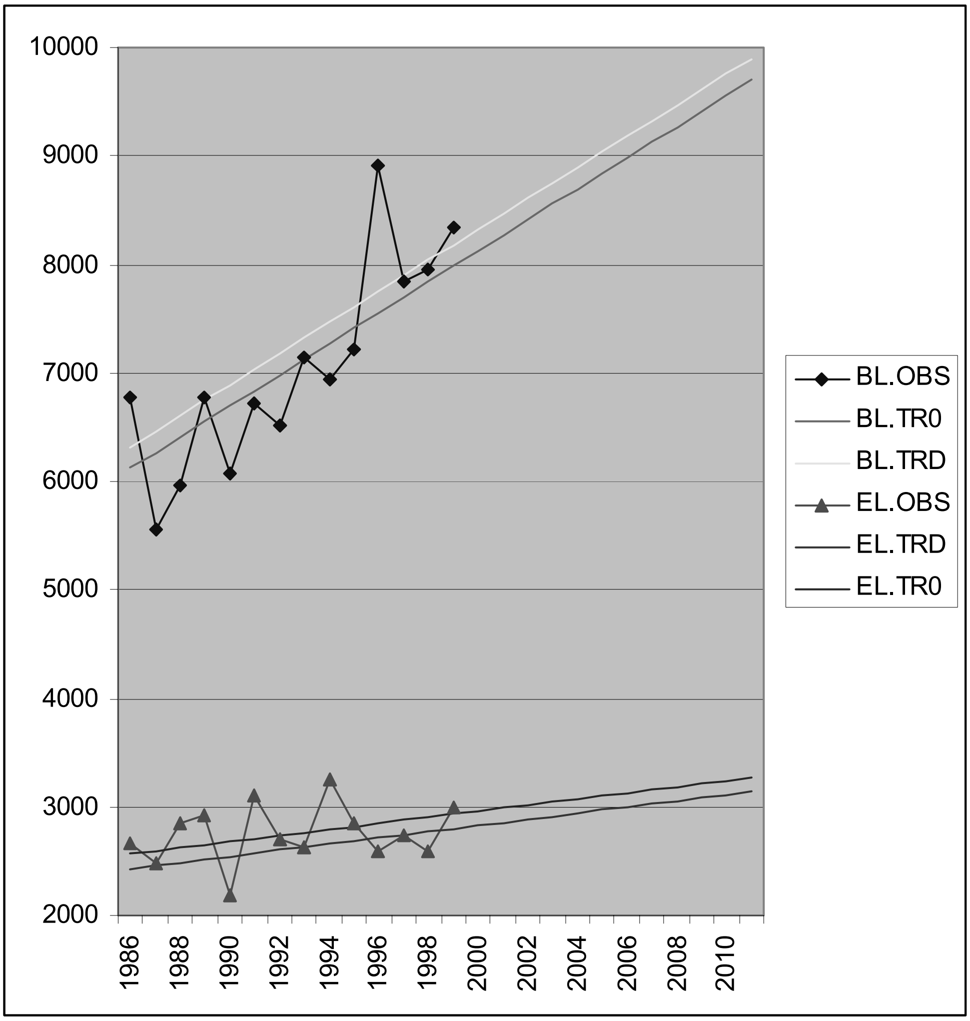
Because we want to tie together the slopes in different Member States, it is useful to normalise the errors with the average yield in the Member State $AVYLD_m$ because the yields may differ a lot (SWHE in NL: 8.0 t/ha, in PT 1.5 t /ha). Furthermore we like to achieve a good fit particularly in those Member States where the respective item has an above average share in total output, hence the additional weighting with the average share $SHTO_m$.

Slope parameters of two Member States may differ by at most 0.01, if both slopes are greater than zero. In a projection from 1998 to 2010 deviations of the yield increases of up to about 13% would be allowed. Figure 3.3-1 below shows that, occasionally, the harmonisation imposed by our procedure involves a certain sacrifice in terms of fit. The unrestricted trend lines would have had a higher slope in BL and a slope close to zero in EL. If it is considered implausible that yield developments in the EU are completely unrelated, then our harmonised trends will be preferred.

Furthermore the slopes may be set to zero which usually occurs if the ex post data would suggest a decreasing trend line. Decreasing trends are not impossible in case of certain farm structure changes, but it is considered more likely that they stem from errors in the data or other unfortunate circumstances.

The constant terms $\mu_{m,i,j,0}$ were unconstrained in the estimation but for the projection they have been recalculated to make the trend line pass through the base year value. Consequently the graph shows both the trend line actually estimated (TR0), with a best fit constant, and the modified trendline passing through the base year value which has been used for the projection (TRD). This accounts to some degree for the possibility that the observed trends may not be deterministic (around a certain trend line) but stochastic (drift term added to last observation). Finally we have to explain that only those observations were considered usable which do not deviate from the (three-year average) base year by more than 50%. This cut off criterion is evidently a very simple one, which was most convenient to implement.

Figure 3.3-1: Ex post observations and yield projections for soft wheat in BL and EL



3.3.2 Trend projections for areas

In the case of area projections it is useful to match the individual area projections with the total area projection. Independent trends of all areas and total areas may yield a strongly declining or increasing residual are to be allocated between endogenous crop activities. This happens easily if, for example, both total area and (exogenous) grassland have downward trends, which are estimated independently and very likely to run apart if the projection horizon is sufficiently long.

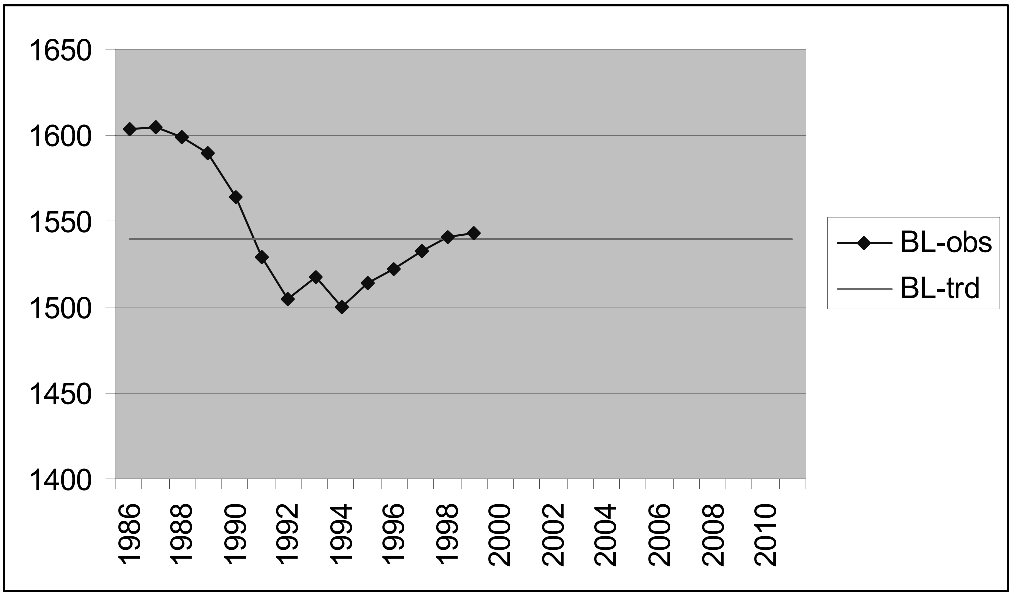
The solution chosen involves three steps:

1. to estimate total area with detailed checking of each member state
2. to estimate for each individual areas the ratio of this area to the largest area (usually SWHE, GRAS in DK and FI)
3. to transform these projections on area ratios into absolute areas which add up to total area

Step 1

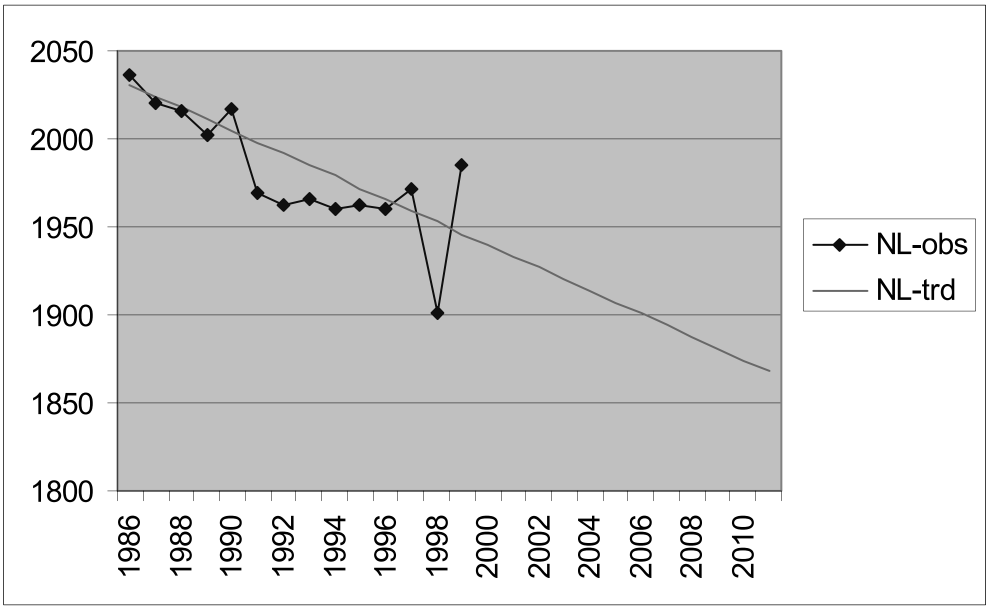
On the first task we encountered a number of cases which will be reproduced here without giving the complete set of series (they may be looked at more conveniently in electronic form). The first case has been when the ex post data did not allow to estimate any trend with a reasonable degree of confidence in it. In Figure 3.3-2 the choice of the estimation period is evidently crucial for the slope to be estimated. Without some clue as to whether there has really been a turning point in the development of total are and why, it seems prudent to assume a constant area. The same conclusion has been drawn for DE, IT, DK, and EL, for similar reasons.

Figure 3.3-2: Ex post observations and projections for total area in BL



The second case is when we have accepted a simple linear trend over all years of our database (1986-1999). This holds for FR, AT, and NL, the country depicted in the next graph.

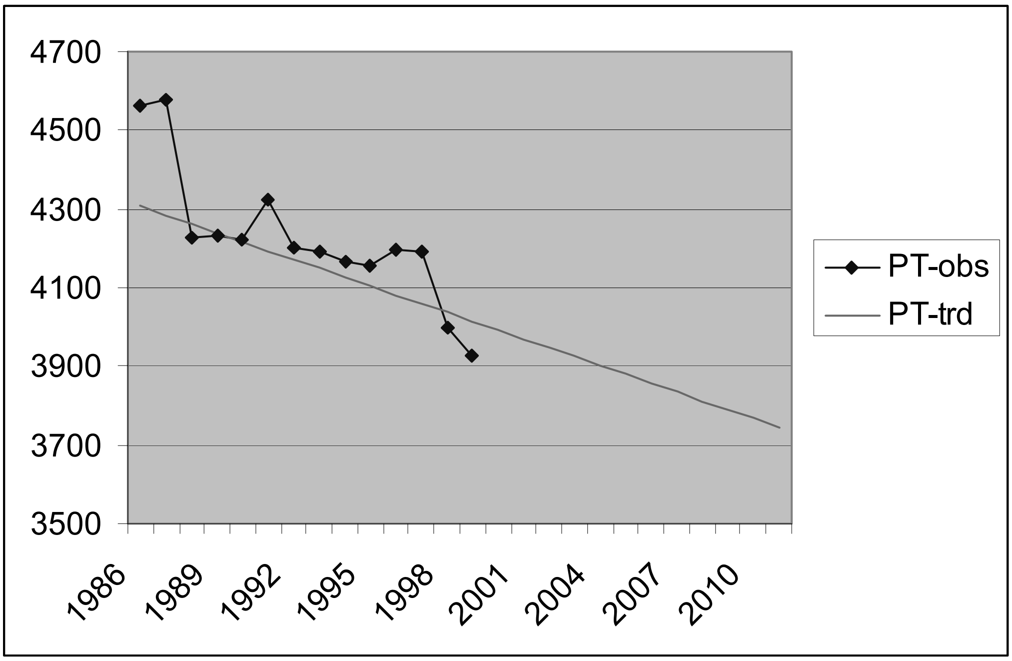
Figure 3.3-3: Ex post observations and projections for total area in NL



The last two observations may appear somewhat odd. However, because the area data were looking internally consistent (as opposed to the case of EL) and because a similar negative trend would materialise without the last two observations, we accepted the simple trend.

The third category includes Member States where we have accepted a linear trend after accounting for some structural change in some form.

Figure 3.3-4: Ex post observations and projections for total area in PT



It appears that the 1986-87 observations are likely to be affected by some statistical break, and consequently they have been simply removed from the observations to be used. The same seems to apply to IR, ES and FI whereas the breaks in UK and SE could be fixed appropriately with dummy variables.

The examples chosen reveal that a lot of judgement is required for case by case projections of individual series. Statistical criteria alone are insufficient. Based on these alone it might have been conceived to include a dummy on the slope parameter in BL above (Figure 3.3-1) and to come up with an increasing trend line, which would be difficult to believe. This kind of time consuming judgement can only be applied to the most crucial series, but it would quickly exhaust total resources available when applied to each of thousands of series to be projected.

Steps 2 and 3

The trends on the area ratios have been estimated with the standard procedure to be explained in the next section. Given these trend estimates on area ratios, we may compute absolute areas as follows:

$$\hat{LVL}_{m,n,t} = \hat{TOTA}_{m,t} / \sum_j \hat{LVLR}_{m,j,t} \tag{138}$$

$$\hat{LVL}_{m,j,t} = \hat{LVLR}_{m,j,t} \cdot \hat{LVL}_{m,n,t}$$

where

$\hat{LVL}_{m,n,t}$	=	Projection of absolute area for the numeraire crop n (SWHE or GRAS) in Member State m and year t
$\hat{TOTA}_{m,t}$	=	Projection of total area (from step 1) in Member State m and year t
$\hat{LVLR}_{m,j,t}$	=	Projection on area ratio j in Member State m and year t
$LVLR_{m,j,t}$	=	$LVL_{m,j,t}$ / $LVL_{m,n,t}$ = Observation on area ratio j in Member State m, year t
$\hat{LVL}_{m,j,t}$	=	Projection of absolute area for numeraire crop j in Member State m, year t

The results will be investigated after a look at our standard procedure for trend projections.

3.3.3 Trend projections for other variables

The standard procedure for trend projections is a simple linear trend on time, independent of other series, with two modifications applied to yield projections as well: (1) All observations deviating by more than 50% from the base year value have been discarded. (2) The constant term was recalculated to force the trend line pass through the base year value.

However in many cases linear trends would be implausible over the desired horizon, because all linear projections with a nonzero slope would eventually leave any admissible interval around the base year value. To tackle this problem of trends declining or increasing beyond reasonable bounds we used a non-linear trend line in case that the linear end year projections relative to the base year would have passed some trigger bound κ_1. The non-linear trend line should impose the constraint:

$$EST_t / VAR_{bas} > \kappa_2 \tag{139}$$

This is satisfied if we compute the projection of EST_t using an auxiliary variable AUX_t:

$$EST_t = VAR_{bas} \cdot (\kappa_2 + \exp(AUX_t)) \tag{140}$$

where

EST_t	=	estimated value for a variable in year t
VAR_{bas}	=	observed value for a variable in base year
AUX_t	=	auxiliary variable for non-linear trend estimation in year t
κ_2	=	percentage lower bound for non-linear trend estimation in year t

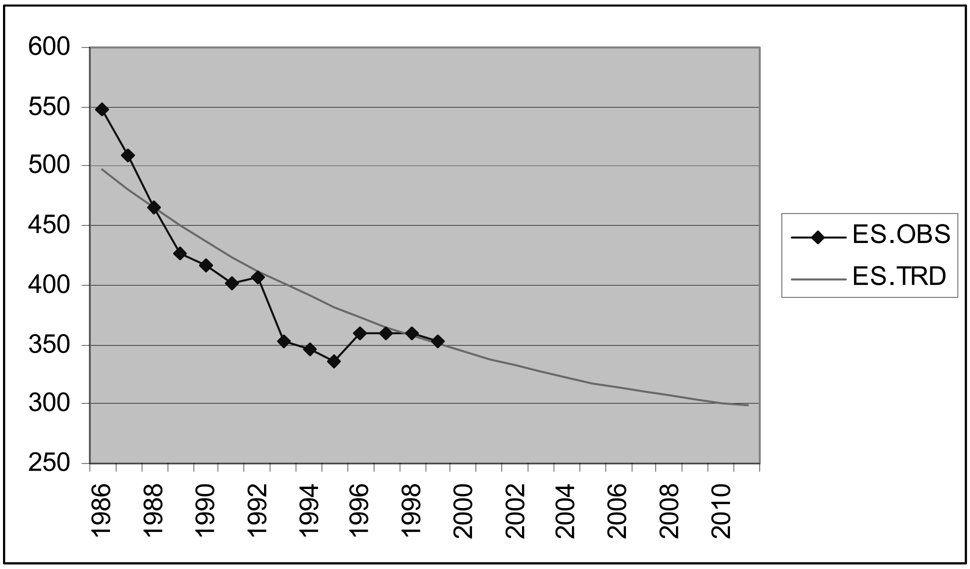
We specify $AUX_t = \mu_0 + \mu_1 \cdot t$ with an expected $\mu_1 < 0$ for falling trends. However, regardless of how negative AUX_t may become, it will always hold that $EST_t > VAR_{bas} \cdot \kappa_2$. Our equation to be estimated by OLS is then

$$\begin{aligned} &VAR_t = VAR_{bas} \cdot (\kappa_2 + \exp([\mu_0 + \mu_1 \cdot t])) \Leftrightarrow \\ &VAR_t / VAR_{bas} - \kappa_2 = \exp([\mu_0 + \mu_1 \cdot t]) \Leftrightarrow \\ &\log(VAR_t / VAR_{bas} - \kappa_2) = \mu_0 + \mu_1 \cdot t \end{aligned} \tag{141}$$

Currently it is specified that $\kappa_1 = 0.8$ and $\kappa_2 = 0.7$. In case of increasing linear trends passing beyond an upward triggering value ($\kappa_3 = 1.3$), a corresponding procedure is used which imposes an upper asymptotic bound ($\kappa_4 = 1.4$).

The next graphs show a few examples[32] on how the results are looking like if the non-linear estimation is activated. Examples for the standard linear case are less interesting and therefore omitted here.

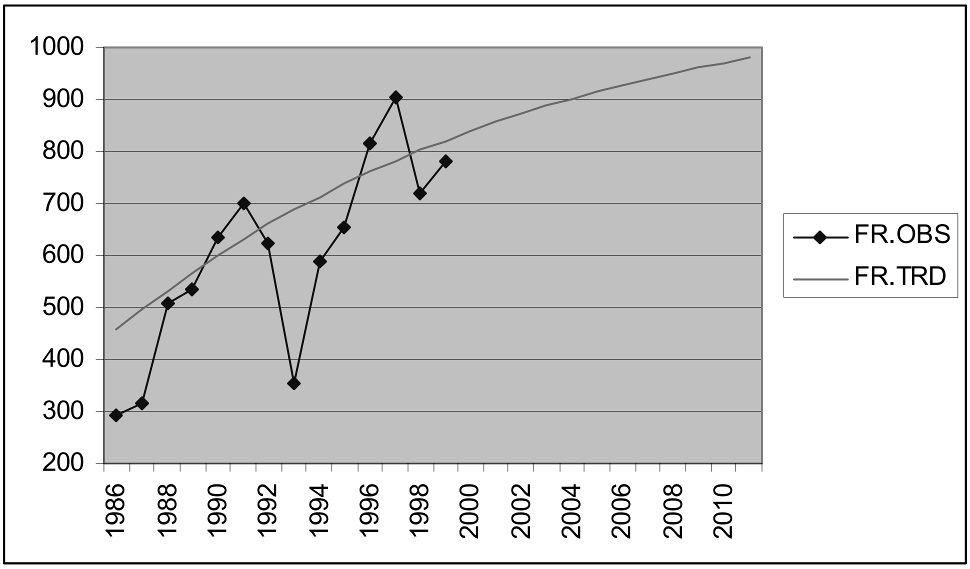
Figure 3.3-5: Ex post observations and projections for the unit value of vegetables in ES



[32] The full set of results comprises a rather voluminous data set, which is not included here. It is part of the CAPSIM database, which is delivered with the model and can be checked electronically.

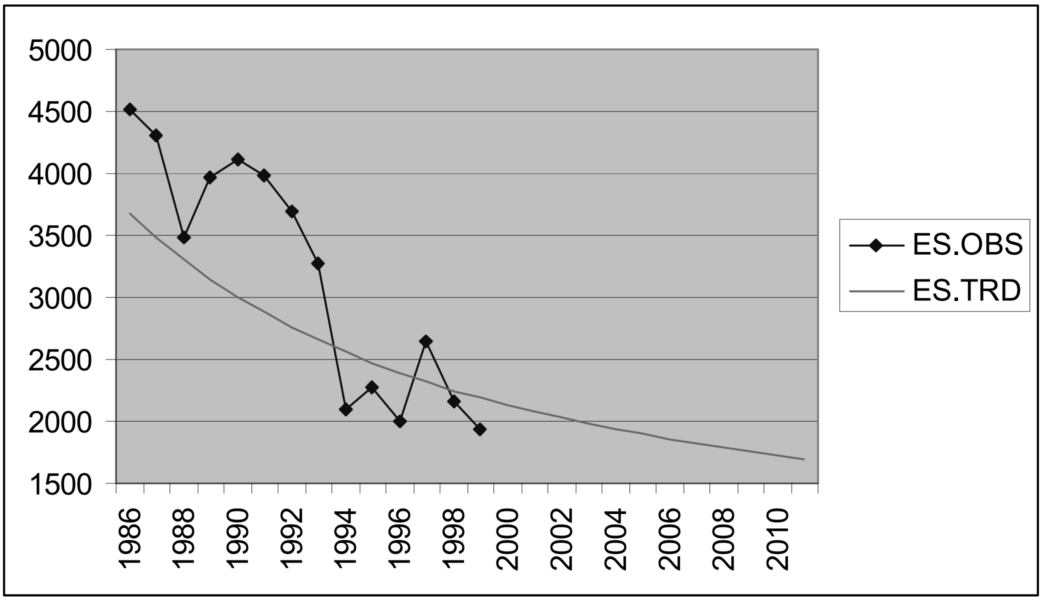
Producer vegetable prices have been declining strongly in Spain over the last years, presumably due to some changes in composition of the aggregate. Lacking further knowledge about the reasons for this decline it would appear to be wise to dampen this decline in the projection to some extent, which is exactly what the non-linear "bending" procedure does.

Figure 3.3-6: Ex post observations and projections for industrial use of soft wheat in FR



There is a strong upward trend in industrial use of soft wheat in France over the past 14 years. An ordinary linear trend would yield a projection beyond 1200 000 t in 2011. While not impossible it is considered wise here to err on the conservative side and to be careful in the projections. This is what is automatically built into the "bending" procedure.

Figure 3.3-7: Ex post observations and projections for fallow land in ES



Here we have an example of an area projection generated in the procedure explained in section 3.3.2. Because the trend line for the area ratio $LVLR_{ES,FALL,t}$ was strongly downward trending, it was subject to non-linear estimation. This forced the decline to taper off soon, whereas a simple OLS projection would have resulted in negative areas after 2008.

The non-linear bending procedure has been applied already in MFSS99 (Witzke, Verhoog, Zintl 1999). There it was envisaged to complement this robust ad hoc remedy with some statistical procedure based on recursive residuals. While such an amending would definitely improve the projection approach it would not dispense with the need to check for implausible projections. In the case of fallow land in ES no outliers are likely to be identified. Given that the current procedure is only meant to provide a first set of default projections, no additional sophistication is introduced so far.

3.4 Policy variables

This document describes the sources and further processing of policy variables. To permit comparisons and checks an attempt was made to establish a database at least for the years since the 1992 CAP reform. However, at a minimum a complete data set for the base year and for the projection year(s) is indispensible.

Some of the policy variables are related to activities and others to products, as has been explained above. Activity related are:

PREM	Premium per ha or head specific for activity [→ eq. (74)],
HIST	Historical yields for group premiums [→ eq. (74)],
PRET	Official premium per ton for group premiums [→ eq. (74)],
CEIL	Ceiling on levels for premiums [→ explanation to (74)],
SETR	Official set aside rate [→ eq. (75)].

Product related are:

QTS1	Quota on sales 1 [→ sections 2.4.3, 2.4.6],
QTS2	Quota on sales 2 [= B quota → section 2.4.6],
PADM	Administrative price [→ eq. (83)],
TARA	Specific tariff [→ eq. (83)],
TARR	ad valorem tariff [→ eq. (83)],
PAYT	Producer payment per ton (only used for dairy premium → eq. (74)),
EXPQ	Export quota [→ eq. (101)],
IMPQ	Import quota (for exogenous change in import quantities→ eq. (102)).

The raw data were collected from different sources in an excel file first. From there the raw data were written into GAMS tables in the form of "prn" (text) files. Two GAMS programs handled further processing of the policy data, according to the above grouping separate for activity and product related policy variables.

3.4.1 Activity related policy variables

Ex post years

Data sources were first the DG Agri data on ceilings, set aside issues and FEOGA data, see section 3.2.6. Initial information on the historical yields came from the CAPRI database because those are regionally specific and reflect expert knowledge on regional small producer share. The weighted average across regions was used as raw data information on national historical yields.

Calculation of CAP *premiums* started from FEOGA expenditures for single activities or groups of activities and from ex-post activity levels as estimated in COCO and aggregated in CAPSIMDAT.GMS (see section 3.2.2). Dividing the FEOGA positions by the corresponding activity level gave premiums per activity. Lacking detailed knowledge about budgetary rules implemented in the past years in the FEOGA, we allocated the budget years to the previous calendar year based on some inspection of the data[33]. For single activity premiums (sheep and goats premium, suckler cow premium, special male premium, special durum wheat premium) this procedure gave immediately the required results.

For arable crops we started from the official premiums per ton for arable crops as declared by the Commission. Initial values for *historical yields* were taken from the CAPRI database as mentioned above. However, because these historical years were not consistent with FEOGA expenditures, we decided to scale the historical yields as follows. First we calculated 'estimated' expenditures as

(CAPRI) historical yield (*crop*) * activity level (*crop*) * declared CAP premium (*group*)

The sum of these estimated expenditures over the crops of a group may be compared to the observed FEOGA expenditures (3-year AV 98) and used to derive a conversion factor for this group. In the end three groups were distinguished: cereals, oilseeds and pulses. In first tests it was tried to treat corn and fodder maize as separate groups. But the deviations of the 'declared' expenditures and observed FEOGA expenditures were very large such that it appeared wise to include them in the cereals group and thereby distribute any inconsistencies over a larger group of items. In general, the deviations of the resulting calibrated historical yields are relatively small, but occasionally they are huge. These large deviations only appear in the case of pulses. They may result from very low expenditures in this group. (small absolute deviations go often hand in hand with high relative deviations) It is obvious for Greece, Spain, The Netherlands, Sweden and Finland. It is even more problematically for Ireland and Portugal. There is no FEOGA expenditure, but pulses are cultivated nonetheless even though on a small area. Therefore the calibrated historical yields take a value of zero. In the next revision of the database it might be considered to include pulses as well in the cereals group. In case of set aside, we simply derived historical yields from FEOGA expenditure divided by the set aside area (3 year average 1998) divided by the premium per ton for cereals.

[33] This procedure seemed appropriate as the first CAP expenditure positions appeared in 1994 and for the new members (Sweden and Finland) in 1996. However it is not necessarily the right allocation, as cereal premiums are paid to the farmer in the time from the end of one year to the beginning of the next one

Ex ante years

The reference scenario will be for the next years the full implementation of the Agenda 2000 decisions, as presented in DG-Agri Newsletter 10. Additionally there was an adjustment of historical yields for several Member states. The precise values were taken from an Excel file sent by DG-Agri in 1999 (e-mail Rob Peters). In Spain and Italy the national percentage increase is immediately applied to the base year yields. Sweden and Finland receive a supplement for drying cereals and oilseeds. This additional premium was converted into increased historical yields (in the above Excel file as well) to avoid the introduction of an additional premium. The set aside rate is set to 10% of the grand culture area. Oilseeds are included in the cereal regime. This implies that farmers receive the lower cereal premium per ton, but multiplied with historical yields for cereals. As the different cereals (due to different shares) have different historical yields on the Member state level, a choice had to be made and finally the historical yield of soft wheat was applied to the oilseeds. Furthermore there were changes in the premium per ton for cereals and pulses.

For animals, the base year premiums (specified as explained above) were adjusted with the official percentage increase, if any, from DG-Agri Newsletter 10. The revised ceilings were taken from the Special edition Newsletter of 11.03.1999. The national envelopes from Newsletter 10 have topped up the new slaughter premiums for adult cattle. We assumed thus that these envelopes were entirely used in this way. The premiums for calves have been entered, on the contrary, based on the official 50 € specification.

Specifying modified policy variables for other policy simulations than the reference run is in the user's responsibility.

3.4.2 Product related variables: prices and quotas

Ex post years

Quotas for milk and sugar are implemented based on DG-Agri tables conveniently provided by DG Agri. For export quotas and quantities of subsidised exports we used the WTO notifications by the EU, see section 3.2.6. Administrative prices are included in many official documents. We relied mainly on European Commission Directorate of Agriculture 1997, 1999b, and for sugar on Linde et al. 2000. These "raw data" were included in separate worksheets in the Excel file "prod_pol_expost.xls". The worksheet "prod_pol_expost" compiles the data in GAMS table format for storage as a text file "prod_pol_expost.prn" which is in turn input for final calculations (in program "polp_cal.gms").

For milk quotas (QTS1) the raw data are converted from marketing years to calendar years which apply to the Eurostat production data ($x(t) = 0.25*x(t-1/t)+0.75*x(t/t+1)$). In a second step the three-year average is calculated. For sugar quotas (QTS1 and QTS2) no conversion or average was necessary, as they have been constant during the base period.

Regarding WTO limits for crop products the raw data for WTO marketing years are allocated in full to the calendar year ($x(t) = x(t/t+1)$). For all animal products they are converted from marketing years to calendar years using equal weights ($x(t) = (x(t-1/t)+ x(t/t+1)/2)$. Subsequently the three-year average is calculated. Remember that some further conversion is implied by the definition of adjusted WTO limits in (101), but this is handled internally and does not require user input. For this purpose the notified exports are part of the auxiliary input variables, see section 3.2.6.

Administrated prices were constant in the base period and did not require further conversion here. Specific tariffs $\underline{TARA}_i$ for items without administered prices are calculated backwards from border prices, imposing equation (83) to hold for the base period, with $FLEV_i = \underline{TARR}_i = 0$. Consequently the complete price difference between EU and border prices is currently attributed to a specific tariff. Of course there are other solutions (for example to use $\underline{TARR}_i \neq 0$), but for calibration to hold, it has to be consistent with equation (83).

Ex ante years

The Agenda 2000 changes in quotas for milk were implemented based on an Excel file sent by DG-Agri (email from Rob Peters 31.03.1999, see also the Special edition Newsletter of 11.03.1999). Regarding export quotas, the 2000/2001 notification to the WTO is the final specification maintained in the Agenda 2000 reference run. Changes in administrative prices are described in DG-Agri, Newsletter 10. All these data are first included in separate worksheets in the Excel-file prod_pol_exante.xls. The worksheet "prod_pol_exante" therein collects all data, which are stored as txt file “prod_pol_exante.prn” for further processing.

New quotas for milk were decided at the Berlin Summit for production years 2000/01, 2001/02, 2005/06, 2006/07 and 2007/08 with non-uniform increases over Member States. These growth rates are applied to the quotas in the year 2000. The new dairy premium is the sum of the EU premium and the national envelopes divided by the milk quota in 2009[34].

No changes have been decided for the sugar CMO. However, sluggish demand growth and tight WTO limits would trigger some intervention with unchanged quotas. In this case the sugar CMO provisions require a corresponding cut in quotas which is distributed across Member States according to the declassification key. This required quota cut (A+B) turned out to be about 380000 t for the EU 15 up to the year 2009 according to some trial and error.

As mentioned above, WTO limits are adjusted internally according to eq. (101). However, official administrative prices also had to be converted to CAPSIM definitions. This conversion with the ratio of base year EU prices to the official administrative price in the base year is handled internally to permit a specification of administrative prices according to official definitions, as most users will be familiar with. It implies that CAPSIM applies the *changes* of administered prices as specified by the user but that it calculates internally with levels of administered prices which may differ from official prices:

$$\underline{PADM}_i = \underline{PADM}_{i,official} * \beta_{EP,i} / \beta_{PADM,i,official} \qquad (142)$$

where

$\underline{PADM}_i$	=	Administered EU price of product i (in CAPSIM definition)
$\underline{PADM}_{i,official}$	=	Official administered EU price of product i as supplied by the user
$\beta_{EP,i}$	=	EU level market price of product i in the base year
$\beta_{PADM,i,official}$	=	Official administered EU price of product i as supplied by the user in the base year

34 Due to the quota regime the payment per ton PAYT may be converted internally into a corresponding premium per cow PREM without changing the results. This was done to avoid modification of our spreadsheet macros showing the components of activity revenues as in Table 4.3-2 below.

A user input is not necessary for tariffs, if the user is satisfied with the default assumption of no change. In other cases the user should adopt the responsibility to specify modified policy variables for other policy simulations than the reference run.

3.5 Border prices

Data on border prices must be provided for the base year and the reference run, by definition, for all CAPSIM products with exogenous border prices. As may be checked in Table 2.5-2, this applies to trade regimes 3, 4, 7, 8, 9, and 10. If border prices are at least available for the base year, a reasonable reference run may be performed without projection of border prices based on the assumption that border protection is fixed (regimes 5 and 11). Furthermore there is no need for border prices of non-tradable products (regime 6). In many policy simulations there is in addition no need for exogenous projections of border prices because these may be endogenous (regimes 1 and 2).

Endogenous modelling of border prices is impossible in the reference run because the required parameters $\phi_{NETTRD,i,0}$ and $\phi_{NETTRD,i,1}$ are not yet specified. It is for this reason that the cells corresponding to the rows for regimes 1 and 2 in Table 2.5-2 are empty in the reference run column. However, modelling the reference run according to the other regimes, for example with fixed border prices, will lead to simulation results for trade quantities (or border prices, depending on the item). These reference run results are subsequently used first to convert the WATSIM based net trade elasticities into slope parameters $\phi_{NETTRD,i,1}$ and then into constants $\phi_{NETTRD,i,0}$ which calibrate to the reference run result. It has been checked that the reference run repeated as a policy simulation with appropriate regrouping of items to trade regimes 1 and 2 and parameters $\phi_{NETTRD,i,0}$ and $\phi_{NETTRD,i,1}$ fixed to their calibrated values would indeed reproduce the reference run result. The essence of this procedure may be summarised as in section 3.2.6 above: the exogenous assumptions (on border prices and sometimes net trade quantities) will be translated into parameters which are held fixed in all policy simulations related to this reference run.

To permit the use of data from different sources, possibly differing in price levels from the CAPSIM database, we introduced world market prices for the base year as the ratio of the border price over the EU price, that is in the form of a reciprocal protection coefficient. These coefficients are currently calculated based on unit values, which have been computed from FAO data. In many cases however, these unit values have not been copied directly from FAO but over the WATSIM database. This means that some checking and some transformations are already incorporated in them. Prices for the projection year are introduced as world market price change relative to the base in index form. They are currently based on FAPRI projections (FAPRI 2002) as presented in Table 3.5-1.

If no border price was available for the base year ("na" entry in column 1) it was usually assumed that the border price equals the EU price, given that these are mostly unimportant cases, except for durum wheat and veal. For those it has been assumed that the price ratios shown in Table 3.5-1 for soft wheat and beef apply to the aggregates of durum + soft wheat and veal + beef and that the ratios of border prices equal those of EU prices.

Nominally constant prices are assumed in CAPSIM if exogenous inputs are needed but no information is given, except for members of set FXPW (regimes 8 and 9) where it is assumed instead that border prices change as those of soft wheat. However, note that in regimes 5 and 11 the border price may be computed from EU prices assuming a fixed border protection (e.g. for vegetables)

Table 3.5-1: Assumptions on border prices and border price changes in CAPSIM

Item	Border price in % of EU price in 1997/99	Border price change 2009-1998
SWHE	93%	11%
DWHE	na	na
BARL	81%	15%
MAIZ	88%	11%
OCER	75%	13%
PULS	100%	7%
POTA	100%	7%
RAPE	100%	0%
SUNF	100%	8%
SOTH	100%	1%
OLIV	45%	na
TIND	na	na
VEGE	69%	na
FRUI	67%	na
WINE	100%	na
OCRO	na	na
BEEF	69%	4%
VEAL	na	na
PORK	94%	15%
SGMT	82%	na
EGGS	95%	na
POUM	81%	7%
OANI	na	na
RICE	77%	-6%
MOLA	97%	7%
STAR	na	na
SUGA	34%	4%
RAPO	100%	7%
SUNO	100%	3%
SOYO	100%	-2%
OLIO	100%	na
RAPC	100%	18%
SUNC	100%	43%
SOYC	100%	14%
BUTT	54%	20%
SMIP	73%	15%
CHES	52%	20%
OMPR	52%	20%

3.6 Expert data

As stated in section 3.1 expert data input is possible for

- Yields
- Exogenous activity levels, input demands, consumer demands
- Total final consumption expenditure and inflation
- Set aside and non-food areas
- Net trade quantities

Indispensable input is only total final consumption expenditure (or GDP growth) and the inflation rate, which is usually included in DG Agri's "Prospects" publication of the current year. This information will be inherited to the policy simulations compared with the reference run if agriculture is assumed to have a negligible impact on the overall economy in the EU.

In other cases expert information may be used to overwrite a default specification which is judged inappropriate. This holds evidently for yields but also for the activity levels for sets FXACT and REF_A_L0 (see section 3.2.6). However, expert input may also replace endogenous projections for activity levels ($\not\subseteq$ FXACT $\cup$ REF_A_L0), input demands, and consumer demands. If an exogenous projection is provided, the variable will be fixed and the constant parameter $\alpha_{m,s,0}$ (or the commitment parameter $\delta_{m,u}$) will be rendered variable, otherwise the behavioural equation would be infeasible. The constant parameter will assume exactly that value which, together with all other exogenous and endogenous price variables, gives the exogenous forecast as a result of the behavioural function now. This option has been used in the current reference run, for example to impose the DG Agri durum wheat forecast, which incorporated information on recent developments. Another example is feed demand for other cereals, which appeared grossly exaggerated in the initial simulations[35]. A similar approach has also been used for consumer demand where the commitment parameters are turned into variables in case of exogenous forecasts. This option has been used to impose consumer demand projections for major cereals, meats and milk products from DG Agri which were deemed better informed than our standard result. An attractive property of the functional forms on the supply (NQ) and demand side (GL) is that neither symmetry, nor homogeneity or curvature is affected by these changes. Given that the current representations of set aside and non-food production in equations (75) and (76) are grossly simplified it may be recommended to specify exogenous forecast of set aside and non-food areas which incorporate their expected response to the given the scenario.

Expert information for yields, activity levels, input demands, consumer demands, final consumption expenditure and inflation is all specified as the average yearly geometric growth rate $\underline{GRATE}_{m,j,i}$ from the base year (currently 1998) to the simulation year, either as a general rate applicable to all EU Member States (MS) or as a projection specific for MS.

$$DATA_{m,j,i,t} = \beta_{m,j,i} \cdot [1 + \underline{GRATE}_{m,j,i}]^{(t-bas)} \quad (143)$$

[35] This may be difficult to avoid at the current level of disaggregation, which lumps together oats, rye, paddy and other cereals.

where

$DATA_{m,j,i,t}$ = Projection value of data matrix element j,i for Member state m and year t

$\underline{GRATE}_{m,j,i}$ = Average geometric growth rate for data matrix element j,i for Member state m and horizon (t-bas)

$\beta_{m,j,i}$ = Base year value of data matrix element j,i for Member state m

This growth rate input is expected to minimise the errors due to different units in CAPSIM and in the users own database.

Finally there is the option to supply exogenous projections for net trade quantities. An exogenous input is only required if the item should be modelled according to trade regimes 3 to 7 *and* if the default assumption for net trade (= base year value) is considered inappropriate. Providing a value for exogenous net rate is thus no necessity but it may turn out a useful option if the net rate results appear unrealistic otherwise useful.

Expert information for net trade is specified as the average yearly *arithmetic* growth rate $\underline{GNET}_{j,i}$ from the base year (currently 1998) to the simulation year, to permit a change in sign for net trade:

$$NETTRD_{i,t} = \beta_{NETTRD,i} \cdot [1 + \underline{GNET}_i *(t\text{-}bas)] \quad (144)$$

where

$NETTRD_{i,t}$ = Projection for net trade of item i in year t

$\underline{GNET}_i$ = Average arithmetic growth rate for net trade of item i over horizon (t-bas)

$\beta_{NETTRD,i}$ = Base year net trade of item i

Remember that it is possible to impose both a border price *and* a certain net trade in the reference run, if some other parameter related to net trade is rendered variable, and for the relevant cases (POTA, VEAL, PORK, POUM) we chose to use the constants of related activity levels, as if we liked to impose a certain activity level projection. Note that this is not possible if the constant has been "used" already for the implementation of an exogenous forecast for the activity level (DWHE case). This example also shows that a "reasonable" specification of exogenous inputs is by no means a trivial task, even though Appendix II: User Manual tries to alert the user for many pitfalls.

4. Model output

4.1 Standard CAPSIM tables

The results of a model run are stored in standard CAPSIM tables of the same structure as the input data of the base year (see sections 8.1 and 8.2). Each table is complete and consistent for the projection year (in the sense of section 3.2.1). The EU-aggregate is calculated and stored in a similar structured table as those for Member States. Output occurs in 3 technical forms:

- A CSV-file, which can be loaded into Excel.
- A GAMS-format file for export to the GSE interface
- A sequential SDA-file to store the model results by FORTRAN in a TAB-file

4.2 Selective output tables

Experience with CAPSIM has shown that an efficient check of a simulation should start with certain summary results the overall market picture and then move on to the components of the market balances and their determinants. This led to the preparation of selective output tables for potentially interesting variables to be displayed in the GAMS listing which is routinely checked after each simulation. The same tables are available through the GSE use surface but lacking an up to date version of GSE, the following tables are based on the CAPSIM listing. The variables can be checked for all items/activities and all MS and the EU aggregate, but below we will confine ourselves usually to the EU level and particularly interesting items.

Overall market picture (SUP, DEM, NET)

This table brings together supply (SUP), demand (DEM) and excess supply (NET= NETTRD+ITS) and will usually be the first table to check. Table 2.1-5 presented above is based on the same parameter, but here we will look at the results for milk products.

Table 4.2-1: Overall market picture on EU markets [1000 t] for milk products in a CAPSIM reference run for 2009 ("Y") and in the base year ("BAS")

	PARAMETER	overall				
	sup.bas	sup.y	dem.bas	dem.y	net.bas	net.y
EU000.COMI	121941	125371	121941	125371	0	0
EU000.BUTT	1888	1892	1884	1846	4	46
EU000.SMIP	1109	938	1021	977	89	-39
EU000.CHES	6635	6939	6379	6939	256	0
EU000.OMPR	43686	45065	42666	45065	1021	0

The increase in milk production COMI is caused by the 2.7% increase in the quota against our base period which is itself due to the last increase in Agenda 2000 and minor earlier changes. Human consumption of milk products is rising according to exogenous assumptions (leaning towards the DG Agri "Prospects"), because this is a reference run result. Net trade for cheese CHES and other milk products OMPR has been assumed to decline exogenously to zero (regime 7). Otherwise the balances on milk fat and protein would have triggered higher imports of butter and skimmed milk powder (in regime 9), if supply of milk fat and protein is essentially determined by the rise in the quotas.

Before moving on to further investigation of a simulation it will be wise to check parameters "ITSlst" and "VIOlst". The former displays any intervention activity ITS_i that would usually trigger an reconsideration of a certain scenario. The latter gives any violation of WTO limits $XQTVIO_i$ that would equally require a change in policy. Both parameters are zero in the reference run and will not be displayed here, but small violations of WTO limits occur in the milk liberalisation scenario discussed below, which would have to be re-specified for this reason (and others, see below).

Production (PRD)

Total production is identical to supply from the previous table.

Table 4.2-2: Production in the EU [1000 t] of selected items in a CAPSIM reference run for 2009 ("Y") and in the base year ("BAS") with deviations ("DEV")

PARAMETER	prdlst		
	BAS	Y	DEV
EU000.BARL	52372	51796	-0.011
EU000.MAIZ	37644	44304	0.177
EU000.COMI	121941	125371	0.028
EU000.BEEF	7020	6933	-0.012
EU000.VEAL	788	728	-0.076
EU000.BUTT	1888	1892	0.002
EU000.SMIP	1109	938	-0.154
EU000.CHES	6635	6939	0.046
EU000.OMPR	43686	45065	0.032

Table 4.2-2 is thus only useful to reduce an overload of information, but is does not add anything to the supply side from the overall market picture.

Activity levels (LVL)

According to equation (1) production equals yields times activity levels for agricultural (raw) products. In policy simulations yields are the same as in the reference run, but in a comparison with the base year it may be interesting to check whether changes in production may be traced back to changes in activity levels or to yield growth:

Looking at the coarse grains BARL and MAIZ we may conclude that the marked differences in the change of production (see Table 4.2-2) must be mainly due to differences in assumed yield growth, because the change in activity levels differs only by 5 percentage points on the EU level. Looking at activity levels in the cattle sector we see that the dairy herd would decline in spite of increasing milk production. Furthermore marked shifts are to be expected between single activities. Finally it is evident that results for single Member States may differ considerably from the EU level.

Table 4.2-3: Selected activity levels in Germany and in the EU [1000 ha or hd] in a CAPSIM reference run for 2009 ("Y") and in the base year ("BAS") with deviations ("DEV")

PARAMETER	lvllst		
	BAS	Y	DEV
DE000.BARL	2220	2168	-0.024
DE000.MAIZ	360	365	0.015
DE000.DCOW	4925	4056	-0.176
DE000.SCOW	735	895	0.219
DE000.BULF	2024	1998	-0.013
DE000.HEIF	814	739	-0.091
DE000.CAMF	629	343	-0.455
DE000.CAFF	228	232	0.018
EU000.BARL	11362	10785	-0.051
EU000.MAIZ	4206	4239	0.008
EU000.DCOW	21491	18323	-0.147
EU000.SCOW	11783	12816	0.088
EU000.BULF	11017	10639	-0.034
EU000.HEIF	4724	4337	-0.082
EU000.CAMF	3810	3230	-0.152
EU000.CAFF	2227	2271	0.019

Revenues (REV and NREV)

Gross and net revenues are displayed in the same table. For crops the difference is due to land costs, for animals the difference is due to energy and protein costs. For fattening activities in the cattle sector the "gross" revenues are already net of the cost for calves, because they are handled with negative yields in equation (74). As activity levels are driven by net (shadow) prices it is interesting to check whether the own net (shadow) revenues are sufficient to explain the changes in Table 4.2-3 above. Because the revenues are not yet aggregated to the EU average at the time they are displayed, we will only show the results for Germany.

The stronger increase in the net revenue of maize clearly explains why maize is expanding relative to barley. It may appear surprising that the difference is not greater but this is because net revenues of all cereals are increasing simultaneously, even though to a different extent.

Table 4.2-4: Selected gross and net revenues in Germany [€/ha or €/hd] in a CAPSIM reference run for 2009 ("Y") and in the base year ("BAS") with deviations ("DEV")

PARAMETER	srevlst					
	gross.bas	gross.y	gross.dev	net.bas	net.y	net.dev
DE000.BARL	908	938	0.032	789	843	0.069
DE000.MAIZ	1371	1555	0.134	1198	1418	0.184
DE000.DCOW	1908	2304	0.207	1111	1111	
DE000.SCOW	356	436	0.225	86	171	0.996
DE000.BULF	816	734	-0.1	728	641	-0.119
DE000.HEIF	540	479	-0.112	346	272	-0.212
DE000.CAMF	94	11	-0.887	75	-11	-1.145
DE000.CAFF	97	66	-0.313	77	44	-0.426

In the cattle sector it has to be explained that the constancy of the shadow net revenue of dairy is an assumption made for the parameter adjustments in the reference run[36]. Net revenues of suckler cows are increasing strongly because the decline in the dairy herd causes calves prices to rise (see Table 4.2-5 below) and this increase is stronger in Germany than on the EU average. The differing changes in "gross" revenues in fattening male (CAMF) and female (CAFF) calves suggest that these price increases are stronger for male calves, whereas male (BULF) and female (HEIF) adult cattle are apparently less affected by calves prices.

The development of gross revenues may be affected by a downward scaling of premiums. The corresponding factors $PREMFAC_{m,j}$ and $PRETFAC_{m,j}$, see equation (74) are displayed on another parameter "PFACTlst" which is omitted here.

Prices (PP, FP, CP, NP, UMA_P)

Because CAPSIM distinguishes producer prices (PP), feed prices (FP), net feed prices (NP) and consumer prices (CP), this table collects all these prices and highlights their differences. Furthermore the unit margin in processing of each product (UMA) is displayed.

EU prices of barley are declining stronger under Agenda 2000 than prices for maize because initial support was higher (Table 3.5-1). National producer prices follow proportionally according to equation (85), which adds to above average yield growth for maize to explain the relatively favourable development of maize revenues in Table 4.2-4.

EU BEEF prices are assumed to fall according to the drop in administrative prices (Regime 9) whereas support for VEAL prices is assumed to be maintained partly (Regime 4). Calves prices (YCAM, YCAF) are strongly rising in Germany, in particular for male calves' YCAM, as mentioned above, to maintain the equilibrium on the calves market. Because there is already some scarcity of milk protein and imports of skimmed milk powder SMIP (see Table 4.2-1), it is assumed that from the official drop of the intervention prices for skimmed milk powder of 15% only 7.5% would be effective on markets such that the administrative price has been cut less than for butter. This determines EU and national producer prices for butter and skimmed milk powder. Note that this was an ad hoc answer to a weakness of the current trade representation, which might be handled explicitly with a gross trade specification. Looking finally at producer prices for cheese (CHES) and other milk products (OMPR) we see that they would follow those of the intervention products only partly, because domestic demand is growing significantly.

[36] Otherwise the increase in the quotas would have triggered an increase in the shadow revenue and a decrease in the quota rent. Because this mechanical result would neglect the increase in milk yield, it was considered preferable to assume a constant net revenue.

Table 4.2-5: Selected producer prices (P), feed prices (F), net feed prices (N), consumer prices (D), and unit margins (M) in Germany [€/t] in a CAPSIM reference run for 2009 ("Y") and in the base year ("BAS") with deviations ("DEV")

PARAMETER plst	P.bas	P.y	P.dev	F.bas	F.y	F.dev	N.bas	N.y	N.dev	D.bas	D.y	D.dev	M.bas	M.y	M.dev
DE000.BARL	105	98	-0.068	121	113	-0.068	27	25	-0.059	2870	3281	0.143			
DE000.MAIZ	124	121	-0.021	144	140	-0.021	43	48	0.121	2888	3408	0.18			
DE000.COMI	289	257	-0.108	334	298	-0.108	309	274	-0.114	451	420	-0.069	-20	-20	0.002
DE000.BEEF	2319	1855	-0.2							5031	4621	-0.081			
DE000.VEAL	2373	2260	-0.047							5084	4986	-0.019			
DE000.YCAM	78	197	1.522												
DE000.YCAF	78	144	0.838												
DE000.BUTT	3478	2956	-0.15							3989	3439	-0.138	530	512	-0.033
DE000.SMIP	2059	1905	-0.075	2383	2204	-0.075	2209	2012	-0.089	3193	3057	-0.043	233	169	-0.276
DE000.CHES	3606	3503	-0.029							6157	6151	-0.001	1228	1294	0.054
DE000.OMPR	699	672	-0.039							1078	1078	8.37E-04	433	439	0.013
EU000.BARL	110	103	-0.068												
EU000.MAIZ	121	118	-0.021												
EU000.BEEF	2929	2343	-0.2												
EU000.VEAL	3125	2977	-0.047												
EU000.BUTT	3758	3194	-0.15												
EU000.SMIP	2092	1935	-0.075												
EU000.CHES	4710	4558	-0.032												
EU000.OMPR	829	799	-0.036												
WO000.BARL	90	103	0.145												
WO000.MAIZ	107	118	0.107												
WO000.BEEF	2019	2321	0.15												
WO000.VEAL	2154	2477	0.15												
WO000.BUTT	2040	2445	0.199												
WO000.SMIP	1524	1753	0.15												
WO000.CHES	2430	2908	0.197												
WO000.OMPR	427	512	0.198												

Changes in net feed prices are seen to be different in sign for barley (BARL) and maize (MAIZ). This is caused by a decrease in the value of nutrients in Germany. With constant nutrient prices, net feed prices would decrease for both coarse grains, somewhat stronger than the corresponding gross feed prices. Constant nutrient prices would imply, however, a feed supply in Germany which exceeds energy requirements, see Table 2.1-4. A decrease in the energy price (which dominates the simultaneous increase in the protein price for coarse grains) stimulates animal production and discourages energy rich feed use to restore the balance[37]. This correction moderates the decline in the net feed price of barley and brings about a clear *increase* in the net feed price of maize whereas both gross feed prices are declining, even though differently.

Consumer prices are declining less or may even increase, because there are significant margins which are partly increasing according to exogenous trends (see the example of coarse grains). The margins shown in Table 4.2.-5 are those in the processing industry, here in the dairy industry. They are declining for skimmed milk powder, because production is an increasing function of (endogenous) margins and production of skimmed milk powder goes down in the reference run.

Note finally that the border price changes are determined by the exogenous assumptions in Table 3.5-1 because this is a reference run.

Prices of scarce resources

The prices of resources land, feed energy, feed protein, milk fat, and milk protein are also displayed:

Table 4.2-6: Prices of resources in Germany [€/t] in a CAPSIM reference run for 2009 ("Y") and in the base year ("BAS") with deviations ("DEV")

PARAMETER		PResourceLst	
	BAS	Y	DEV
DE000.ENNE	9.3	6.8	-0.263
DE000.CRPR	280.6	389.5	0.388
DE000.FAT	3559.4	2950.7	-0.171
DE000.PRT	4958.0	4732.8	-0.045
DE000.LND	148.0	117.3	-0.207

Human consumption (CNS)

For human consumption it will be sufficient to look at milk products to give an example for this kind of output. Note that the changes are exogenously specified because this is a reference run. The commitments of demand functions are rendered variables instead to adjust them in line with these settings.

37 The nutrient balances are displayed on a parameter "EBALLlst" as in Table 2.1-4 above.

Table 4.2-7: Human consumption in the EU [1000 t] of milk products in a CAPSIM reference run for 2009 (“Y”) and in the base year (“BAS”) with deviations (“DEV”)

	PARAMETER	cnslst	
	BAS	Y	DEV
EU000.BUTT	1795	1737	-0.033
EU000.SMIP	393	331	-0.158
EU000.CHES	6185	6752	0.092
EU000.OMPR	42496	44893	0.056

Input demand (INP)

For other items feed demand is more important than consumer demand. Non feed inputs are only plant related inputs (IPLA) and general inputs (IGEN), apart from the residual factor aggregate which is not covered explicitly. For illustration only barley and maize are shown.

Table 4.2-8: Input demand in Germany and in the EU [1000 t] of coarse grains and raw milk in a CAPSIM reference run for 2009 (“Y”) and in the base year (“BAS”) with deviations (“DEV”)

	PARAMETER	inplst	
	BAS	Y	DEV
DE000.BARL	7269	8052	0.108
DE000.MAIZ	2461	2364	-0.039
DE000.COMI	1355	1629	0.202
EU000.BARL	32017	39360	0.229
EU000.MAIZ	30832	29850	-0.032
EU000.COMI	4255	4886	0.148

The changes are opposite in sign for the coarse grains because net feed price is also changing differently, see above. The differences are ultimately going back to the different levels of initial support for these cereals. Direct feed use of cow milk is expected to increase with declining (net) feed prices, but these are nonetheless tiny quantities.

Processing to secondary products (PRC)

This is the third component of demand, which may be dominating for certain items, such as raw milk. The bulk of raw milk (COMI) is processed in dairies such that processing of raw milk closely follows production. Small quantities of processed milk products (BUTT, SMIP, CHES, OMPR) are again used as inputs for further processing. These quantities have been assumed constant such that the deviation to BAS is zero.

Table 4.2-9: Processing of milk products in the EU [1000 t] in a CAPSIM reference run for 2009 ("Y") and in the base year ("BAS") with deviations ("DEV")

	PARAMETER	prclst	
	BAS	Y	DEV
EU000.COMI	114210	116861	0.023
EU000.BUTT	30	30	
EU000.SMIP	11	11	
EU000.CHES	180	180	
EU000.OMPR	7	7	

Industrial use (IND)

Data for industrial use on market are exogenous trend projections because this is usually only a minor component of demand. Its importance is highest for barley where it attains about 15% of total demand due to the brewery sector, see Table 4.3-4 below.

Table 4.2-10: Industrial use of selected items in the EU [1000 t] in a CAPSIM reference run for 2009 ("Y") and in the base year ("BAS") with deviations ("DEV")

	PARAMETER	indlst	
	BAS	Y	DEV
EU000.SWHE	3619	4306	0.19
EU000.BARL	7639	8006	0.048
EU000.MAIZ	3352	3869	0.154

Linked use (LNK)

Seed use and losses are simply related to production, see equation (96), such that this component of demand is predominantly included here for the sake of completeness.

Table 4.2-11: Use linked to production of selected items in the EU [1000 t] in a CAPSIM reference run for 2009 ("Y") and in the base year ("BAS") with deviations ("DEV")

	PARAMETER	lnklst	
	BAS	Y	DEV
EU000.SWHE	3677	4094	0.113
EU000.BARL	2680	2645	-0.013
EU000.MAIZ	727	839	0.153

Total welfare effects

After a look at the allocative results it would be interesting to investigate the welfare changes following from a policy simulation. As an example we will use an abolishment of milk quotas and intervention prices for butter and skimmed milk powder. The premiums, including the dairy premium, have been maintained in the same amounts as in the Agenda 2000 reference run. The market effects of this simulation are not discussed her, but some of them will be supplemented in the next section 4.3. On the other hand it would have been confusing to omit the discussion of reference run results above and jump immediately to the policy simulation.

However, this section is only meant to illustrate the kind of output available from CAPSIM in general rather than giving an in depth interpretation of particular simulations. Consequently we may look at the welfare tables here without a detailed prior analysis of the allocative effects from the milk scenario.

A summary table gives the welfare impacts compared to the reference run for Member States and for the EU.

Table 4.2-12: Welfare effects of a milk liberalisation scenario in the EU [Million €] compared to an Agenda 2000 reference run for 2009

PARAMETER WELFLst

	AGR	PRC	CNS	FEO	TOT
BL000	-263.9	42.8	185.8	11.2	-24.2
DK000	-272.3	45.9	96.9	5.3	-124.2
DE000	-1363.1	213.0	1202.7	65.0	117.6
EL000	-195.3	-13.7	176.0	4.3	-28.7
ES000	-411.8	44.9	381.2	20.5	34.8
FR000	-1438.5	-8.6	1361.1	44.5	-41.5
IR000	-237.7	69.6	63.2	3.7	-101.3
IT000	-816.9	39.7	872.5	34.7	129.9
NL000	-484.5	135.6	318.2	17.3	-13.3
AT000	-94.4	-33.9	141.1	6.7	19.4
PT000	-83.8	-1.1	98.4	4.0	17.6
FI000	-116.6	-2.1	113.4	4.0	-1.3
SE000	-190.3	51.3	148.5	7.2	16.7
UK000	-895.6	334.9	733.8	38.1	211.2
EU000	-6865.0	918.4	5892.9	266.5	212.8

The drop in butter and skimmed milk powder prices causes raw milk prices to decline as well (by 20%) which is the evident reason of sizeable agricultural income losses (AGR). This is only partly moderated by the abolishment of milk quotas, which leads to an increase in milk production in most Member States, because quota rents and border price developments have been assumed quite favourable.

Processing industry profit (PRC) is increasing in most Member States because production of milk products and processing of cow milk is increasing. This requires a small increase in processing margins which benefits the industry. Declining processing industry profits are usually occurring in Member State with reduced processing of cow milk (or sheep milk) but this is not typical in this scenario.

The gains for consumers (CNS) and for taxpayers (FEO) will be expected in this policy simulation. It is interesting to note that the balance for single Member State may be quite heterogeneous. It will mainly depend on the national production and consumption structure together with the shares in financing the EU budget. Policy relevant simulations may involve therefore compensatory elements, which are ignored in this hypothetical simulation.

EAA values at producer prices (EAA)

Additional tables[38] permit to disaggregate the major welfare components.

Table 4.2-13: Selected contributions to NVAF of EU agriculture [Million €] in a CAPSIM reference run for 2009 ("REF") , in the base year ("BAS"), and in a milk liberalisation scenario

PARAMETER EAAlst	BAS	Y	REF
EU000.COMI	36353	26966	32321
EU000.BEEF	20562	16385	16246
EU000.TOOU	250589	266917	272233
EU000.TOIN	130822	147082	145424
EU000.GVAD	119767	119835	126809
EU000.NVAF	117518	121992	128857

It is evident that the loss of income originates in the milk sector in this policy simulation. Other products are less affected, even if they are related to milk such as beef.

Processing industry income

The next table shows the important contributions from the dairy industry to the total income effect in the processing industries, using Germany as an example.

The "DMARG" rows show there give the pure revenue effect of the scenario (unit margin times quantity) whereas "DPROF" is the income effect obtained from an integration along the behavioural functions, see section 2.6.3. As has been explained above the margins of secondary milk products have to increase if their production is increasing in Germany. The margin of cow milk is negative because the processing industry is expected to pay less to farmers than the internal value of fat and protein. To stimulate an increased processing of cow milk this (negative) margin has to decrease a bit further which increases the profit of dairies. For sheep and goat milk the changes have opposite sign but are quite insignificant in magnitude.

38 Note that the REF column of parameter "EAAlst" in Table 4.2-13 is not displayed by default in the GAMS listing of the milk liberalisation scenario. It has been added from the listing of the reference run to permit a comparison. Tables with three (and more) scenarios may be compiled using the GSE surface and they are offered in the integrative output tables, see section 4.3.

Table 4.2-14: Selected contributions to the change in processing industry profit [DPROF: Million €], changes in total margin [DMARG: Million €] and unit processing margins [UMA: €/t] in a milk liberalisation scenario in Germany

PARAMETER DPROFLst	Y	REF
COMI.DPROF	6.9	
COMI.DMARG	27.1	
COMI.UMA	-20.2	-19.9
SGMI.DPROF	-0.3	
SGMI.DMARG	-0.5	
SGMI.UMA	-175.1	-185.1
BUTT.DPROF	7.7	
BUTT.DMARG	31.3	
BUTT.UMA	550.6	512.5
SMIP.DPROF	0.0	
SMIP.DMARG	2.0	
SMIP.UMA	174.0	168.8
CHES.DPROF	111.1	
CHES.DMARG	228.6	
CHES.UMA	1362.6	1293.9
OMPR.DPROF	86.4	
OMPR.DMARG	121.9	
OMPR.UMA	446.7	438.6
GVAD.DMARG	412.9	
NVAF.DPROF	213.0	

Equivalent variation (EV)

The next table shows that the total welfare gain for consumers (TOOU.EV) is mainly stemming from milk products, using Germany as an example.

Table 4.2-15: Selected contributions to the equivalent variation [EV: Million €], selected consumer prices [UVAD: €/t] and expenditure [EXPD: Million €] of a milk liberalisation scenario in Germany

PARAMETER EVlst	Y	REF
BUTT.UVAD	2857.0	3438.6
BUTT.EXPD	1698.0	1873.7
BUTT.EV	331.6	
SMIP.UVAD	2841.6	3057.0
SMIP.EXPD	83.7	90.0
SMIP.EV	6.3	
CHES.UVAD	5903.6	6150.6
CHES.EXPD	10353.4	10614.8
CHES.EV	429.4	
OMPR.UVAD	1042.5	1078.5
OMPR.EXPD	9408.2	9612.4
OMPR.EV	321.4	
TOOU.EV	1202.7	

FEOGA impacts

Finally we may look in detail at the budgetary impacts[39]. The premiums to activities have been allocated according to their main output to single items.

Total endogenous FEOGA expenditure would increase in the reference run mainly due to the additional premiums in the cattle sector. The reference run results also reveal certain limitations of the current calculations on refunds: With net trade of cheese and other milk products assumed to decrease to zero according to Table 4.2-1 we might have expected a stronger decline of estimated expenditure (mainly refunds) on these items. However in this case we are estimating subsidised exports from estimated gross exports (including the intra trade) according to option 3 in equation (109) which hardly changes at all. This illustrates once more the need for improvements in modelling trade.

The milk liberalisation scenario reduces refunds for butter and skimmed milk powder to zero, but the estimate for depreciation of intervention stocks DEP_i currently includes a constant term which does not vanish even with a zero price difference, see equation (110). This estimate may be reconsidered. Refunds on cheese and other milk products are not completely eliminated because the drop in butter and skimmed milk powder prices drives down their prices as well (-9% for CHES, -6% for OMPR), but not down to the border price level, which had been estimated quite low in Table 3.5-1. This may be another indication of the milk market specification being not entirely satisfactory[40]. The total budget effect from Table 4.2-16 above is calculated from the difference in the total FEOGA line LEVL and the line TAXO showing the sugar levies. To obtain the impacts by Member States this total impact is allocated using the shares of Member States in financing the total EU budget, as explained above. Finally it should be mentioned that flexible levies and sugar levies are also displayed per ton on corresponding parameters (FLEVlst for $FLEV_i$, LEVYlst for ALEVY, BLEVY). Given their limited interest in this simulation they will not be reproduced here.

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39 Note that the REF column of parameter "FEOGlst" in Table 4.2-16 is not displayed by default in the GAMS listing of the milk liberalisation scenario. It has been added from the listing of the refrence run to permit a comparison. Tables with three (and more) scenarios may be compiled using the GSE surface and they are offered in the integrative output tables, see section 4.3.

40 It might have been possible to obtain more convincing budget impacts with some finetuning of exogenous assumptions, for example on border prices and exogenous net trade of CHES and OMPR. However, the milk simulation was undertaken here mainly to illustrate the simulation capacities and output options of CAPSIM. In a specific milk study, it would be considered an intermediate result, which has to be improved.

Table 4.2-16: FEOGA expenditure [Million €] in the base year ("BAS"), in a milk liberalisation scenario ("Y"), and in an Agenda 2000 reference run ("REF")

PARAMETER FEOGlst	BAS	Y	REF
SWHE	3568	3714	3717
DWHE	1811	1935	1936
BARL	3072	3069	3072
MAIZ	953	1128	1129
OCER	1481	1419	1422
PULS	597	536	536
RAPE	1240	965	966
SUNF	932	613	614
SOTH	391	205	205
MAIF	871	967	971
GRAS	1278	2050	2050
COMI		3250	3105
BEEF	4014	6640	6631
VEAL	113	285	281
PORK	141	143	141
SGMT	1258	1235	1254
EGGS	19	22	21
POUM	80	76	75
RICE	95	89	89
SUGA	1547	1506	1503
BUTT	505	31	240
SMIP	441	89	188
CHES	203	113	140
OMPR	783	440	499
OOUT	14375	14375	14375
LEVL	39766	44895	45158
TAXO	733	762	758

Note: See the list at the end of this documentation for the meaning of the item codes in CAPSIM.

4.3 Integrative output tables

The output discussed in section 4.2 has its merits but it is very limited in the number of variable displayed in each table (at most 3). This is almost unavoidable if we want to present tables for all items and all MS. In we confine ourselves to single regions and even single items we may compile small tables collecting both the relevant variables and their determinants in small "integrative" output tables. Mainly for historical reasons these tables have been developed in Excel with the help of certain macros. This section will show how to read and interpret the integrative output tables, even though a lot of this information has been presented in different form already in section 4.2.

Activity levels

This table gives activity levels together with a break down of the activity net revenue. Line DCOW.COMI in Table 4.3-1 shows that milk yields are expected to increase by 20% from the 1998 base year to the 2009 reference situation. In the same way the lines DCOW.BEEF, DCOW.YCAM, DCOW.YCAF indicate that yields of DCOW in terms of beef, male calves and female calves (lower due to the own requirements for replacement) are not expected to change significantly. The small increse of DCOW.COMI in the simulation is a pure aggregation effect, because yields are assume exogenous at the Member State level, compare Table 4.3-2 below. Aggregation effects also affect the prices indicated in the EU table (UVAP lines). To avoid confusion, the excel table gives the following warning at the top of the sheet:

"Note that the manually "calculated GREV" will differ from the GREV position in the tables, if this the EU table and if the activity has outputs which are also produced by other activities. For example DCOW, SCOW, BULF, HEIF all produce BEEF. The EU average BEEF price for BULF should be weighted with MS BEEF production by BULF whereas the EU average BEEF price for HEIF should use BEEF production by HEIF as weights. As these weights will differ, there is an aggregation error if we use the overall EU average price of BEEF (from DCOW, SCOW, HEIF, and BULF) to calculate the EU average GREV of an activity. These aggregation effects should be absent from MS tables.
Finally note that the calculated NREV will differ from the NREV in the table if NREV is a true shadow revenue (applies to fixed activities or milk quotas)."

These aggregation effects are visible in the EU GREV lines, even though they are quite mild for DCOW (in contrast to CAMF, for example).

Table 4.3-1: Activity levels and components of net revenue for dairy cows in the EU, base year ("BAS"), milk liberalisation scenario ("Y"), and reference run ("REF")

Activity levels and intermediate variables
Activity : DCOW

	BAS	REF	REF-BAS	SIM	SIM-REF
DCOW.COMI	5673.95	6842.41	20.6%	6853.22	0.2%
UVAP.COMI	298.12	257.80	-13.5%	205.54	-20.3%
DCOW.BEEF	71.41	76.10	6.6%	76.55	0.6%
UVAP.BEEF	2928.86	2343.32	-20.0%	2341.26	-0.1%
DCOW.YCAF	175.28	176.06	0.4%	175.23	-0.5%
UVAP.YCAF	146.87	187.87	27.9%	151.79	-19.2%
DCOW.YCAM	444.56	444.52	0.0%	444.75	0.1%
UVAP.YCAM	142.90	226.22	58.3%	197.35	-12.8%
DCOW.HIST	0.25	0.25	0.0%	0.25	0.0%
DCOW.EPET	0.00	98.27		98.31	0.0%
DCOW.EPEM	0.00	169.48		169.76	0.2%
DCOW total premia	0.00	194.05		194.34	0.1%
calculated GREV	1989.94	2269.98	14.1%	1896.54	-16.5%
DCOW.GREV	1980.94	2269.47	14.6%	1888.55	-16.8%
DCOW.ENEC	290.28	215.40	-25.8%	206.03	-4.4%
DCOW.PRTC	204.37	272.49	33.3%	282.28	3.6%
calculated NREV	1495.29	1782.09	19.2%	1408.23	-21.0%
DCOW.NREV	1106.49	1104.98	-0.1%	1400.24	26.7%
DCOW.LEVL	21491.35	18322.63	-14.7%	19143.16	4.5%

Table 4.3-2 below shows at the German example that calculated GREV and the table entry from the model variable $REV_{m,j}$ coincide in Member State tables.

Table 4.3-2: Activity levels and components of net revenue for dairy cows in Germany, base year (“BAS”), milk liberalisation scenario (“Y”), and reference run (“REF”)

Activity levels and intermediate variables
Activity : DCOW

	BAS	REF	REF-BAS	SIM	SIM-REF
DCOW.COMI	5777.27	7120.49	23.3%	7120.49	0.0%
UVAP.COMI	288.61	257.31	-10.8%	210.27	-18.3%
DCOW.BEEF	84.10	84.10	0.0%	84.10	0.0%
UVAP.BEEF	2318.95	1855.16	-20.0%	1855.16	0.0%
DCOW.YCAF	138.33	138.33	0.0%	138.33	0.0%
UVAP.YCAF	78.30	143.89	83.8%	116.70	-18.9%
DCOW.YCAM	449.43	449.43	0.0%	449.43	0.0%
UVAP.YCAM	78.30	197.47	152.2%	162.00	-18.0%
DCOW.HIST	0.29	0.29	0.0%	0.29	0.0%
DCOW.EPET	0.00	100.79		100.79	0.0%
DCOW.EPEM	0.00	177.16		177.16	0.0%
DCOW total premia	0.00	206.39		206.39	0.0%
calculated GREV	1908.42	2303.23	20.7%	1948.58	-15.4%
DCOW.GREV	1908.41	2303.61	20.7%	1948.92	-15.4%
DCOW.ENEC	331.27	244.21	-26.3%	242.64	-0.6%
DCOW.PRTC	230.15	319.48	38.8%	324.00	1.4%
calculated NREV	1347.00	1739.54	29.1%	1381.94	-20.6%
DCOW.NREV	1111.27	1111.28	0.0%	1382.28	24.4%
DCOW.LEVL	4925.34	4056.30	-17.6%	4218.32	4.0%

The central part of the activity tables gives the calculation of total premiums to the activity from group premiums (here slaughter premium) and historical yields and specific premiums (here: dairy premium). Historical yields for the slaughter premium are defined to be the slaughtered heads per activity level which differs between Member States according to the average service life of a dairy cow. Potential scaling of official premiums has been taken into account by defining “effective” premiums for storage and display purposes:

$$EPET_{m,j} = \underline{PRET}_{m,j} * PRETFAC_{m,j} \qquad (145)$$

$$EPEM_{m,j} = \underline{PREM}_{m,j} * PREMFAC_{m,j}$$

where

$EPET_{m,j}$ = effective premium per unit of historical yield of activity j in Member State m

$EPEM_{m,j}$ = effective specific premium per unit of activity j in Member State m

$\underline{PRET}_{m,j}$ = premiums per unit of historical yield in activity j in Member State m

$PRETFAC_{m,j}$ = scaling factor to enforce ceilings on common premiums PRET for activities j in Member State m

$\underline{PREM}_{m,j}$ = specific premiums per unit of activity j in Member State m

$PREMFAC_{m,j}$ = scaling factor to enforce ceilings on specific premiums for activities j in Member State m

It will be recognised in the tables that the milk liberalisation scenario assumes that premiums do not change compared to the Agenda 2000 reference run.

In the bottom of the tables net revenues are calculated from gross revenues. For that purpose the costs of energy ENEC and protein PRTC have to be deducted because this is an animal activity. Given the requirements of DCOW the decrease of the energy price and the increase in the protein price turn out to cancel more or less such that the nutrient costs are quite stable. The difference of this calculated net revenue NREV and the table entry for NREV is the percentage quota rent which is estimated to be about 25% on the EU average. Due to our assumption of constant shadow revenues (see footnote 36) the increase in gross revenue goes along with a further increase in quota rents (to about 38% in the EU) such that, according to this simulation, the price cuts in the milk liberalisation scenario would not deter an increase in production. In the milk liberalisation scenario market derived net revenues are still higher than the shadow revenues of the reference run such that the dairy cow herd increases (line LEVL).

Supply

The integrative supply tables show how supply is generated by different activities which may change quite differently. An illuminating example is veal.

Table 4.3-3: Supply of veal and producing fattening activities in the EU, base year ("BAS"), milk liberalisation scenario ("Y"), and reference run ("REF")

Supply from levels and yields Product: VEAL	BAS	REF	REF-BAS	SIM	SIM-REF
CAMF.VEAL	120.43	122.28	1.5%	122.58	0.2%
CAMF.LEVL	3809.93	3230.13	-15.2%	3390.87	5.0%
CAFF.VEAL	147.69	146.62	-0.7%	145.34	-0.9%
CAFF.LEVL	2227.33	2270.62	1.9%	2270.03	0.0%
GROF.VEAL	787.77	727.90	-7.6%	745.56	2.4%

As has been mentioned above, the decline in the supply of veal in the reference run is mainly due to fewer male calves being fattened. These differences between the sexes are caused by the somewhat more favourable treatment of male cattle (increased special male premium) which tends to relatively increase male calves prices.

Demand

An interesting example for the disaggregation of demand is barley which is increasing strongly in the reference run due to the increase in feed demand, see Table 4.2-8 above.

Table 4.3-4: Demand components for barley in the EU, base year ("BAS"), milk liberalisation scenario ("Y"), and reference run ("REF")

Demand and components Product : BARL					
	BAS	REF	REF-BAS	SIM	SIM-REF
UVAP.BARL	110.36	102.73	-6.9%	102.96	0.2%
UVAD.BARL	1908.90	2174.68	13.9%	2175.06	0.0%
LOSF.BARL	482.56	483.43	0.2%	482.18	-0.3%
SEDF.BARL	922.73	910.27	-1.4%	909.36	-0.1%
INTF.BARL	0.00	0.00		0.00	
STCM.BARL	110.25	0.00	-100.0%	0.00	
HCOM.BARL	110.53	115.61	4.6%	115.57	0.0%
FEDM.BARL	32016.62	39360.49	22.9%	39437.78	0.2%
SEDM.BARL	1007.24	991.19	-1.6%	989.76	-0.1%
LOSM.BARL	267.41	260.05	-2.8%	259.80	-0.1%
INDM.BARL	7639.49	8005.64	4.8%	8005.64	0.0%
PRCM.BARL	0.00	0.00		0.00	
dem .BARL	42556.83	50126.68	17.8%	50200.09	0.1%

The integrative demand table permits to analyse in detail how a given change in total demand is coming about.

Market balance

The market balance tables bring together supply and demand as Table 4.2-1 above, but they also show the estimated gross trade figures. It will be instructive to look at cheese in Germany.

Table 4.3-5: Market balance and its components for cheese in Germany, base year ("BAS"), milk liberalisation scenario ("Y"), and reference run ("REF")

Market balance Product: CHES					
	BAS	REF	REF-BAS	SIM	SIM-REF
sup .CHES	1595	1691	6.0%	1773	4.9%
dem .CHES	1646	1794	9.0%	1822	1.6%
excess supply1	-50.81	-103.35	103.4%	-48.79	-52.8%
IMPT.CHES	495.54	548.08	10.6%	493.52	-10.0%
EXPT.CHES	444.72	444.72	0.0%	444.72	0.0%
net trade.CHES	-51	-103	103.4%	-49	-52.8%
INTP.CHES	0.00	0.00		0.00	
excess supply2	-51	-103	103.4%	-49	-52.8%

In line with the assumed disappearance of cheese net exports in the reference run, excess supply at the member state level (= $NETMS_{mi}$ from equation (100) because CHES $\in$ MSBAL) also tends to decrease. The next lines show that gross trade is estimated assuming that the smaller of exports and imports remains constant and the larger changes according to the change in excess supply. This is evidently a crude estimate but without explicit modelling of gross trade it is impossible to produce a sophisticated estimate. The EU gross trade result is simply the aggregate over EU Member States. The last lines give an alternative calculation of excess supply from these gross trade estimates and public intervention purchases, if any.

Welfare effects

An integrative table with welfare effects gives more details on the EAA components than Table 4.2-12 above, but without showing all Member States at the same time. The income calculation shown in the top part follows equation (103). It reveals that all taxes and non allocated subsidies are assumed to remain at their base year levels and that depreciation is projected exogenously. The agricultural income loss is clearly seen to stem from lower market revenues in the milk liberalisation scenario. The presentation of FEOGA impacts together with the base year values shows more clearly that compared to the Agenda 2000 package this milk liberalisation scenario has a negligible budget impact because no compensation has been assumed whatsoever.

Table 4.3-6: Welfare components in the EU, base year ("BAS"), milk liberalisation scenario ("Y"), and reference run ("REF")

Sectoral income account						
	BAS	REF	REF-BAS	SIM	SIM-REF	SIM-REF
TOOU	250589	272233	8.6%	266917	-2.0%	
TOIN	130822	145424	11.2%	147082	1.1%	
GVAD	119767	126809	5.9%	119835	-5.5%	
SUBO	10957	10957	0.0%	10957	0.0%	
EAAS	25792	33914	31.5%	34023	0.3%	
TAXO	3207	3207	0.0%	3207	0.0%	
EAAT	724	724	0.0%	724	0.0%	
DEPR	35161	38988	10.9%	38988	0.0%	
NVAF	117518	128857	9.6%	121992	-5.3%	-6865
Processors						
						SIM-REF
Profit						918
Consumer welfare						
	BAS	REF	REF-BAS	SIM	SIM-REF	SIM-REF
EXPD	509076	607486	19.3%	602527	-0.8%	
EQUV						5893
FEOGA expenditure						
	BAS	REF	REF-BAS	SIM	SIM-REF	SIM-REF
Gross	39727	45158	13.7%	44895	-0.6%	-262
Levies	732	758	3.5%	762	0.5%	4
Net	38994	44400	13.9%	44133	-0.6%	-267
Welfare						
						SIM-REF
						213

5. Software

As mentioned in the introduction CAPSIM relies technically on the GAMS software, more precisely distribution 20.05. Model solver is CONOPT3. The CAPSIM software is a package of GAMS-programs, which are necessary for input preparation, model simulations, and processing of output.

It has been mentioned frequently that a special user surface has been developed at the LEI for CAPSIM under the heading "GAMS Simulation Environment" (GSE). Its capabilities are described in the corresponding documentation for GSE, but this section will include cross-references to this user surface, where appropriate.

5.1 Core model software

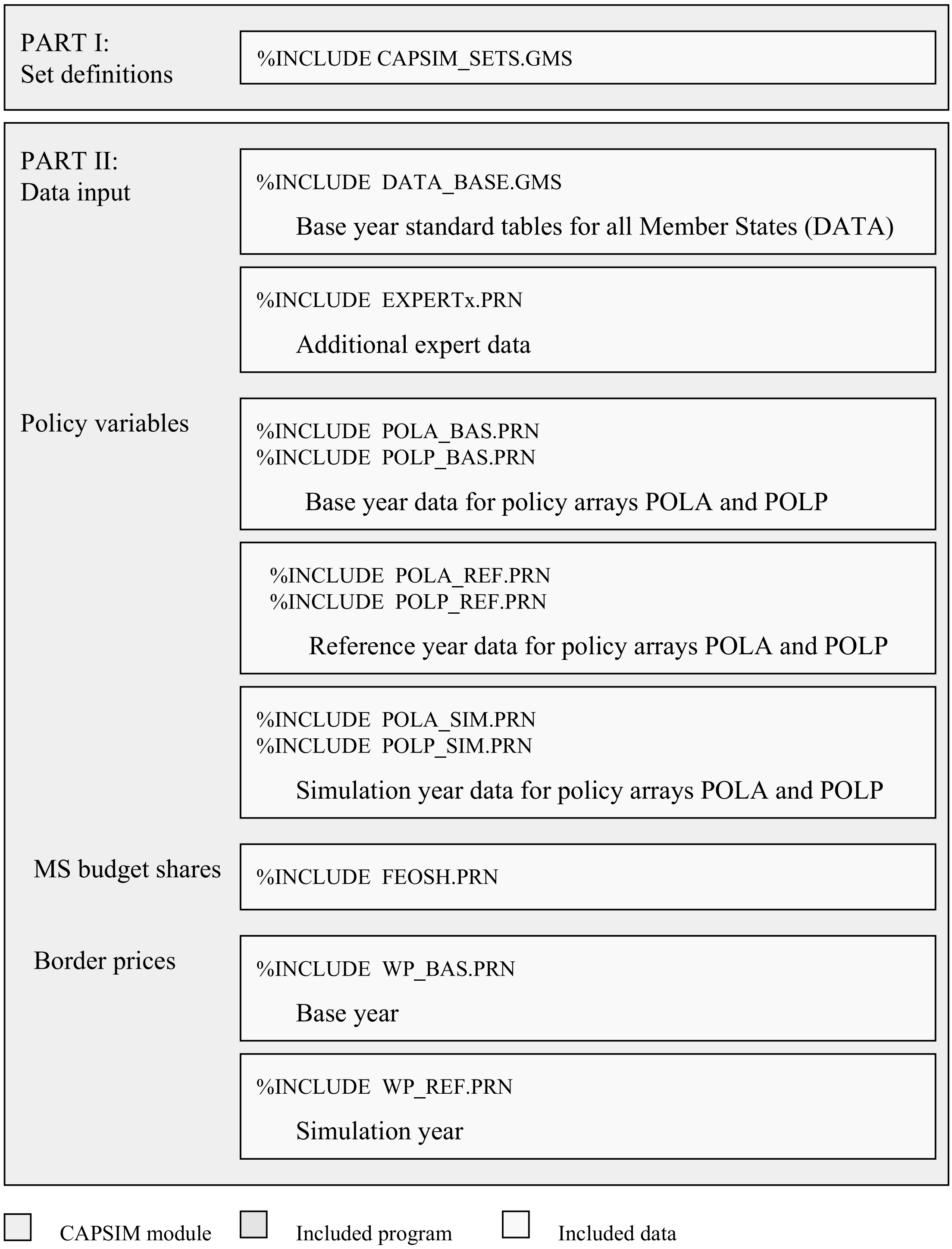
The following sections and figures show the program flow of CAPSIM including all separate modules and other include files. Regarding the content of these modules this documentation can only give an overview. The greatest level of detail is provided by the statements in the code itself, which contains in addition detailed comments.

5.1.1 PART I: Set definitions

Most of the set definitions used in GAMS files are collected in file CAPSIM_SETS.GMS, for example:

- Sets defining the data structure like standard CAPSIM table columns and rows, activities, items, input and outputs, regions etc.
- Sets defining the default treatment of products and activities, for example which trade regime applies
- Sets defining the policy variables and the products that are touched by policy

Figure 5.1-1: CAPSIM.GMS flowchart (Part I and Part II)



5.1.2 PART II: Data input

This part includes all input data for the base year, data of the selected reference run and further exogenous projections for the simulation year (trends, expert data etc.).

- The file DATA_BASE.GMS includes two kinds of data:

    - The standard CAPSIM tables for the base year in the form of a multidimensional parameter DATA. An update of this database must be done always for the whole set of standard tables to guarantee completeness and consistency according to section 3.2.1.
    - Default trends for yields and other exogenous variables, as described in chapter 3.3. These trends can only be updated for the reference run, for example by GSE[41]. Policy simulations will automatically run with the same trends as the associated reference run.
- The file EXPERTx.PRN includes expert growth rates for yields and other exogenous variables. For the reference run and simulation run these exogenous inputs can be updated by GSE, with a text editor, with excel or with an auxiliary GAMS program.
- For policy variables for activities and products a number of files are included for the base year, the reference run and the simulation run (e.g. POLA_BAS.PRN, POLP_BAS.PRN etc.). The policy variables are described in chapter 3.4. The user can update the policy variables for reference and simulation run by GSE or direct manipulation of these files.
- The Member States shares in financing the EU-budget are included for the base and the reference year by the file FEOSH.PRN, which includes DG budget data, see section 3.2.6.
- Border prices are included by files WP_BAS.PRN for the base year and WP_REF.PRN for the reference year. The user can update the border prices for the reference run by GSE or direct manipulation of the latter file.

5.1.3 PART III: Define model structure and assign base year data

This part is handled in the included file CAPSIM_DEF.GMS.

[41] The modelling team currently uses a different technical solution, namely revised inputs from a TAB file, but this is immaterial for other users.

Figure 5.1-2: CAPSIM.GMS flowchart (Part III)

PART III:
Assign base year data and define market model

%INCLUDE CAPSIM_DEF.GMS

- Define the model structure
  - Parameters, variables and model equations
  - Define the model equations
  - Technical definition of the model
- Set base year values for model variables
  - Initialisation of quantities
    - Special: Disaggregation of sugar beet quantities

%INCLUDE SUGAR_DAT.GMS

Data for A, B and C sugar beet on production, quota and prices

- Initialisation of domestic prices
  - Special: Set base values for milk products
- Settings related to international trade:
  - Quantities
  - Prices and matching tariffs
- Disaggregation of sugar beet prices

%INCLUDE CAPSIM_SUGP.GMS

Parameters of beet transmission function

- Set net (shadow) revenues
  - For animal activities requirements, nutrient contents, net revenues and net feed prices are simultaneous results of entropy problem
  - Special: Net revenues for MILK are initialised based on estimated quota rents for dairy

%INCLUDE MLKQRENT.PRN

percentage quota rent for dairy

- Set net revenues for crop activities after estimating land costs

CAPSIM module | Included program | Included data

In the *first part* of CAPSIM_DEF.GMS parameters, variables and equations are declared and model equations are defined.

In the *second part* the base year data are assigned from the input data to model variables and parameters. This initialisation sometimes involves final security checks, adjustments and further processing of the input data.

- Quantities.

  First sugar beet levels and yields have to be disaggregated. In NewCronos only totals of sugar beet data are available. Additional data on quota, production and price for A, B and C sugar beets are included by the file SUGAR_DAT.GMS which collects result from the sugar study mentioned previously. The selected NewCronos data for levels and yields are disaggregated accordingly for A, B and C beet.

  Other domestic quantities can be taken over essentially without further adjustments from the standard tables.

- Prices

  Initial assignments are usually straightforward for producer prices, consumer prices, feed prices, EU market prices. This permits also to compute consumer and processing margins. An entropy based procedure is needed has to determine fat and protein prices together with margins in the dairy industry according to section 3.2.3.

- Variables related to international trade

  Net trade is assigned based on gross trade figures in the database. Base year border prices are assigned as explained in section 3.5. Specific tariffs are calculated according to section 3.4.2.

- Sugar beet prices

  Because beet prices partly depend on international sugar prices (see section 2.4.6) base year prices for sugar beet may be initialised only after international sugar prices. NewCronos gives only an aggregate sugar beet unit value. The included module CAPSIM_SUGB.GMS determines parameters for the price transmission function and consistently estimates base year prices for A-, B-, and C-sugar beet.

- Net (shadow) revenues.

  Those for animal activities are specified according to section 3.2.4. Net revenues for DCOW are calculated from estimated percentage quota rents for dairy, see section 2.4.3. These estimates have been calculated using a small GAMS module, MLKQRENT.GMS. Alternative estimates may be supplied from other sources but the supply side parameters should be re-calibrated in this case because the profit shares $\underline{SHA}_{m,i}$ would change. Net revenues for crops may be calculated given land costs. The estimate of land costs has to acknowledge land heterogeneity, see section 2.1.2.

- FEOGA data related to activities and products

Figure 5.1-3: CAPSIM.GMS flowchart (Part III following)

PART III:
Assign base year data and define market model (following)

- Set FEOGA base year data

```
%INCLUDE FEOGA.PRN
%INCLUDE FEOGP.PRN
```

Premiums + product related budget data

- Set elasticities and other parameters
  - Include demand elasticities and parameters derived from separate calibration

```
%INCLUDE PARAMD.GMS
%INCLUDE DBAS_PAR.GMS
%INCLUDE DO_PAR.GMS
```

- Assume processing elasticities and set parameters
- Include supply elasticities and parameters derived from separate calibration

```
%INCLUDE PARAMS.GMS
%INCLUDE A_L00_PAR.GMS
%INCLUDE A_I00_PAR.GMS
```

- Include net trade elasticities

```
%INCLUDE ENETT.PRN
```

- Assume elasticity and parameters for set aside

- Initialise levels and scaling factors for variables (the latter to make them equal to 1 in BAS)

☐ CAPSIM module ☐ Included program ☐ Included data

In the *third part* of CAPSIM_DEF.GMS elasticities and parameters are set:

- Demand side parameters are included in file PARAMD.GMS, which is a result of a calibration module ELACALD.GMS (methodology: section 2.2.2). In case of (minor) revisions of the database only the commitments were re-calibrated and stored on the file DBAS_PAR.GMS. In addition commitments may be shifted in a reference run, see PART V below. The shifted commitments are obtained by running a reference run with consumption fixed and commitments released for selected items (see Appendix II: User Manual). They are stored in and read back from a file DO_PAR.GMS.

- Processing elasticities are assigned based on a standard assumption and converted to parameters.
- Supply side parameters are included from file PARAMS.GMS, which is a result of the calibration module ELACALS.GMS (methodology: section 2.1.2). In addition the constants may be shifted to reproduce a reference run. Shifted constants are obtained by running this reference run with netputs fixed and constant parameters released for selected items (see Appendix II: User Manual). They are stored in and read back from files A_L00_PAR.GMS and A_I00_PAR.GMS.
- Elasticities for net trade wrt EU border price are included from file ENETT.PRN (methodology: section 2.5.2).
- The elasticity of the effective set aside rate is set to 0.4 according to section 2.4.2. Constants to reproduce the base year and the selected reference run are calculated accordingly.
- Levels and scaling factors are set for most variables.

5.1.4 PART IV: Initial assignments of exogenous variables for simulation year

Exogenous variables have to be assigned by data for the simulation year before entering the simulation. This assignment takes place on a multidimensional array DATA that is passed on and updated during the execution of the code. Usually there is a default setting, which may be overwritten by the user. Additionally some policy variables are adapted to CAPSIM definitions.

- Macroeconomic assumptions are the inflation rate and the growth of total final consumption expenditure, which should be user, supplied for the reference run. Population growth is set by trend values on default but they may be replaced with user supplied estimates These expert data are included from the file EXPERTx.PRN (see Part II).
- Adaptation of some policy variables for later CAPSIM use:
  - Administrative ceilings (DG-Agri) are already stored on the array for policy variables. They have to be adapted to the CAPSIM database using the ratio of CAPSIM ceiling use (activity levels, export volumes) to official ceilings use in the expost period, as included in files CUSE.PRN (premium ceilings use) and EUSE.PRN (export ceilings use).
  - If administrative prices are available for the base year, the corresponding official administrative prices are converted (multiplied) with the ratio of CAPSIM EU market prices to official administrative prices in the base period, if the latter are assumed to determine market price. This conversion occurs both for the base and for the simulation year.
  - If no tariffs for the simulation year are supplied, base year values are assumed to apply[42].
  - Official WTO ceilings, which are already stored on the array for policy variables, have to be adjusted according to equation (101). The required data on export ceiling use are included in file EUSE.PRN.
- Required prices for international trade are assumed constant if not provided by the user in Part II. Base year trade is set as default for items $i \in$ MSBAL. The growth rates from file EXPERTx.PRN (see Part II) for exogenous projections on net trade are transformed into absolute values.
- Default data for yields in the simulation year stem from trend estimations (see section 3.3.1), technically from a module CAPSIMTRD.GMS (section 0). In the reference run these default trends are overwritten with exogenous forecasts from file EXPERTx.PRN (see Part II), if available.
- Required trend values for activity levels, industrial use on market, EU prices, depreciation and wages in the simulation year are copied to the DATA array.
- Base year data for average EU margins between consumer prices and EU market prices are included from a file CNS_MARG98.GMS. These EU margins are calculated as the 1998 average from MS trends, weighted with the 1998 trend projection for human consumption (in module CAPSIMTRD.GM) and cannot be recalculated from the 3 year

[42] This implies that tariffs have to be set to a value close to but different from zero if their abolishment is to be simulated. Setting a tariff to zero would be equivalent to set it to the base year value.

average ex post data on BAS. In addition the corresponding average EU margin for the simulation year is copied to array DATA.

- Geometric growth rates from file EXPERTx.PRN (see Part II) are converted into absolute values on array DATA.

Figure 5.1-4: CAPSIM.GMS flowchart (Part IV)

PART IV: Initial assignments of exogenous variables for simulation year

- Set macroeconomic developments
- Adaptation of policy variables:
  - Official ceilings are adjusted with data on ceiling use

    %INCLUDE CUSE.GMS

  - The official PADM may be converted to the quality on CAPSIM EU markets
  - Default setting for tariffs (same as in BAS) is applied
  - WTO ceilings are adjusted using export data on ceiling use

    %INCLUDE EUSE.GMS

- Complete border prices and settings for international trade
- Collect trend projections for yields on DATA array
- Collect trends for other exogenous positions (prices, EAA)
- Set EU level consumer margins for BAS and simulation year

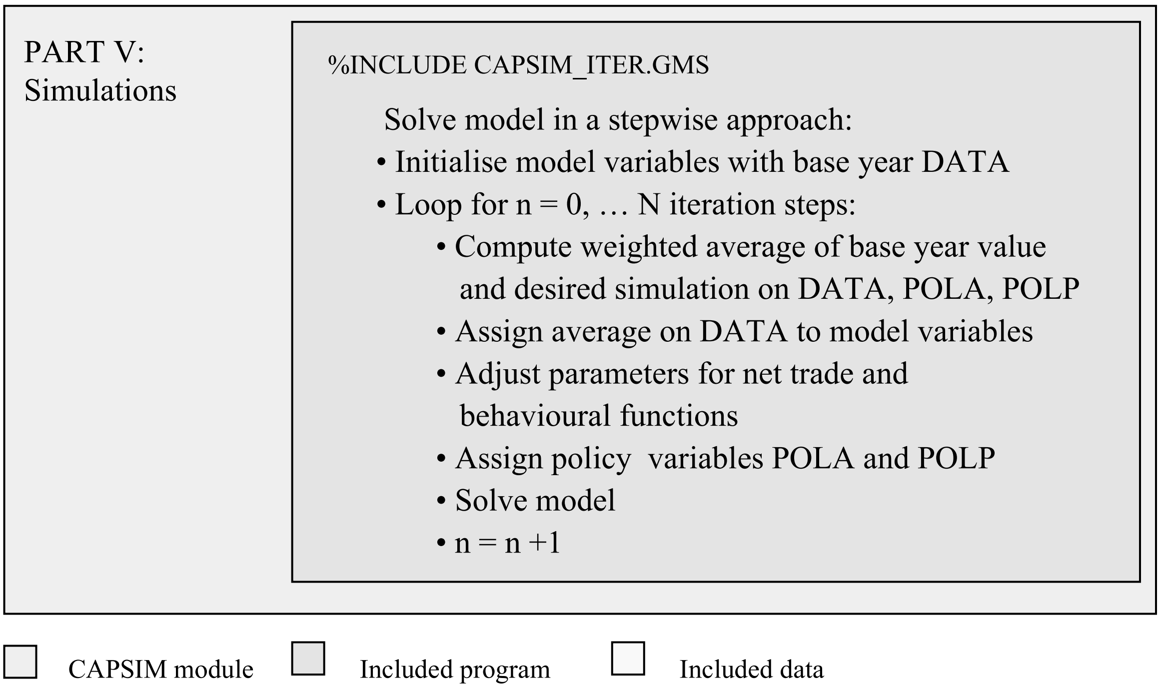
  %INCLUDE CNS_MARG98.GMS

- Apply any other exogenous projections

☐ CAPSIM module ☐ Included program ☐ Included data

5.1.5 PART V: Simulation

Figure 5.1-5: CAPSIM.GMS flowchart (Part V)



The model is solved in a stepwise approach in a module CAPSIM_ITER.GMS. This module is mainly assigning exogenous variables (projections or policy variables) from array DATA used for storage and simultaneous processing of many items to low dimensional model variables such as $LVL_{m,j}$. Because solution may be difficult if exogenous variables have changed a lot from the base year, which was used for initialisation and calibration, all changes of exogenous variables are divided in N steps. In step n the model is solved with exogenous variables set to X(n) = (1-n/N) * X(BAS) + n/N * X(SIM) such that the model always starts with X(0) = X(BAS), base year values, and ends with X(N) = X(SIM), the desired specification to be simulated. Solution values for endogenous variables of each iteration will automatically provide the starting values for the next iteration and the loop is naturally initialised with the ex post data from the base year. Experience showed that setting N = 5 will frequently lead to a regular (optimal) solution in reasonable time. In case of infeasible or nonoptimal intermediate results the number of steps N is increased automatically. The main steps in the loop are the following:

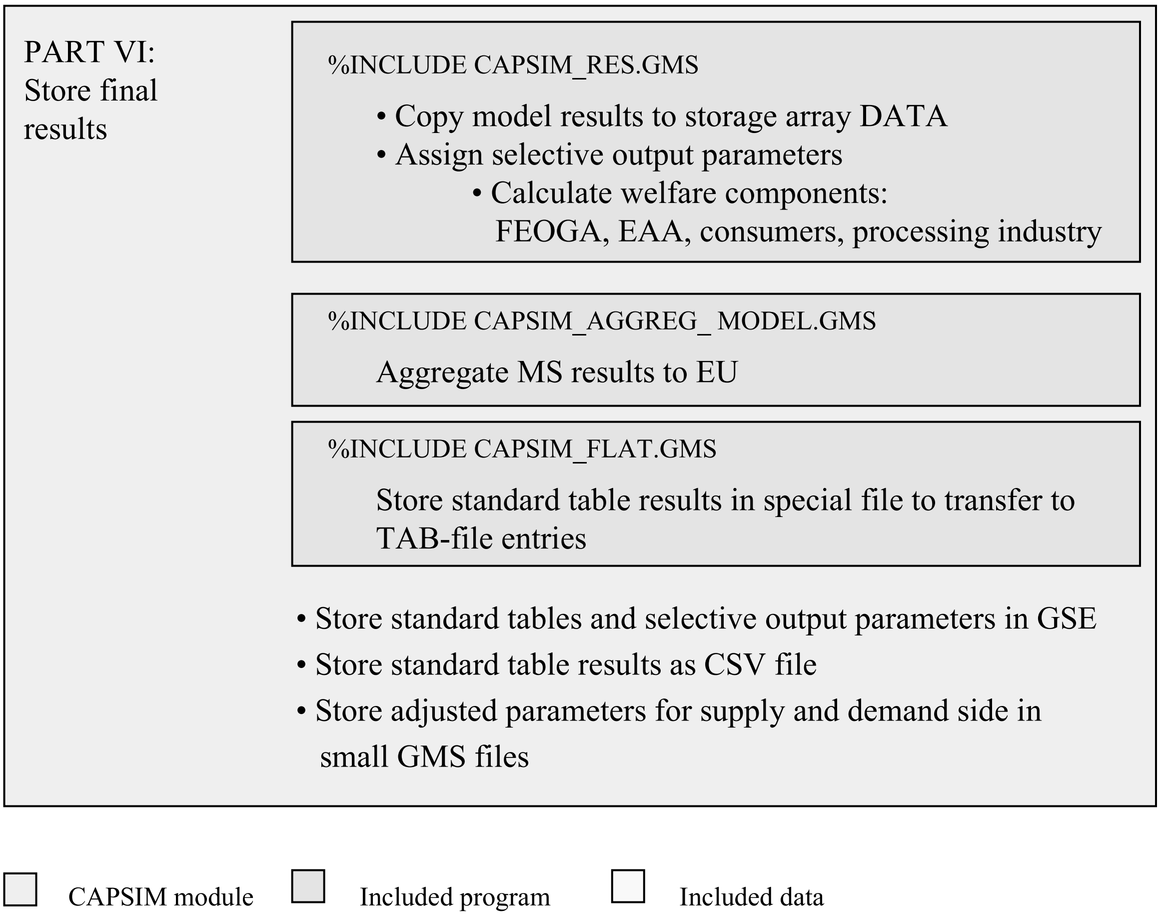
1. For iteration n the average X(n) of base year and desired values is taken on array DATA and corresponding arrays for policy variables (POLA, POLP).
2. Modified exogenous projections are assigned to lower dimensional parameters and variables as used in the model equations, similar to the assignments in Part III.
3. Adjust parameters of behavioural functions in case of exogenous projections:

   Commitments have to be released (with lower bound < upper bound) in case of exogenous projections for consumer demand in the reference run. In a similar way the constants of supply side behavioural functions must be released (with lower bound < upper bound) in case of exogenous projections for activity levels or input demand. These adjustments only apply to the reference run, see Appendix II: User Manual . In policy simulations the solutions values for the above parameters from the reference run are kept fixed. Parameters of net trade function are computed as explained in section 3.5, if this is a policy simulation (rather than the reference run).

4. Adjust and implement modified policy variables for iteration n. Implementation here means assignments to model variables or bounds. Examples: Sugar quotas are converted to sugar beet area quotas, administered prices are assigned to lower bounds for corresponding EU prices and so forth.
5. The model is solved for iteration step n and the iteration index is increased.

5.1.6 PART VI: Store model results

Figure 5.1-6: CAPSIM.GMS flowchart (Part VI)



After a successful simulation the model results are still on model variables such as $LVL_{m,j}$, but for storage purposes they have to be copied to the standard array DATA for later export. Most results are also stored in “selective output tables” (see section 4.2) which permits the user to compare conveniently simulated and base year values (and perhaps reference run values) for model variables with indices assuming all permissible values, e.g. in case of $LVL_{m,j}$ for all regions and activities. These selective output tables may be accessed in different form (GAMS listing or GSE) and in total they permit a quite detailed analysis of simulation results. Some parameters collect the welfare components. They are computed according to section 2.6.

Storage of results occurs currently in several forms:

- Standard table results on array DATA are stored in a special format called TAB file for use by the modelling team
- Standard results and selective tables are stored to the GSE database if CAPSIM is steered through the GSE user surface
- Selective tables are displayed in the GAMS listing and will be stored with this listing
- Standard tables are also written to CSV files for integrative display using excel macros (see section 4.3). These excel tables may be accessed through GSE as well.

In the case of a reference run, the modified constants and commitment are stored in small GMS files. For a proper co-ordination with the policy simulations these files should be renamed after the reference run to make sure that they are used in the policy simulations, see Appendix II: User Manual . An updated version of GSE should be able to handle this in a more convenient form.

5.2 Auxiliary software used to initialise the model

The previous section offered a detailed guide through the main program and included data and sub-programs of CAPSIM, which are active in each simulation. It is expected that a technical model administrator at the Commission may want to check and improve the technical solution chosen in this software such that the rather detailed exposition may be useful help for this kind of user.

This situation is different with the establishments of the database, the estimation of default trends and the parameter calibration. These tasks are due only at greater intervals. The current technical solution may be revised at this opportunity to fix some problems. Other technical solutions are currently considered, for example, to update the database. Default trends may be estimated with various commercial software packages.

It appears therefore that a detailed documentation of this auxiliary software may be of little help if the responsible individuals choose other technical solutions. If the same software will be applied, it is very likely that this will be handled by individuals with considerable technical skills who should be able to understand the auxiliary software with the help of the comments therein and the general information provided in this documentation. The focus of this documentation has been put elsewhere therefore rather than on these auxiliary programs. Nonetheless they should be characterised in brief form here.

CONSUMER.GMS

Consumer prices and consumer expenditures are calculated on the product differentiation of the COCO database by the CONSUMER.GMS module using the methodology of section 3.2.5. The COCO module includes this program to finalise the database for these items. The results are stored in the columns UVAD (Unit value consumer price) and EXPD (Consumer expenditure) of the COCO standard table. They will be imported into CAPSIM together with other COCO data, see section 0.

CAPSIMDAT.GMS

This program mainly aggregates the so-called COCO data (see section 3.2.2) to the CAPSIM level as defined in Appendix I: Codes and symbols. In addition it handles a number of special cases which dominate the code length but which are far less important in terms of affected figures. The bulk of the database is a straightforward aggregate from the pre-processed COCO data.

We may identify the following blocks of statements

- Include raw data from COCO and other sources (updated inhabitants, additional prices and quantities, EU prices for processed products, nutrient contents of feedstuffs, DG Agri set aside data)
- Estimate energy and protein prices in a restricted least squares approach
- Impose various minor patches for a few data problems unresolved in COCO (OCRO, FLOW in SE, PULS in UK and so forth).
- Aggregate the COCO data to the CAPSIM level (CAPSIM data). This is a straightforward aggregation except for the vertical aggregation of animal activities. The coefficients of integrated activities are in the simplest cases (e.g. pigs fattening and sows) the totals (e.g. of pork produced) from the two activities divided by the chosen activity level for the aggregate (pigs fattening).
- Complete feed data for by products from the milling and brewery industry, manioc and fish meal
- Estimate disaggregated feed prices consistent with the EAA aggregate value for total feed.
- Incorporate DG Agri data on set aside and intervention purchases (partly in an entropy problem)
- Build EU aggregate, three years average and store CAPSIM data

CAPSIMTRD.GMS

This program is technically performing the trend estimations explained in section 3.3. The main parts of the program are the following:

- Include CAPSIM data (result of the CAPSIMDAT.GMS module, see above) for the expost years
- Calculate and set margins for consumer prices (column UMAC)
- Regression of activity yields as described in section 3.3.1
- Regression for total area as described in section 3.3.2
- Trends for remaining series as described in section 3.3.3
- Build EU aggregate and store results in standard tables for the trend years

ELACALS.GMS

This program is implementing the entropy approach to the supply side parameter calibration presented in section 2.1.2. It is organised in the following main sections:

- Include and initialise the base year data in exactly the same way as in the main program Parts I-III
- For elasticity initialisation include prior results, if available
- Include data for link of animal levels and feed from CAPREG and aggregate to CAPSIM definitions
- Calibration of elasticities as described in section 2.1.2

- Store results in external files

ELACALD.GMS

This program is applying the entropy approach of section 2.2.2 to the demand side calibration. The main parts are here:

- Include CAPSIM data for the Member States for the base year
- For elasticity initialisation include prior results, if available
- Calibration of elasticities as described in section 2.2.2
- Store results in external files

6. Options for further development

This documentation has already indicated on various occasions that there are numerous options for further development and improvement of CAPSIM. This is the usual situation with modelling systems unless they have reached a dead end in their evolution. This final section tries to bring together these options and group them in a way helpful for planning the future. Some of these options may be tackled in parallel, some may be dropped altogether but most frequently it will be useful to address them in the sequence indicated.

Further improvement of user-friendliness

It has been mentioned several times that it is quite unfortunate that the *GSE user surface* does not reflect many changes in the CAPSIM core programs of the last months, in particular the interplay of reference run and policy simulations. The next opportunity should probably be used therefore for an update to make full use of the considerable investment already spent for the development of the present GSE.

The main strength on the GSE is in the user-friendly handling of input and output options for model use. Regarding output options it appears that the CAPRI team in Bonn has developed a HTLM/XML based reporting system with numerous links between different tables of increasing detail, which is not yet incorporated in GSE. These output facilities might be incorporated in the same way as the current Excel macros (see section 4.3). Improvements of user-friendliness may be addressed at any time, but given that they will be useful at any stage of further development of CAPSIM there are few reasons to postpone them for long.

Update of database for EU15 with some disaggregation

The current base year 1997/99 is not up to date anymore. Before or simultaneously with the pending major task to extend the system for the Candidate Countries there are a few weaknesses of the current model, which could be fixed in an update of the EU15 database.

One of these is a reconsideration of the product and activity disaggregation. This is advisable to incorporate a more appropriate description of set aside with an explicit distinction of voluntary and obligatory set aside. The second evident example is the disaggregation of the current other cereals aggregate OCER into rye, oats, paddy, and other remaining cereals.

Issues of minor scope which are nonetheless worth earmarking are the inclusion of the available statistical information on land rental prices in EU Member States (as suggested in the CAPSIM Reference Group) and on aggregate labour use in agriculture. The latter would permit to calculate for each simulation income measures, which are akin to the Eurostat agricultural income indicators.

Methodological Improvements

An updated and possibly disaggregated database would require a revised parameter calibration. This would be a good opportunity to address a few weak points, which have been identified in the current applications of CAPSIM. The first of these is a co-ordinated recalibration of nutrients, requirements and all supply side parameters to avoid the problems due to some net revenues and net prices being close to zero (see sections 2.1.3, 3.2.4). A second option would be to impose simultaneous market clearing for nontradable fodder during the calibration in the same way as in the subsequent simulations. This would further improve the possibilities to check the simulation behaviour of CAPSIM already during the calibration.

A major modification to be considered would be to include additional data points (beyond the respective base year) in the calibration procedure. This would gradually move the current calibration procedure to an econometric estimation problem and has been discussed on Reference Group meetings.

The current specification for trade is the first trade component incorporated in CAPSIM or its predecessor models and consequently it is simplified in various aspects. Some of these can be addressed in the current framework. This applies to the preliminary specification of net trade elasticities. This holds also for the exogenous specification of net trade of cheese CHES and other milk products OMPR (see section 2.5.2) which should be revised. This might also be a good opportunity to include consumption subsidies which are an important budgetary position related to milk products but which are not yet explicit represented in CAPSIM.

A major improvement would be to move from the current net trade to a gross trade specification, based on the Armington approach with adjustments in the database. As explained in section 2.5.3 this is probably the only way to incorporate the WTO limits in a proper way in CAPSIM or any other modelling system. An additional challenge would be to identify explicitly subsidised and unsubsidised exports. However, this is only conceivable in conjunction with gross trade modelling.

A far-reaching modification would be to render the supply system dynamic and to incorporate adjustment lags and price expectations. This would permit to model the transition period of policy changes and to obtain a series of yearly supply balance sheets linked together through stock changes. The challenge of this improvement does not really lie in the conceptual framework for this kind of approach, which is frequently implemented in the literature. The difficulty is with the empirical implementation in the framework of a disaggregated sector model as CAPSIM, which requires sufficient time.

Finally we may reconsider the fixed yields assumption for the supply side. There are various options to generalise the current framework and some of them might be less demanding than the move to a dynamic version. It is certainly true that fixed yields are a simplification which is avoided in many competing modelling systems even though the empirical significance of variable yields has been considered limited above.

Enlargement to EU25

The greatest and probably most relevant improvement for future usefulness of CAPSIM would be provided by a full integration of all Candidate Countries into CAPSIM. Appendix

III: Coverage of Candidate Countries presents the current possibilities to obtain results for an enlarged EU with CAPSIM but it is fair to characterise these options as largely ad hoc. Database problems are sure to be major issues in a full enlargement but they are difficult to foresee in detail and in their scope. A methodological challenge specific to these countries is an acceptable description of the subsistence sector, which decreases in importance but cannot be neglected in the immediate future.

There may be many other possibilities to improve CAPSIM, but this collection of options for the future tried to be selective and to rely mainly on weaknesses, which have been addressed in this report. Options, which appeared very unlikely to be implemented in the next future, have been omitted from the list.

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8. Appendix I: Codes and symbols

8.1 CAPSIM table: Column codes

Crop (or land using) activities

SWHE	Soft wheat
DWHE	Durum wheat
BARL	Barley
MAIZ	Maize
OCER	Other cereals
PULS	Pulses
POTA	Potatoes
SUGB	Sugar beet, aggregate
SUBA	Sugar beet, A
SUBB	Sugar beet, B
SUBC	Sugar beet, C
RAPE	Rape and turnip rape
SUNF	Sunflower seed
SOTH	Soya beans and other oilseeds
OLIV	Olives for oil
TIND	Textiles and industrial crops
VEGE	Vegetables
FRUI	Fruits
WINE	Wine
OCRO	Other final crop products
MAIF	Fodder maize
OFOD	Other fodder

GRAS	Grass/Grazing
SETA	Set aside
NONF	Non food production on set aside
FALL	Fallow land

Animal activities

DCOW	Dairy cows
SCOW	Other cows
BULF	Bulls fattening
HEIF	Heifers
CAMF	Male calves fattening
CAFF	Female calves fattening
PIGS	Pig fattening
SHEE	Sheep and goat fattening
HENS	Laying hens
POUF	Poultry fattening
OANI	Other animals

Farm use activities

SEDF	Seed on farm
LOSF	Losses on farm
INTF	Internal use on farm
NETF	Sales, purchases of the farm sector

Marked use activities

FEDM	Feed
SEDM	Seed, market
INDM	Industrial use
PRCM	Processing
HCOM	Human consumption

LOSM	Losses, market
STCM	Change in stocks, market
STKM	Final stocks on market
STCI	Change in intervention stocks
STKI	Final intervention stocks
IMPT	Imports, total
EXPT	Exports, total
EXPS	Exports, subsidised
EXPL	Net exports of life animals

Production

GROF	Gross production or input for the farm sector
MAPR	Marketable production of secondary products

Prices

UVAP	Unit value EAA producer price
UVAF	Unit value feeding stuffs
UVAB	Unit value EAA basic price
PRIC	Selling price from statistics
UVAD	Unit value consumer price
UVAI	Unit value imports
UVAE	Unit value exports (border price)
UMAP	Unit margin processing
UMAC	Unit margin consumption

Monetary aggregates (agriculture)

EAAP	EAA at producer price current prices
EAAB	EAA at basic prices current prices
EAAS	Subsidies current prices
EAAT	Taxes current prices

Monetary aggregates (beyond agriculture)

EQUV	Equivalent variation
DPIP	Change in processing industry profit
FEOG	FEOGA expenditure
REFU	Export refunds
EXPD	Consumer expenditure

Other columns

INHA	Inhabitants
ENNE	Net energy lactation content of feed
CRPR	Crude protein content of feed
FATS	Fat content of milk products
PROT	Protein content of milk products

8.2 CAPSIM table: Row codes

Crop products

SWHE	Soft wheat
DWHE	Durum wheat
BARL	Barley
MAIZ	Maize
OCER	Other cereals
PULS	Pulses
POTA	Potatoes
SUGB	Sugar beet
SUBA	Sugar beet, A
SUBB	Sugar beet, B
SUBC	Sugar beet, C
RAPE	Rape and turnip rape

SUNF	Sunflower seed
SOTH	Soya beans and other oilseeds
OLIV	Olives for oil
TIND	Textiles and Industrial crops
VEGE	Vegetables
FRUI	Fruits
WINE	Wine
OCRO	Other final crop products
MAIF	Fodder maize
OFOD	Other fodder
GRAS	Grass/Grazing

Animal products

COMI	Cow and buffalo milk
BEEF	Beef
VEAL	Veal
PORK	Pork
SGMI	Sheep and goat milk
SGMT	Sheep and goat meat
EGGS	Eggs
POUM	Poultry meat
OANI	Other animal products
YCAM	Young calves male
YCAF	Young calves female

Other output (EAA relevant)

OOUT	Other output

Processed products

RICE	Rice equiv. milled rice

MOLA Molasses

STAR Potato starch

SUGA Sugar

RAPO Vegetable fats and oils - rape

SUNO Vegetable fats and oils - sunflower

SOYO Vegetable fats and oils - soya/other oil seeds

OLIO Vegetable fats and oils - olives

RAPC Oilcakes – rape

SUNC Oilcakes - sunflower

SOYC Oilcakes – soya

OLIC Oilcakes – olives

BUTT Butter, total

SMIP Skinned milk powder

CHES Cheese

OMPR Other products of milk

Input items

IGEN General cost items

IPLA Chemical fertiliser

FPRI Feed rich protein imported

FENI Feed rich energy imported

FOTI Feed other: imported or industrial

FEED Animal feedingstuffs, aggregate

Components of net revenues of activities

EPEM Effective premium per ha or head

EPET Effective premium per t

HIST Historical yield

GREV Gross revenues

LNDC	Land costs
PRTC	Protein costs
ENEC	Energy costs
NREV	Net revenues

Aggregate monetary positions

PRMV	Total premiums to activity
DEPB	Depreciation buildings
DEPM	Depreciation machines
INTR	Interest received
INTP	Interest paid
RENT	Rents and other real estate rental charges to be paid
WAGE	Compensation of employees
PROV	Gross production
TOIN	Total intermediate input
SUBO	Subsidies
TAXO	Taxes linked to production
GVAD	Gross value added
NVAF	Net value added at factor costs

Other rows

LEVL	Levels of activities
ENNE	Net energy lactation requirements
CRPR	Crude protein requirements
ICAM	Input calves male
ICAF	Input calves female
SLGH	Number of slaughtered heads per activity unit

8.3 Sets in CAPSIM

AACT	= ACAT ∪ FCAL ∪ {PIGS, SHEE, HENS, POUF, OANI}	Animal production activities
ACAT	= {DCOW, SCOW, BULF, HEIF}	Adult cattle activities
AGRO	= {SWHE, DWHE, BARL, MAIZ, OCER, PULS, POTA, SUGB, RAPE, SUNF, SOTH, OLIV, TIND, VEGE, FRUI, WINE, OCRO, COMI, BEEF, VEAL, PORK, SGMI, SGMT, EGGS, POUM, OANI, MAIF, OFOD, GRAS, YCAM, YCAF, OOUT}	Agricultural outputs
A_L0_EU	= {PIGS, POUF, CAFF, CAMF, POTA}	Activities related to trade regime 4
BRCE	= {SWHE, DWHE, BARL, MAIZ, OCER, RAPE, SUNF, SOTH, TIND, RICE, MOLA, STAR, RAPC, SUNC, SOYC, OLIC }	Food group bread & cereals
CACT	= GCOP ∪ {POTA, SUBA, SUBB, SUBC, OLIV, TIND, VEGE, FRUI, WINE, OCRO, MAIF, OFOD, SETA, NONF}	Crop production activities without GRAS and FALL
CERE	= {SWHE, DWHE, BARL, MAIZ, OCER}	Cereals
FCAL	= {CAMF, CAFF}	Fattening of calves activities
FEED	= ITEM \ {OCRO , BEEF , VEAL , PORK , SGMT, EGGS , POUM , OANI },	Feed items
FRVE	= {SUBA, SUBB, SUBC, PULS, OLIV, VEGE, FRUI }	Food group fruit & vegetables
FXACT	= { OANI, GRAS}	Exogenous non quota production activities
FXCNS	= {TIND, WINE, OCRO, OANI, OLIO, MOLA, STAR}	Items with exogenous consumption
FXEP	= {TIND, WINE, OCRO, OANI, OLIO, OLIC, IPLA, IGEN, REST}	Items with EU prices set by exogenous assumptions
GCOP	= OILS ∪ CERE ∪ {PULS, SETA, NONF, MAIF}	Grandes culture activities with premiums
ICAL	= {ICAM, ICAF}	Gross input of young cattle
INDINP	= {IPLA, IGEN}	Industrial inputs
INTERV	= {SWHE, DWHE, BARL, MAIZ, OCER, BEEF, SUGA, SMIP, BUTT}	Items with intervention prices
ITEM	= AGRO ∪ SECO ∪ SECMLK ∪ NOFEED ∪ {FPRI, FENI, FOTI}	Items (inputs + outputs)
LANDUSE	CACT ∪ {FALL, GRAS}	Crop production activities

		with GRAS and FALL
MEAT	= {BEEF, VEAL, PORK, SGMT, POUM, OANI }	Food group meat
MICE	= {COMI, SGMI, EGGS, SMIP, CHES, OMPR}	Food group milk cheese & eggs
MSBAL	= { SUBA, SUBB, SUBC, OLIV, COMI, SGMI, OMPR, CHES, OFOD, GRAS, MAIF, YCAM, YCAF}	Items with constrained Member State net exports
NOFEED	= INDINP ∪ {REST}	Non-feed inputs
OILS	= {RAPO, SUNO, SOYO, OLIO, BUTT}	Food group oils & fats
OILS	= {RAPE, SUNF, SOTH}	Oilseeds activities
PACT	= LANDUSE ∪ AACT	Production activities
POTA	= {POTA}	Food group potatoes
REF_A_LO	= {DCOW, OCRO, OLIV, TIND, WINE }	Activities with exogenous levels and endogenous constant term in reference run
RAW	= {OCER, POTA, RAPE, SUNF, SOTH, OLIV, COMI, SGMI, SUBA, SUBB, SUBC}	Raw products with associated processed outputs
SECO	= {RICE, MOLA, STAR, SUGA, RAPO, SUNO, SOYO, OLIO, RAPC, SUNC, SOYC, OLIC }	Processed (non milk) products
SECMLK	= {SMIP, BUTT, CHES, OMPR}	Processed milk products
SREV	= {OANI, SETA, DCOW}	Activities with free shadow revenue
SUGA	= {SUGA}	Food group: sugar rich
YCAL	= {YCAM, YCAF}	Gross or net output of young cattle

8.4 Indices in CAPSIM

m		EU Member States
s,t,p	∈ PACT ∪ ITEM	Netputs
j,k	∈ PACT	Production activities
a	∈ AACT	Animal activities
i,u,v,w	∈ ITEM	Items
f,g	∈ FEED	Feed items (in section 2.4.2: farms)
n	∈ NOFEED	Non-feed items
d,h	∈ ITEM	Final demand or processed items
z		Support points
c	∈ {FAT, PRT}	Milk contents
r	∈ RAW	Raw product items

8.5 Variables in CAPSIM

ALEVY = levy on A sugar

$\underline{AREA}_{f}$ = Total area in farm f (exogenous)

$\underline{AREA}_{m}$ = Total area in Member State m (trend projection)

AUX_{t} = auxiliary variable for non-linear trend estimation in year t

$AVYLD_{m,i,j}$ = average yield over the years t in Member State m

BLEVY = levy on B sugar

$\underline{CEIL}_{ACAT,m}$ = ceiling for set ACAT in Member State m

$\underline{CEIL}_{FCAL,m}$ = ceiling for set FCAL in Member State m

$\underline{CEIL}_{GCOP,m}$ = ceiling for set GCOP in Member State m

$\underline{CEIL}_{j,m}$ = ceiling for activity j in Member State m

$\underline{CEIL}_{OILS,m}$ = ceiling for set OILS in Member State m

$CNS^{HD}_{m,i}$ = per capita demand quantity of item $i \in$ ITEM in Member State m

$CNS_{m,i}$ = food consumption of good $i \in$ ITEM in Member State m

$\mathbf{CNS}_{m,I}$ = column vector of consumption quantities $i \in I \subset$ ITEM (I = 1, …, N) in Member State m

$\hat{CNS}_{m,I}$ = aggregate consumption quantity I in Member State m

$\hat{\mathbf{CP}}_{m}$ = column vector of aggregate consumer prices $\hat{CP}_{m,I}$ in Member State m

$\mathbf{CP}_{m,I}$ = column vector of consumer prices $CP_{m,i}$, $i \in I \subset$ ITEM in Member State m

$CP_{m,i}$ = consumer price of item $i \in$ ITEM in Member State m

$\underline{CPS}_{m,z,i}$ = support point z of consumer price i in MS m

$DATA_{m,j,i,t}$ = Projection value of data matrix element j,i for Member state m and year t

DEM_{i} = demand of good $i \in$ ITEM in the EU

DEP_{i} = EAGFF expenditure on depreciation of intervention stocks for item $i \in$ ITEM in simulation year

$EARC_{m,s,p}$ = final arc elasticity of netput s wrt price variable p in Member State m

$ENTC_{m}$ = cross entropy in consumer price estimation

$ENTS_{m}$ = cross entropy in supply side calibration for Member State m

$ENTD_{m}$ = cross entropy in demand side calibration for Member State m

EP_{i} = EU level market price of item $i \in$ (ITEM $\cup$ {FAT, PRT})

EST_{t} = estimated value for a variable in year t

EV^{HD}_{m} = equivalent variation per head of moving from reference run to policy simulation

EV_{m} = total equivalent variation of moving from reference run to policy simulation

$\underline{EX}^{HD}_{m}$ = consumer expenditure per head in Member State m

$EX_{m,I}$ = expenditure on group $I \subset$ ITEM in Member State m

$\underline{EXPE}_{m}$ = total private expenditure (nominal) in Member State m

$\underline{EXPQ}_{i}$ = official WTO limit for item i

$\underline{EXS}_{m,z,I}$ = support point z of expenditure group I in MS m

$EXPT_{m,i}$ = gross export estimate for Member State m

$FLEV_i$ = flexible levy / export restitution for $i \in$ ITEM

$\underline{FSH}_{m,A,F}$ = (base year) share of animal activity A in total use of feed quantity F in Member State m

$FP_{m,f}$ = feed price of item f in Member State m

$\underline{GRATE}_{m,j,i}$ = Average geometric growth rate for data matrix element j,i for Member state m and horizon (t-bas)

$\underline{GNET}_i$ = Average arithmetic growth rate for net trade of item i over horizon (t-bas)

$HEL_{m,u,v}$ = Hicksian price elasticity of item $u \in$ ITEM wrt consumer price of item $v \in$ ITEM in Member State m

$HEL_{m,u,v|U}$ = Hicksian price elasticity of item u wrt price of item v ($u,v \in U$) given expenditure on group U ("within group elasticity") in Member State m

$\hat{HEL}_{m,U,V}$ = Hicksian price elasticity of aggregate item U wrt price of aggregate item V in Member State m

$\underline{HELS}_{m,z,u,v}$ = support point z of elasticity $HEL_{m,u,v}$ of consumer demand u wrt price of item v in Member State m

$\underline{HIST}_{m,j}$ = historical yield of main product in activity $j \in GCOP \cup ACAT \cup FCAL$ in Member State m

$\underline{IMPQ}_i$ = exogenous estimate for change in gross import quantity use of item i

$\underline{IND}_{m,i}$ = industrial use of good $i \in$ ITEM in Member State m, exogenous

$INHA_m$ = inhabitants in Member State m

$INP_{m,i}$ = demand for input $i \in (FEED \cup INDINP) \subset ITEM$ in Member State m

ITS_i = intervention sales of good $i \in$ ITEM in the EU

$LEVY_{SUGA}$ = estimated levies on sugar in the EU

$LNK_{m,i}$ = use of good $i \in$ AGRO linked to production (seed use + losses on farm + consumption on farm) in Member State m

$LNKF_{m,i}$ = linked use of item i allocated to the farm sector in Member State m

$\mathbf{LVL}_{f,NOSET}$ = column vector of crop areas $LVL_{f,j}$ of crop activity $j \neq$ set aside on farm f

$LVL_{f,SETA}$ = area of set aside on farm f

$LVL_{m,j}$ = level (usually ha or hd) of production (crop or animal) activity $j \in$ PACT in Member State m

$\hat{LVL}_{m,n,t}$ = Projection of absolute area for the numeraire crop n (SWHE or GRAS) in Member State m and year t

$\hat{LVLR}_{m,j,t}$ = Projection on area ratio j in Member State m and year t

$LVLR_{m,j,t}$ = $LVL_{m,j,t} / LVL_{m,n,t}$ = Observation on area ratio j in Member State m and year t

$\hat{LVL}_{m,j,t}$	=	Projection of absolute area for numeraire crop j in Member State m and year t
$MEL_{m,u,v}$	=	Marshallian price elasticity of item u ∈ ITEM wrt consumer price of item v ∈ ITEM in Member State m
$MEL_{m,u,E}$	=	Expenditure elasticity of item u ∈ ITEM in Member State m
$MEL_{m,i,I}$	=	elasticity of good i ∈ I wrt. group expenditure in Member State m
$\hat{MEL}_{m,I,E}$	=	elasticity of group I consumption wrt. total expenditure in Member State m
$\underline{MELS}_{m,z,u,E}$	=	support point z of elasticity $HEL_{m,u,E}$ of consumer demand u wrt expenditure in Member State m
$NETMS_{m,i}$	=	net exports of good i ∈ MSBAL ⊂ ITEM from Member State m
$NETP_{m,s}$	=	quantity of netput s ∈ PACT ∪ INDINP ∪ FEED in Member State m
$\hat{\boldsymbol{NETP}}_{m}$	=	column vector of aggregate netput quantities $\hat{NETP}_{m,I}$, I ⊂ {PACT ∪ NOFEED ∪ FEED} in Member State m
$\hat{NETP}_{m,A,F}$	=	aggregate use of feed item F in activity A in Member State m
$\hat{NETP}_{m,F}$	=	aggregate feed quantity F ⊂ FEED in Member State m
$NETTRD_{i}$	=	net exports of good i ∈ ITEM \ {COWO, IPLA, IGEN, REST} from the EU
$NP_{m,i}$	=	net price of item i ∈ NOFEED ∪ FEED in Member State m
$\underline{PADM}_{i}$	=	Administered EU price for i ∈ INTERV
$\underline{PADM}_{i,official}$	=	Official administered EU price of product i as supplied by the user
$PENE_{m}$	=	shadow price of energy in Member State m
$PLND_{f}$	=	shadow rental price of land in farm f
$PLND_{m}$	=	shadow rental price of land in Member State m
$PP_{m,i}$	=	producer price of item i ∈ ITEM in Member State m
$PPO1_{i}$	=	user supplied difference of subsidised exports and net trade
PRC_{r}	=	total processing of raw product r ∈ RAW in the EU industry
$PRD_{EU,i}$	=	production of milk product i ∈ {BUTT, MIPO, OMPR} in the EU industry
$PRD_{m,i}$	=	production of item i ∈ ITEM \ {COWO} in Member State m (or in EU industry for i ∈ {BUTT, MIPO, OMPR} ⊂ ITEM)
$PREMFAC_{m,j}$	=	scaling factor to enforce ceilings on specific premiums for activities j ∈ PACT in Member State m
$\underline{PREM}_{m,j}$	=	specific premiums per unit of activity j ∈ PACT in Member State m
$PRETFAC_{m,j}$	=	scaling factor to enforce ceilings on common premiums PRET for activities j ∈ GCOP ∪ ACAT ∪ FCAL in Member State m
$\underline{PRET}_{m,j}$	=	premiums per unit of historical yield in activity j ∈ GCOP ∪ ACAT ∪ FCAL in Member State m
PRM_{j}	=	EAGFF expenditure on activity j ∈ PACT in simulation year
$PPRT_{m}$	=	shadow price of protein in Member State m

$PROB_{m,z,i,CP}$ = final probability weight for support point z of consumer price i in Member State m

$PROB_{m,z,u,v}$ = final probability weight for support point z of elasticity of consumer demand u wrt price of item v in Member State m

$PROB_{m,z,s,t}$ = final probability weight for support point z of elasticity of netput s wrt price variable t in Member State m

$PROB_{m,z,u,E}$ = final probability weight for support point z of elasticity of consumer demand u wrt expenditure in Member State m

$PSETLO_f$ = shadow price of set aside lower bound on farm f

$PSETUP_f$ = shadow price of set aside upper bound on farm f

PT_f = shadow price of operating capacity constraint T_f on farm f

PT_m = shadow price of technology constraint T_m in Member State m

QTL_m = $QTL_{m,SUBA} + QTL_{m,SUBB}$ = aggregate area quota in Member State m

$QTL_{m,SUBA}$ = A quota in Member State m, converted into beet area

$QTL_{m,SUBB}$ = B quota in Member State m, converted into beet area

$REFU_i$ = EAGFF expenditure on refunds for item $i \in$ ITEM in simulation year

$\hat{\mathbf{R}}_m$ = column vector of aggregate netput prices $\hat{R}_{m,I}$, $I \subset \{PACT \cup NOFEED \cup FEED\}$, in Member State m

$\hat{R}_{m,\tilde{A}}$ = net revenue of aggregate animal activity $\tilde{A} \subset AACT$ in Member State m

$RES_{m,i,j,t}$ = error in percent of average yield in Member State m and year t

$SHTO_{m,i}$ = average share of the item in the total output value in Member State m

$\mathbf{REV}_{f,NOSET}$ = column vector of revenues $REV_{f,j}$ of crop activity $j \neq$ set aside on farm f

$REV_{f,SETA}$ = revenue of set aside on farm f

$REV_{m,j}$ = gross revenue of activity $j \in$ PACT in Member State m

$REVS_{m,j}$ = shadow revenue of activity $j \in$ PACT in Member State m

$RN_{m,t}$ = normalised price variable $t \in PACT \cup INDINP \cup FEED$ in Member State m

$RN^{\circ}_{m,t}$ = normalised price variable $t \in PACT \cup INDINP \cup FEED$ in Member State m in the reference situation

$RN^{p}_{m,t}$ = normalised price variable $t \in PACT \cup INDINP \cup FEED$ in Member State m in price variable run p

$SEL_{m,s,t}$ = supply side elasticity of netput s wrt price variable t in Member State m

$SEL_{m,i,j|I}$ = supply side elasticity of netput i wrt netput price j within netput aggregate I in Member State m

$SEL_{m,I,J}$ = supply side elasticity of netput aggregate I wrt aggregate J in Member State m

$\underline{SELS}_{m,z,s,t}$ = support point z of elasticity $SEL_{m,s,t}$ of netput s wrt price variable t in Member State m

$\underline{SETR}_m$ = obligatory set aside rate in Member State m

$\underline{SHA}_{m,i}$ = $R_{m,i}\, NETP_{m,i}/\pi_m$ = (base year) share of netput i in total profit of agriculture in Member State m

$\underline{SHA}_{m,I}$ = $\hat{R}_{m,I}\, \hat{NETP}_{m,I}/\pi_m$ = (base year) share of netput aggregate I in total profit of agriculture in Member State m

$\underline{SHA}_{m,FEED}$ = profit share of total feed in Member State m

$SHB_{m,v}$ = $CP_{m,v} \cdot CNS^{HD}_{m,v}\ /\ \underline{EX}^{HD}_{m}$ = budget share of product v in Member State m

$\underline{SHB}_{m,V}$ = $\hat{CP}_{m,V}\hat{CNS}_{m,V}/EX_m$ = (base year) budget share of aggregate item V in Member State m

$\underline{STC}_{m,i}$ = private stock changes of good i in Member State m, exogenous

$\underline{SUBT}_{m,i}$ = Subsidy per ton of item i in Member State m

$SUBX_i$ = estimated subsidised exports of item i ∈ ITEM from the EU

SUP_i = supply of good i ∈ ITEM in the EU

$\underline{TARA}_i$ = specific tariff (fixed amount per t)

$\underline{TARR}_i$ = ad valorem tariff

$\underline{TOFO}_m$ = total food expenditure in MS m [mio €]

$\hat{TOTA}_{m,t}$ = Projection of total area in Member State m and year t

$UMA_{c,reg,i}$ = unit margin to consumer level of item i in region reg (reg = m, EU)

$UMA_{p,m,i}$ = unit margin in production/processing of item i in Member State m

VAR_{bas} = observed value for a variable in base year

WP_i = Border price for i ∈ ITEM

$\underline{XQT}_i$ = adjusted WTO limit for item i

$XQTVIO_i$ = violation of WTO limits for item i ∉ INTERV to the EU

$\underline{YLD}_{m,i,j}$ = (exogenous) yield of activity j ∈ PACT in terms of item i ∈ ITEM \ {COWO} in Member State m

8.6 Parameters in CAPSIM

$\alpha_{m,s}$, $\alpha_{m,s,t}$ = parameters of the profit function in Member State m

$\beta_{CP,m,i}$ = base year consumer price of item i in Member State m

$\beta_{DEP,i}$ = base period depreciation on product i

$\beta_{EP,i}$ = base period EU level market price of product i

$\beta_{EXPQ,i}$ = official WTO limit for item i in base period

$\beta_{INTP,i}$ = base period intervention purchases of product i in the EU

$\beta_{LEVY,SUGA}$ = base period levies on sugar

$\beta_{LNK,m,i}$ = base period use of good i linked to production (seed use + losses on farm + consumption on farm) in Member State m

$\beta_{LVL,m,j}$ = base year level of activity j in Member State m

$\beta_{NETTRD,i}$ = net trade of item i in base period

$\beta_{PADM,i,official}$ = Official administered EU price of product i as supplied by the user in the base year

$\beta_{PLND,m}$ = base year rental price of land in Member State m

$\beta_{PP,m,i}$ = base period producer price of product i in Member State m

$\beta_{PRD,m,i}$ = base period production of good i in Member State m

$\beta_{PRM,j}$ = EAGFF expenditure on activity $j \in PACT$ in base year

$\beta_{PRET,m,j}$ = premiums per unit of historical yield in activity $j \in GCOP \cup ACAT \cup FCAL$ in Member State m in the base period

$\beta_{PREM,m,j}$ = specific premiums per unit of activity $j \in PACT$ in Member State m in the base year

$\beta_{REFU,i}$ = base period refunds on product i

$\beta_{SUBX,i}$ = base period subsidised exports of product i from the EU

$\beta_{SLACK,i}$ = original slack of WTO limit for item i in base period (= $\beta_{EXPQ,i} - \beta_{EUSE,i}$, with $\beta_{EUSE,i}$ = base period use of WTO limit)

$\beta_{UMAC,EU,i}$ = base year unit margin to consumer level of item i in EU

$\beta_{UNSUBX,SUGA}$ = unsubsidised exports of sugar (apart from C sugar)

$\beta_{YLD,m,i,j}$ = base year yield of good i in activity j in Member State m

$\beta_{WP,i}$ = base period EU border price of product i

$\chi_{m,u,v}$ = marginal budget share parameters of the consumer demand equation in Member State m

$\delta_{m,u}$ = commitment parameters of the consumer demand equation in Member State m

$\varepsilon_{CNS,m,h,EXPE}$ = expenditure elasticity of food demand h in Member State m

$\varepsilon_{CNS,m,h,i}$ = elasticity of food demand h with respect to consumer price of item i in Member State m

$\varepsilon_{SETR,m}$ = elasticity of actual set aside to the obligatory set aside rate in Member State m

ε_{F} = small positive number in fallow land equation (= 0.001)

$\phi_{EXOF,m}$ = exogenous uncompensated fallow in Member State m

$\phi_{NET,EU,i}$ = slope parameter for Member state net exports reflecting price responsiveness of net trade in the EU

$\phi_{NET,m,i}$ = constant parameter for Member state m net exports, derived from base year net exports

$\phi_{SET,m}$ = constant set aside parameter for Member State m

$\gamma_{m,r,h}$ = processing coefficient: tons of processed output h per ton of raw product r

$\gamma_{m,SUGB,PRC}$ = fixed cost per ton of processed sugar beet

$\gamma_{i,c}$ = content of item c ∈ {FAT, PRT} in item i ∈ {BUTT, MIPO, OMPR, MILK, EGMI}

$\gamma_{i,PRC}$ = fixed processing cost associated with milk item i ∈ {BUTT, MIPO, OMPR, MILK, EGMI}

$\eta_{m,s}$ = energy requirement (s ∈ AACT) or content (s ∈ FEED) in Member State m

κ_2 = percentage lower bound for non-linear trend estimation in year t

λ_j = land requirement of activity j (=1 for j∈ CACT, 0 otherwise)

$\mu_{m,i,j,0}$ = constant term in trend for yield of i in activity j in Member State m

$\mu_{m,i,j,1}$ = slope in trend for yield of i in activity j in Member State m

$\theta_{m,z,i,CP}$ = initial probability weight for support point z of consumer price i in Member State m

$\theta_{m,z,s,t}$ = initial probability weight for support point z of elasticity of netput s wrt price variable t in Member State m

$\theta_{m,z,u,v}$ = initial probability weight for support point z of elasticity of consumer demand u wrt price of item v in Member State m (= 0.499 for z = 2,3)

$\theta_{m,z,u,E}$ = initial probability weight for support point z of elasticity of consumer demand u wrt expenditure in Member State m

$\rho_{m,s}$ = protein requirement (s ∈ AACT) or content (s ∈ FEED) in Member State m

$\sigma_{m,u,v|U}$ = Allen elasticity of substitution of item u wrt item v within aggregate U in Member State m

$\sigma_{m,U,V}$ = Allen elasticity of substitution of aggregate U wrt aggregate V in Member State m

$\tau_{m,i,j|I}$ = Allen elasticity of transformation of netput i wrt netput j within aggregate I in Member State m

$\tau_{m,I,J}$ = Allen elasticity of transformation of aggregate I wrt aggregate J in Member State m

$\tau_{m,\tilde{A},FEED}$ = Allen elasticity of transformation of animal aggregate Ã wrt total feed in Member State m

$\psi_{PRC,SUGB}$ = fixed cost per ton of processed sugar beet

$\psi_{m,r,0}$ = constant in processing function of raw product r in Member State m

$\psi_{m,r,r}$ = slope in processing function of raw product r in Member State m

ξ_j = set aside requirement of 1 ha of crop j

ω_{IND} = share of net revenue for sugar industry fixed cost and profit

$\omega_{m,SUBX}$ = weight of A levies in price determination of SUBX (X = A, B) in Member state m

8.7 Function symbols

π_m = profit function for agriculture in Member State m

ν_m = profit function for processing industry in Member State m

$C_{m,A}(.)$ = feed cost function per head of animal activity A ⊂ AACT in Member State m

C_m	=	cost function in Member State m
e_m	=	expenditure function in Member State m
V_m	=	indirect utility function in Member State m
G_m	=	marginal budget function in Member State m
F_m	=	commitment function in Member State m
T_f	=	operating capacity constraint on farm f
T_m	=	transformation function in Member State m
$G_{m,i}$	=	$\partial G_m / \partial CP_{m,i}$
$F_{m,i}$	=	$\partial F_m / \partial CP_{m,i}$
$\mathbf{D}_{m\,\vert I}$	=	column vector of demand functions $D_{m,i\,\vert I}$, $i \in I \subset$ ITEM conditional on group expenditure $EX_{m,I}$ in Member State m
$\hat{D}_{m,I}$	=	aggregate demand function I in Member State m

9. Appendix II: User Manual

This "user manual" is intended to help users of CAPSIM in the first steps to actually perform certain simulations on their own. For that purpose we have to explain how the different inputs for a CAPSIM simulation should be handled technically. The purpose and meaning of these inputs has been described in some detail already in Section 3 of the CAPSIM final report and this will not be repeated here.

Instead we will show one after the other how the different input options can be used and give some hints on how they should be used. It is unfortunate that this introduction cannot be adapted to the existing user surface for CAPSIM developed in the LEI under the heading of Gams Simulation Environment (GSE) by Wietse Dol and Foppe Bouma. The reason is that GSE does not yet permit to handle the most recent version of CAPSIM which incorporates a number of improvements over the version from June 2003 when GSE and CAPSIM were used in conjunction on a training session for Eurostat staff. Consequently we have to show the inputs in a format different from the GSE layout. Even though we are using our own user surface (see figure 2 in Witzke, Verhoog, Zintl 2001) it is not very helpful for future users to display screenshot from this technology if it is unlikely to be used in the future. However it is quite sure that the ultimate model input will be in the form of GAMS code. Consequently the common denominator will be to show all inputs quite close to form as they are imported to GAMS.

Another qualification ha to be made in this introductory section. All recent applications of CAPSIM (and other models) to serious policy issues such as Agenda 2000, MTR proposals, sugar CMO options and so forth have required changes in the model structure because the earlier versions have not been able to answer the questions at hand in a satisfactory way. Adjusting the source code of CAPSIM in a meaningful way will usually be the task of a specialist operator or even the model developer. Nonetheless it is useful to introduce an enlarged group of Commission staff to a system like CAPSIM because a great deal of time required for the preparation and analysis of major policy proposals is devoted to the fine tuning of assumptions and use of policy instruments. In this fine tuning Commission services might bring in their expertise if they know how to translate both their expectations on exogenous developments as well as their plans on policy specification into inputs for a quantitative modelling tool. At least on the EU level this is quite new terrain and it is likely that both users and developers will have to learn a lot.

The rest of this user manual is organised according to the inputs which are described in a nontechnical manner in section 3 of the final report. It will be useful to order these inputs as they addressed in the GAMS code:

1. Basic choice between policy simulation and reference run
2. Database import of default trend projections and reference run results on:
   - Yields
   - Exogenous activity levels
   - Exogenous prices
   - Industrial use trends
   - Population trends
   - Exogenous EAA positions (depreciation, wages)
   - Margins for consumer prices
3. Expert data to supplement or replace default trend projections:
   - Yields
   - Exogenous activity levels, input demands, consumer demands
   - Total final consumption expenditure and inflation
   - Set aside and non-food areas
   - Net trade quantities
4. Policy variables related to products and activities
5. Projections on EU border prices
6. Parameters of behavioural functions (activity levels, set aside, processing, consumer demand, net trade)

9.1 Choosing the type of simulation

One of the first and most important user settings steers the type of simulation to be performed. This information is incorporated in a scalar variable "SIM" which may be set to different values:

SIM = 0: Simulation mode to test the base year reproduction, usually only selected by technical experts.

SIM = 1: Simulation mode for the reference run. Permits and requires a multitude of settings.

SIM = 2: Simulation mode for the current MTR package with special treatment of premiums

SIM = 3: Simulation mode for standard policy simulations. Requires few settings beyond policy variables because they are taken over from the reference run.

Technically this crucial setting may be done at the top of the CAPSIM main program with a text editor or within the user surface GSE. In the former case the crucial section of the code in CAPSIM.GMS looks as follows:

```
*
* specify the kind of simulation Bas=> SIM = 0 ,Ref=> SIM=1, MTR=> SIM=2,
*                          => standard policy simulation = 3
* these flags activate appropriate treatments of
*                          * set membership in ENDOPW/FXPW
*                          * origin of trends (type REF or type TRD)
*                          * base year fixing of policy and other exogenous variables [in capsimX.gms]
*                          *
*                          * extension of the group subject to COP premia and ceilings
*                          * set aside equation                                     [in CAPSIMX_def.gms]
*
*                          * calibration of constants in behavioural functions       [in CAPSIMX_iter.gms]
*                          *
*                          * auxiliary output for subsequent sims                    [in CAPSIMX_res.gms]
*
*
$INCLUDE ENVIRONMENT.VAR
*<%INPUT%>
SCALAR SIM/1/;
*SCALAR SIM/3/;
*<%USERLEVEL 9 HIDE%>
*<%/INPUT%>
```

Depending on the desired type of simulation the user should make sure that the desired specification is active (not starred). As will become clear soon, this setting has important consequences.

9.2 Relying on default trends

It has been explained in Section 3.1 that CAPSIM requires different kind of inputs and that for many exogenous variables default trends are provided together with the database. The methodology to estimate these trends, different for some categories of variables has been presented in Section 3.3 as well.

CAPSIM has to read these default trends together with the base year data and the simulation results of a previous reference run to run properly. Currently these data are supplied in a big file "DATA_BASE.GMS" (see Figure 5.1-1). In all applications by EuroCARE this file has been prepared by Eurocare software based on FORTRAN. In applications with GSE, the user surface helps to handle this file. Alternatively it is also conceivable (but probably not very efficient) to handle the database in a spreadsheet or a text editor. Regardless of the technical tools used, CAPSIM expects an input file of the form in Table 9.2-1.

In the top part this file shows a general setting for GAMS (`$ONMULTI`) and sets and parameters to indicate the base and simulation years (`YEARS, ACTYEA, CALYEA`). After a few global settings (`$SETGLOBAL`) for information to be displayed in output and listing files there is a section to give the names and path for 6 output files of CAPSIM:

1. SOL.SDA: This is a complete output file for the FORTRAN based software or for GSE. It may be read by a text editor but in general users will not look into this file.
2. MODEL.CSV: This csv file is input for the spreadsheet macros producing the tables of Section 4.3. It includes the complete data for the base year (BAS), the reference run (REF) and the current simulation result (Y) and may be interesting for some users.

3. SUGAR.CSV: This is a small output table which was convenient during the sugar project but which will be ignored in general.
4. D0.GMS: See section 9.6
5. A_I00.GMS: See section 9.6
6. A_L00.GMS: See section 9.6

Table 9.2-1: Input file DATABASE.GMS (extract) with base year (BAS), default trend (TRD) and reference run (REF) data

```
*
*---------------- global switches ---------------------
*
$ONMULTI
*
 SET YEARS         Years where data are listed /Y   09
BAS 98
TRD 09
REF 09
/;
 SET ACTYEA(YEARS) Actual year to work for     /Y  09 /;
 PARAMETER CALYEA / Y   2009
BAS 1998
TRD 2009
REF 2009
 /;
$setglobal DATE  17.10.03
$setglobal TIME  09:00:07
$setglobal Descri  mlk liberalisation test
*
*---------------- file names --------------------------
*
 file SDATA   standard-formatted file for results / R:\CAPSIM\SRC\GAMS\CURRENT\SOL.SDA /
 file MODELCSV   csv-file for framework data / R:\CAPSIM\XLS\TABLES\MODEL.CSV /
 file SUGARCSV   csv-file for sugar summary / R:\CAPSIM\XLS\TABLES\SUGAR.CSV /
 file D0file   file for demand commitments / R:\CAPSIM\SRC\GAMS\CURRENT\D0.GMS /
 file A_I00file   file for APL parameter for input / R:\CAPSIM\SRC\GAMS\CURRENT\A_I00.GMS /
 file A_L00file   file for APL parameter for level / R:\CAPSIM\SRC\GAMS\CURRENT\A_L00.GMS /
*
*----------- run depended data ------------------------
*
 TABLE DATA(*,*,*,*) "regionalized Capsim basis data"
                         Y           BAS           TRD           REF
BL000.SWHE.SWHE             8.033708E+03  9.700826E+03  9.239716E+03
BL000.SEDF.SWHE             8.563337E+00  9.333790E+00  9.915833E+00
BL000.FEDM.SWHE             1.329315E+03  1.759965E+03  1.604545E+03
BL000.SEDM.SWHE             2.826620E+01  3.012534E+01  3.273057E+01
```

After the important file definitions there is finally the big (more than 16000 lines) data section with 4 columns of which only the first 4 data lines are shown here:

1. Y: this is still empty because it is for the current simulation
2. BAS: these are the base year data.
3. TRD: these are the default trend data
4. REF: these are previous reference run results

The first line of the data section in Table 9.2-1 shows the yield of soft wheat in the base year, according to the default trends and in the reference run. The reference run yield differs from the default trend because the latter has been overwritten with expert information in this reference run (see Table 9.3-1 below). In policy simulations most exogenous projections will be taken from the associated reference run (or from expert information) whereas the default trend column will be ignored and expert inputs are usually inadmissible. This happens automatically as soon as CAPSIM receives the information that SIM > 1. In this way the comparison of reference run and policy simulation occurs “all else equal” and thus permits to identify the policy “impacts”.

If the simulation is a reference run rather than a policy simulation, it is the reference run column REF which will be ignored and the default trends will be used for exogenous projections, except for those variables which are overwritten according to user supplied growth rates. It is therefore only one of the columns, TRD or REF, which will be used in a simulation but it turned out more convenient (with the EuroCARE software) to supply both of them and leave the selection internally to GAMS according to the value given to the indicator variable SIM. The irrelevant column (TRD in a policy simulation, REF in a reference run) may be filled with some data in a mechanical way (our solution) or it may be left empty. Depending on the available tool (EuroCARE software, GSE, or text editor) to supply the input file DATA_BASE.GMS the user may thus choose the most efficient way to provide this input.

9.3 Introducing expert information

It has been mentioned earlier that some of the options to supply expert information will not be open for ordinary policy simulations. This section gives nonetheless a complete introduction for the use of expert information even though the inexperienced user may want to confine him- or herself to policy simulations with only a few settings.

In section 3.6 it has been explained already that exogenous inputs may be specified for a number of variables (yields, activity levels, demand quantities and macroeconomic variables) in the form of growth rates which are translated to absolute values for the simulation year according to equation (143). Technically CAPSIM imports a small file “EXPERTx.PRN” (see Figure 5.1-1) containing the relevant growth rates. Usually it will be convenient to prepare all these growth rates in an underlying spreadsheet, and save them as a text file EXPERTx.PRN. However, technically it is only the latter file which matters to CAPSIM, regardless of how the growth rates are coming about.

EU growth rates will be applied in all Member States except where a different growth rate is entered on the Member State level. To save space only four columns for selected Member States will be shown, because the others look similar. For the vast majority of variables no expert information will be supplied at all, but Table 9.3-1 below shows that a number of growth rates have been supplied for the current reference run.

Regarding the option to overwrite default trends the consumer margins UMAC are a special case. Because they are calculated relative to EU prices (equation (66)), which are usually defined on the producer level, it was expected that they would increase and decreasing trends on these are ignored therefore in CAPSIM. Furthermore we had little confidence in the estimated heterogeneity across EU Member States such that only aggregate EU trends are used. As a consequence, the user may only overwrite the *EU trends* on UMAC but has no influence on consumer margins in Member States which are calculated according to (67).

However, due to their complex calculation it is not recommended to experiment with the default trends on UMAC without good reasons to do so.

Table 9.3-1: Expert information on average geometric growth rates for non trade variables for the EU and selected MS for 1998-2009 in an Agenda 2000 reference run (EXPERTx.PRN)

```
TABLE G_RATE(*,*,*)
                    EU000      BL000      DK000      DE000      IR000
EXPD.LEVL          0.0267
UVAD.REST          0.0188
HCOM.SUGA                     0.0031    -0.0033    -0.0129     0.0041
HCOM.SWHE          0.0058
HCOM.DWHE          0.0058
HCOM.BARL          0.0041
HCOM.MAIZ          0.0041
HCOM.OCER          0.0041
DWHE.LEVL          0.0095
NONF.LEVL           0.007
HCOM.RICE          0.0187
HCOM.VEAL          0.0018
HCOM.BEEF          0.0018
HCOM.PORK          0.0076
HCOM.POUF          0.0135
HCOM.SGMT          0.0051
HCOM.CHES           0.008
HCOM.BUTT          -0.003
HCOM.OMPR           0.005
HCOM.SMIP         -0.0155
FEDM.OCER          0.0041
SWHE.SWHE          0.0136
MAIZ.MAIZ          0.0143
BARL.BARL          0.0038
DWHE.DWHE          0.0122
OCER.OCER          0.0144
SETA.LEVL           0.028
OLIV.LEVL         -0.0222
GRAS.LEVL                     0.0001
GROF.LEVL                                                     -0.0012
OCRO.LEVL                                0.0165
;
```

A few additional comments are worthwhile.

EXPD.LEVL: Aggregate final consumer expenditure might be taken from our default trend projection but given that the EU Commission is publishing forecasts for real GDP growth these estimates can be used here. Note that the entry should be a growth rate for *real* expenditure (or GDP).

UVAD.REST: For a reference run the inflation rate *must* be supplied here because there are no default trends. Usually this will also come from Commission forecasts.

HCOM.SUGA: For a number of items the DG Agri prospects give projections for human consumption which are converted to growth rates in a spreadsheet and entered here, but only in the reference run[43]. Because sugar consumption was evidently important in the sugar study, specific regressions have been untertaken for it such that we have the first example with Member State specific exogenous inputs.

DWHE.LEVL: Activity levels are usually endogenous, except for the set of fixed activities FXACT. In a reference run we may introduce exogenous forecasts also for those activities which are handled endogenously in the policy simulations, for reasons discussed in Section 3.6 and at the beginning of Section 3.3. For DWHE this was decided in the light of preliminary simulation results whereas for other activities (∈ REF_A_L0) this will be the standard solution in the reference run.

NONF.LEVL: Without a growth rate for non-food areas this would be estimated from the base period ratio to set aside. At least for the reference run the DG Agri "Prospects" usually offer a more sophisticated projection, which may be introduced here. However, given the simplistic default treatment of non-food area, it may be recommended to use an exogenous forecast also for policy simulations.

FEDM.OCER: Feed demand is usually endogenous. In a reference run we may nonetheless introduce exogenous forecasts where appropriate. As explained in Section 3.6 this option has been used for other cereals. It would be easy to introduce a corresponding input possibility also for non-agricultural inputs {IPLA, IGEN} but this is not yet foreseen.

SWHE.SWHE: Yields are offered from the default trends calculated by CAPSIM, see Section 9.2. If desired, they may be overwritten here with information from other sources. In this case we used this option to specify yield growth in line with the DG Agri "Prospects". If only EU trends are supplied, CAPSIM will adjust the default trends according to the supplied average but preserve the relative differences in yield growth between MS. In the policy simulations the yields of the associated reference run will be maintained (and any growth rates supplied will be ignored).

SETA.LEVL: For a reference run, the development of set aside area *must* be supplied here (e.g. from the DG Agri "Prospects"), because this forecast is used internally to calibrate the set aside equation. However, given the simplistic treatment of set aside (see Section 2.4.2), it may be recommended to use an exogenous forecast also for policy simulations.

OLIV.LEVL: Olives and other crops are examples of activities which are projected according to the default trends in a standard reference run (OLIV,OCRO ∈ REF_A_L0). These default trends may be overwritten here with other forecasts. In policy simulations these activities will be endogenous (and growth rates will be ignored).

GRAS.LEVL: Grassland is always treated as an exogenous activity (GRAS ∈ FXACT) and projected according to the default trends. It appeared useful to overwrite these in a number of MS. It may but need not be appropriate to change this exogenous forecast in policy simulations, for example if a policy is likely to

[43] Remember that the policy simulations build on these forecasts through the recalibrated commitment parameters.

increase the grassland area in a significant amount. This information may also be supplied in the form of an average growth rate (against the base period!)

GROF.LEVL: Default trends for total area (exogenous) may be overwritten here as well.

Apart from the geometric growth rates in Table 9.3-1 the file EXPERTx.PRN also includes growth rates for exogenous projections of net trade, in this case in the form of "arithmetic growth rates" to permit a change in the net trade position, see equation (144). For the Agenda 2000 reference run Table 9.3-2 shows the exogenous inputs as they are included by the GAMS program. They may be displayed in a more convenient form with the GSE user surface but they can also be manipulated in a text editor.

Table 9.3-2: Expert information on average arithmetic growth rates for EU net trade for 1998-2009 in an Agenda 2000 reference run (EXPERTx.PRN)

```
TABLE G_NETTRD(*,*)
                        Y
PORK              -0.0112
POUM              -0.0961
VEAL                 -0.1
SGMT               0.0185
OMPR              -0.0909
CHES              -0.0909
FRUI               0.0294
VEGE               0.0824
STAR             0.000001
POTA             0.000001
EGGS             0.000001
;
```

Having explained the various trade regimes at some length in Section 2.5.2 it is sufficient here to remind the reader which cases apply.

PORK, POUM, VEAL, POTA: These are in trade regime 4 (because they are members of a corresponding set A_L0_EU) achieving the given net trade balance through an adjustment of constants of activity level equations. Note that a very small positive number is entered for POTA which fixes net trade to its base year value. The exogenous projection will be translated into the constant parameter for net trade equation (99), such that these items will be regrouped into trade regime 1 in ordinary policy simulations. Consequently there is no need to supply growth rates for these items in ordinary policy simulations.

SGMI, EGGS, VEGE, FRUI, STAR: These are in trade regime 5 where the border price is only implicit. Some growth rates *have* to be supplied for these items in the reference run because a zero (or missing) growth rate presupposes that there is at least a reasonable projection for the border price change. In regime 5 EU markets may clear with fixed net trade and the implied border price is calculated backwards from the EU price and an assumed tariff (default = base period, see Section 9.3). These items are also handled according to Regime 1 in ordinary policy simulations, and consequently there is no need to supply growth rates then.

CHES, OMPR: These are in trade regime 7, but the default assumption for this group, net trade as in the base period, was considered implausible. Growth rates may also be supplied in policy simulations and in the milk liberalisation run mentioned above the assumed decline of net exports has been reduced (-0.0833 rather than –0.0909).

Apart from the last examples of CHES and OMPR (and possibly other members of set MSBAL), OCER is the only case where an exogenous growth rate is useful in policy simulations because the unfortunate aggregation level may lead to unreasonable results, see Section 2.5.2. Because the OCER treatment in regime 3 presupposes a certain set membership, it cannot be used for other items (without corresponding changes in the set definitions in CAPSIMx_SETS.GMS). As a consequence, the user should not supply growth rates in policy simulations for net trade beyond the set MSBAL ∪ {OCER}, as this will cause errors. The admissible entries are summarised in Table 9.7-2 below.

Before moving on to other exogenous inputs it may be interesting to look at the milk market results of an Agenda 2000 reference run with all settings as for the reference run described in Section 4.2 except for the growth rates of net trade on CHES and OMPR. Setting these growth rates to zero will activate the default assumption of constant net trade and lead to the following picture which may be compared with Table 4.2-1 above.

Table 9.3-3: Overall market picture on EU markets [1000 t] for milk products in a CAPSIM reference run for 2009 ("Y") and in the base year ("BAS")

PARAMETER overall

	sup.bas	sup.y	dem.bas	dem.y	net.bas	net.y
EU000.COMI	121941	125371	121941	125371	0	0
EU000.BUTT	1888	1798	1884	1846	4	-47
EU000.SMIP	1109	608	1021	980	89	-372
EU000.CHES	6635	7195	6379	6939	256	256
EU000.OMPR	43686	46087	42666	45067	1021	1021

First of all we see that the default treatment of MSBAL items indeed imposes a fixed net trade. Because demand growth was specified in exactly the same amount according to the growth rates in Table 9.3-1 in both simulations higher net exports require correspondingly higher net production of cheese and other milk products. As net trade is also close to zero for raw milk the supply of raw milk will be the same under the quota regime in both simulations. Given the balances on milk fat and protein an increased production of cheese and other milk products necessarily requires lower production of butter and skimmed milk powder, which leads to significant net imports for these items. Given this imbalanced situation it was considered appropriate to influence the composition of milk products through an adjustment of exogenous net trade quantities through the growth rates in Table 9.3-2.

9.4 Changing policy variables

The origin and meaning of various policy parameters for the current Agenda 2000 reference run has been described in section 3.4. Here we may show how the technical model input is looking like for activity related policy variables (Table 9.4-1). The layout of this table will depend on whether it is viewed through a user surface, with a text editor or with some other software. Because similar entries are occurring for each Member State (and none for the EU level) we may look at Germany only (code DE000). Matching tables will be imported into

CAPSIM for the current simulation (POLA_SIM), for the chosen reference run (POLA_REF) and for the base year (POLA_BAS), see Figure 5.1-1 and the user should check that all files contain the appropriate values.

Table 9.4-1: Policy variables related to activities for Germany in 2009, Agenda 2000 reference run (POLASIM.PRN)

```
* political variables in CAPSIM definition for the simulation year
* derived from the programm pola_cal

TABLE    POLA_SIM(*,*,*)
                  SETR     PREM     PRET     HIST     CEIL
DE000    .SWHE       0        0       63     5.17        0
DE000    .DWHE       0    46.17       63     5.06       10
DE000    .BARL       0        0       63     5.05        0
DE000    .MAIZ       0        0       63     5.72        0
DE000    .OCER       0        0       63     4.89        0
DE000    .RAPE       0        0       63     5.17        0
DE000    .SUNF       0        0       63     5.17        0
DE000    .OLIV       0        0        0        0        0
DE000    .PULS       0        0     72.5     5.46        0
DE000    .POTA       0        0        0        0        0
DE000    .OCRO       0        0        0        0        0
DE000    .MAIF       0        0       63     4.27        0
DE000    .GRAS       0        0        0        0        0
DE000    .SETA       0        0       63     6.97        0
DE000    .NONF       0        0       63     6.97        0
DE000    .FALL       0        0        0        0        0
DE000    .DCOW       0        0   100.79        0        0
DE000    .SCOW       0   159.35   100.79        0   639.54
DE000    .BULF       0   161.77   100.79        0   1782.7
DE000    .HEIF       0        0   100.79        0        0
DE000    .CAMF       0        0       50        0        0
DE000    .CAFF       0        0       50        0        0
DE000    .HENS       0        0        0        0        0
DE000    .POUF       0        0        0        0        0
DE000    .OANI       0        0        0        0        0
DE000    .OILS       0        0        0        0      929
DE000    .VEGE       0        0        0        0        0
DE000    .FRUI       0        0        0        0        0
DE000    .PIGS       0        0        0        0        0
DE000    .GCOP     0.1        0        0        0    10156
DE000    .SHEE       0     20.3        0        0     2432
DE000    .SOTH       0        0       63     5.17        0
DE000    .FCAL       0        0        0        0   501.36
DE000    .ACAT       0        0        0        0  4251.15
DE000    .SUBA       0        0        0        0        0
DE000    .SUBB       0        0        0        0        0
DE000    .SUBC       0        0        0        0        0
DE000    .TIND       0        0        0        0        0
DE000    .WINE       0        0        0        0        0
DE000    .OFOD       0        0        0        0        0
```

The following comments to the columns will be useful:

SETR: The obligatory set aside rate may be specified only for the complete cereal, oilseeds, protein crop group (GCOP) and not for individual crops.

PREM: Activity specific premiums are currently included and tested only for a number of activities. However, they may be introduced, abolished or modified according to the interests of the user but "unreasonable" entries may cause simulations to end in an infeasibility.

PRET: Group specific premiums per unit are usually entered in the same amount for all members of the group, for example the arable crop group. However, uniform premiums are not necessary in technical terms. However, the members of a group are tied together through a common ceiling, see below.

HIST: Historical yields are associated with the previous variable PRET, see equation (74). The Agenda 2000 package has shown that occasionally these factors may be changed, as policy requires.

CEIL: Ceilings may be set almost without limitations for activity specific premiums (in reasonable limits) and may cause some downward scaling (PREMFAC < 1 in equation (74)). Ceilings for group specific premiums, however, require the definition of these groups which currently occurs in a basic file (CAPSIM_SETS.GMS, see Figure 5.1-1) which is not accessible to ordinary users. The only predefined groups ready for ceilings are arable crops (GCOP), adult cattle (ACAT), calves for fattening (FCAL) and the set of crops eligible for MTR premiums (MTRACT).

To illustrate the effect of changed policy variables the specific premiums for male cattle BULF.PREM have been set to zero for all Member States. This may be done either by setting the corresponding cells to zero in a text editor, in the GSE user surface or in a small auxiliary GAMS program (our solution). It gives the following results on activity levels, comparable to the above Table 4.2-3, if all other settings are preserved as in the standard Agenda 2000 reference run. This change would evidently change the relative profitability of cattle activities with predictable consequences (Table 9.4-2).

Table 9.4-2: Selected activity levels in Germany and in the EU [1000 ha or hd] in a modified Agenda 2000 run with zero special male premiums for 2009 ("Y") and in the base year ("BAS") with deviations ("DEV")

	PARAMETER	lvllst	
	BAS	Y	DEV
DE000.DCOW	4925	4056	-0.176
DE000.SCOW	735	870	0.184
DE000.BULF	2024	1858	-0.082
DE000.HEIF	814	780	-0.041
DE000.CAMF	629	473	-0.249
DE000.CAFF	228	181	-0.206
EU000.DCOW	21491	18323	-0.147
EU000.SCOW	11783	12490	0.06
EU000.BULF	11017	10175	-0.076
EU000.HEIF	4724	4546	-0.038
EU000.CAMF	3810	3564	-0.064
EU000.CAFF	2227	2005	-0.1

Next we may look at policy variables related to products which are included in files POLP_BAS.PRN, POLP_REF_PRN and POLP_SIM_PRN, see Figure 5.1-1. Because similar entries exist for all Member States we may confine our attention to Germany and to the EU.

Table 9.4-3: Policy variables related to products for Germany and the EU in 2009, Agenda 2000 reference run (POLPSIM.PRN)

```
* political variables in CAPSIM definition for the simulation year
* derived from program polp_cal

TABLE    POLP_SIM(*,*,*)
                    QTS1     QTS2     PADM     MADM     TARA     TARR     PAYT     EXPQ     IMPQ     PPO1
DE000    .COMI    28184.6        0        0        0        0        0    24.88        0        0        0
DE000    .SUGA    2552274   784750        0        0        0        0        0        0        0        0
EU000    .SWHE          0        0   101.31        0        0        0        0    14438        0        0
EU000    .DWHE          0        0   101.31        0        0        0        0        0        0        0
EU000    .BARL          0        0   101.31        0        0        0        0  10843.2        0        0
EU000    .MAIZ          0        0   101.31        0        0        0        0        0        0        0
EU000    .OCER          0        0   101.31        0        0        0        0        0        0        0
EU000    .BEEF          0        0     2224        0        0        0        0    821.7        0        0
EU000    .VEAL          0        0        0        0      500        0        0        0        0        0
EU000    .PORK          0        0        0        0        0        0        0    443.5        0        0
EU000    .EGGS          0        0        0        0        0        0        0     98.8        0        0
EU000    .POUM          0        0        0        0        0        0        0      286        0        0
EU000    .RICE          0        0        0        0        0        0        0    133.4        0        0
EU000    .SUGA          0        0    631.9        0        0        0        0   1273.5        0        0
EU000    .OLIO          0        0        0        0        0        0        0      115        0        0
EU000    .BUTT          0        0  2510.73        0        0        0        0    399.3        0        0
EU000    .SMIP          0        0  1901.06        0        0        0        0    272.5        0        0
EU000    .CHES          0        0        0        0        0        0        0    321.3        0        0
EU000    .OMPR          0        0        0        0        0        0        0    958.1        0        0
;
```

The following comments will be useful

COMI.QTS1: National milk quotas are specified according to the Agenda 2000 decision. For the illustrative milk liberalisation run these quotas are set to zero which is automatically taken to mean “no quota” rather than a ban on milk production.

SUGA.QTS1: The sugar A (= QTS1) and B (= QTS2) quotas are determined by iterative cuts of the base period quotas according to the declassification key of the sugar CMO to avoid intervention in spite of sluggish demand (by trial and error). The distribution of quota cuts to MS may be handled in a spreadsheet or in a small auxiliary GAMS program (our solution).

SWHE.PADM: The administrative prices are specified as explained in Section 3.4.2. Remember their adjustment according to equation (142). In the milk liberalisation run the support prices for butter and skimmed milk powder are set somewhat below the border prices (€1700 and €1500, respectively) because in technical terms this may ease the solution behaviour compared to setting them to zero. This “trick” may be recommended for all abolishments of support prices.

SWHE.MADM: Currently this is a dummy column for maximum intervention purchases which is not yet sufficiently tested in the model. At the moment MADM should not be used therefore.

VEAL.TARA: Remember from Section 3.4.2 that for items without administered prices the entire difference of EU and border prices is attributed to a specific tariff which is calculated internally, consistent with equation (83). Without an explicit specification of TARA for the simulation it is assumed that this base period tariff shall be maintained. For veal it was calculated to be € 971/t as may be concluded from Table 4.2-5. Hence the € 500 entry for VEAL.TARA reflects the expectation that EU authorities would not only reduce support prices for beef but that they would also adjust border protection for veal somewhat. The zero entry for pork, on the contrary, implies that the base period TARA should not change from the base period, not that it will be set to zero. To enforce a zero tariff, the user should enter a small positive value (e.g. 0.001).

VEAL.TARR: Relative tariffs are foreseen in CAPSIM but so far they have not been used or tested systematically.

COMI.PAYT: The Agenda 2000 milk premium per ton entered here is the sum of the EU premium plus the national envelope divided by the national milk quota in 2006. Remember that they are converted internally into a premium per cow (Footnote 34).

SWHE.EXPQ: Export quotas are specified for calendar years (our solution: in a small GAMS file), but otherwise as given in official documents. The internal adjustment according to equation (101) will translate them to the net trade concept of CAPSIM. For some items the limits entered will be combined internally to a limit for a group. This holds for wheat = {SWHE, DWHE}, coarse grains = {BARL, MAIZ, OCER} and BEAF & VEAL.

SUGA.IMPQ: An import quota has been used in the sugar project to handle increased market access for LDCs. As is explained under equation (102) the entry should be for *additional* gross imports, because the base period gross imports are already incorporated in the internal redefinition of official export quotas in equation (101).

SUGA.PPO1: Policy instruments PPO1 to PPO3 (with zero columns for PPO2 and PPO3 omitted in the table) are dummy columns for ad hoc import of additional policy variables in shortcut solutions to specific issues which may be interesting for users able to manipulate the GAMS code. Usually these columns will be left empty (but they have been used in the aforementioned sugar project).

9.5 Supplying border prices

The input of border prices closely resembles Table 3.5-1 above except that the figures are imported in decimal form. As is the case for the growth rates incorporating expert information, the two files WP_BAS.PRN and WP_REFx.PRN imported in the CAPSIM main program (see Figure 5.1-1) are currently prepared in corresponding spreadsheets, but this may be handled also in GSE or in any other way.

Table 9.5-1: Technical input of reciprocal protection coefficients (left, WP_BAS.PRN) and border price changes in index form (right, WP_REF09.PRN) in CAPSIM

```
*<%input%>
*<%userlevel 99%>
TABLE WP_bas(rows,IOY)   world market prices for the base year
                          BAS
SWHE                 0.93105
DWHE                 0.00000
BARL                 0.81410
MAIZ                 0.88442
OCER                 0.74731
PULS                 1.00000
POTA                 1.00000
SUBA                 0.00000
SUBB                 0.00000
SUBC                 1.00000
RAPE                 1.00000
SUNF                 1.00000
SOTH                 1.00000
OLIV                 0.45358
TIND                 0.00000
VEGE                 0.69374
FRUI                 0.66513
WINE                 1.00000
OCRO                 0.00000
COMI                 0.00000
BEEF                 0.69458
VEAL                 0.00000
PORK                 0.94107
SGMI                 0.00000
SGMT                 0.82041
EGGS                 0.94961
POUM                 0.80807
OANI                 0.00000
MAIF                 0.00000
OFOD                 0.00000
GRAS                 0.00000
YCAM                 0.00000
YCAF                 0.00000
RICE                 0.76868
MOLA                 0.96939
STAR                 1.00000
SUGA                 0.33744
RAPO                 1.00000
SUNO                 1.00000
SOYO                 1.00000
OLIO                 1.00000
RAPC                 1.00000
SUNC                 1.00000
SOYC                 1.00000
OLIC                 0.00000
BUTT                 0.54271
SMIP                 0.72841
CHES                 0.51590
OMPR                 0.51590
IGEN                 1.00000
IPLA                 1.00000
FPRI                 1.00000
FENI                 1.00000
FOTI                 1.00000
REST                 0.00000
;
```

```
*<%input%>
*<%userlevel 1%>
TABLE WP_ref(rows,IOY)   world market prices for the simulation year
                          Y
SWHE             1.11348
DWHE             0.00000
BARL             1.14508
MAIZ             1.10667
OCER             1.12661
PULS             1.07358
POTA             1.07358
SUBA             0.00000
SUBB             0.00000
SUBC             1.07358
RAPE             1.00204
SUNF             1.07711
SOTH             1.00583
OLIV             0.00000
TIND             0.00000
VEGE             0.00000
FRUI             0.00000
WINE             0.00000
OCRO             0.00000
COMI             0.00000
BEEF             1.15002
VEAL             0.00000
PORK             1.16230
SGMI             0.00000
SGMT             0.00000
EGGS             0.00000
POUM             1.10118
OANI             0.00000
MAIF             0.00000
OFOD             0.00000
GRAS             0.00000
YCAM             0.00000
YCAF             0.00000
RICE             0.93596
MOLA             1.07358
STAR             0.00000
SUGA             1.03715
RAPO             1.06580
SUNO             1.02541
SOYO             0.98290
OLIO             0.00000
RAPC             1.18262
SUNC             1.42456
SOYC             1.14011
OLIC             0.00000
BUTT             1.19859
SMIP             1.15000
CHES             1.19671
OMPR             1.19772
IGEN             0.00000
IPLA             0.00000
FPRI             0.00000
FENI             0.00000
FOTI             0.00000
REST             0.00000
;
```

The interrelationship of trade regimes and border price information has been explained already in Section 3.5, but a few comments shall be given nonetheless, first on the base period prices.

SWHE: In the typical case border price information is available, and items are sorted into regime 8 or 9 for the reference run and into regime 1 or 2 for policy simulations.

DWHE: For DWHE and VEAL the border price information was taken to apply to the aggregate of SWHE+DWHE and BEEF+VEAL, respectively.

SUBA: Border price information is not required for members of set MSBAL handled according to regime 6. These do not even require a central EU market price.

TIND, OCRO, OANI, STAR: If no base period border prices are given, but an EU price exists, zero protection will be assumed (except for VEAL and DWHE).

Regarding the border price changes the following comments apply.

SWHE: In the typical case border price changes are available from FAPRI.

PULS: Absent FAPRI information it has been assumed sometimes that Dollar prices are constant but at least the exchange rate changes apply (PULS, POTA, MOLA)

SUBA: Border price changes are not required for members of set MSBAL handled according to regime 6. These do not even require a central EU market price.

TIND, OANI, WINE, OCRO, OLIO, OLIC, OOUT, IPLA, IGEN, REST: Border price changes are not required for items with exogenous specification of EU prices (regime 11). The EU prices are usually taken from default trends (see below) and border prices follow from the assumption of fixed tariffs.

VEGE, SGMI, EGGS, FRUI, STAR: Remember trade regime 5 which is another answer to missing information on border price changes.

FENI, FPRI: Where required (regimes 8+9+10) it has been assumed that border price changes equal those of SWHE in case of missing values.

9.6 Using updated parameters

It has frequently been mentioned that certain parameters of behavioural functions are recalibrated during a reference run to comply with exogenous specifications, e.g. at the beginning of Section 3.3. However, many reference runs will be considered purely explorative until a "satisfying" result has been obtained which should serve as a yardstick for associated policy simulations. These policy simulations should inherit the recalibrated parameters from the associated reference run. To prevent an inadvertent use of "temporary" parameters in a whole series of simulations, including reference runs, the current solution is as follows:

- After each reference run the recalibrated constant terms of activity level equations, of feed demand equations and the commitments of consumer demand equations are exported to files A_L00.GMS, A_I00.GMS and D0.GMS, respectively.
- For policy simulations these recalibrated parameters are imported under different names, as A_L00_PAR.GMS, A_I00_PAR.GMS and D0_PAR.GMS, respectively, see Figure 5.1-3.
- It is in the user's responsibility to copy or rename the exported files, if the reference run is considered usable, to the previously mentioned input files and to save any versions which might be needed at some later point in time.

This solution carries along with it the risk that policy simulations are run without updating the parameters. On the other hand it avoids the risk that valuable files are overwritten inadvertently. It may be that the user surface GSE will offer more convenient solutions to this problem in the future but at the moment this issue is not yet solved in GSE which limits its current usefulness.

The three files are looking as in Table 9.6-1, but to conserve some space we have only reproduced the numbers for one region (Belgium+ Luxembourg = BL000) therein. The other (price related) parameters are only updated occasionally according to the methodology explained in Sections 2.1.2 and 2.2.2 but this will be a task for a system administrator with a sufficient knowledge of GAMS to do without a user manual.

It may also be mentioned here that there is no need to worry about the parameters of the set aside equation and the net trade equation. These are calculated rather simply from the reference run results on set aside areas, net trade quantities and border prices, thus avoiding the need to store these parameters as well.

Table 9.6-1: Updated parameters from an Agenda 2000 reference run for use in policy simulations

DO_PAR.GMS:

```
TABLE DO(*,*,*) Modified commitments in demand functions
                  LEVEL
BL000.SWHE      80.2143
BL000.DWHE      11.3964
BL000.BARL       0.1467
BL000.MAIZ       0.4018
BL000.OCER       1.5623
BL000.BEEF      11.2836
BL000.VEAL      -0.7149
BL000.PORK      33.9685
BL000.SGMT       1.3175
BL000.RICE        2.462
BL000.SUGA      35.9491
BL000.BUTT       4.0386
BL000.SMIP       0.9595
BL000.CHES      11.5755
BL000.OMPR      73.5006
;
```

A_L00_PAR.GMS:

```
TABLE A_L00(*,*,*) modified ALP parameters of levels wrt zero
                  LEVEL
BL000.POTA      46.1757
BL000.TIND      28.3356
BL000.WINE        1.163
BL000.OCRO      75.9097
BL000.DCOW      586.953
BL000.CAMF     264.8065
BL000.CAFF     126.1459
BL000.PIGS    10603.466
BL000.POUF     225.1109
BL000.SETA      20.1059
;
```

A_I00_PAR.GMS:

```
TABLE A_I00(*,*,*) modified ALP parameters of inputs wrt zero
                  LEVEL
BL000.OCER    -120.2818
;
```

9.7 Remembering everything

The previous sections have explained multiple settings for CAPSIM, which have to be kept in mind while applying CAPSIM. The following checklist draws together the main settings to help keeping track of them.

Table 9.7-1: Checklist for user input in reference run and policy simulations

1	Simulation type	▪ SIM?
2	DATA_BASE	▪ Column BAS?
		▪ Column TRD?
		▪ Column REF?
3	Expert growth rates	▪ For nontrade variables (G_RATE)?
		▪ For net trade (G_NET)?
4	Policy variables	▪ For base year (POLA_BAS, POLP_BAS)?
		▪ For reference (POLA_REF, POLP_REF)?
		▪ For current simulation (POLA_SIM, POLP_SIM)?
5	Border prices	▪ For base year (WP_BAS)?
		▪ For current simulation (WP_REFx)?
6	Parameter update (if policy simulation)	▪ For supply side (A_L00_PAR.GMS, A_I00_PAR.GMS)?
		▪ For consumer demand (D0_PAR.GMS)?

Furthermore we may summarise the admissible inputs in the reference run and in policy simulations for the variables concerned.

Table 9.7-2: Admissible exogenous inputs for CAPSIM in a reference run and in policy simulations

	Columns	Rows	Region	Policy simulation	Reference run
TRD	INHA,GROF	LEVL	MS	No	➨
TRD	PACT \ CAMF, CAFF, PIGS, POUF	AGRO \ YCAL	MS	No	➨
TRD	FXACT, REF_A_L0	LEVL	MS	No	➨
TRD	INDM	ITEM	MS	No	➨
TRD	PRICES	FXPTE	EU	No	➨
TRD	EAAP,EAAB	DEPB,DEPM,WAGE	MS	No	➨
TRD	UMAC	ITEM	EU	No	➨
G_RATE	EXPD	LEVL	MSEU	No	➨
G_RATE	UVAD	REST	MSEU	No	➨
G_RATE	PACT \ CAMF, CAFF, PIGS, POUF	AGRO \ YCAL	MSEU	No	➨
G_RATE	HCOM	ITEM	MSEU	No	➨
G_RATE	PACS (becomes element of REF_A_L0)	LEVL	MSEU	No	➨
G_RATE	FEDM	ITEM	MSEU	No	➨
G_RATE	FXACT	LEVL	MSEU	➨	➨
G_RATE	SETA,NONF	LEVL	MSEU	➨	➨
G_NETTRD		ITEM \ FXPTE,MSBAL, OCER, FXPW	EU	No	➨
G_NETTRD		OCER	EU	➨	No
G_NETTRD		MSBAL	EU	➨	➨
G_NETTRD		FXPW from A_L_EU	EU	No	➨
POLP	POLVP	POLPRD	MSEU	➨	➨
POLA	POLVA	POLACT	MSEU	➨	➨
WP		FXPW (regimes 3+4+7+8+9+10)	EU	➨	➨

Specifying the input according to the explanation in this Appendix[44] should permit the user to make first experiences on his/her own with CAPSIM applications.

44 As a kind of postskript we may point to the software section 5.1 for a brief explanation on other input files which are less frequently updated and consequently may be omitted from this introduction, also because their manipulation will closely resemble the update of other files such as EXPERT.PRN. These other input files are: FEOSH.PRN, SUGAR_DAT.GMS, MLKQRENT.PRN, FEOGA.PRN, FEOGP.PRN, PARAMD.GMS, DBAS_PAR.GMS, PARAMS.GMS, ENETT.PRN, CUSE.PRN, EUSE.PRN, CNS_MARG98.PRN.

10. Appendix III: Coverage of Candidate Countries

10.1 Background

Annex 1 of the CAPSIM contract (Lot 2) required in terms of Candidate Countries (CC) that

1. the model be able to reflect the agricultural situation in the CCs and that
2. the model provides product balances for CAP commodities plus crops important in terms of land use, farm income results , factor use and budget results

To achieve these goals while avoiding duplication of efforts it was envisaged to rely heavily on the modelling work in the parallel IDARA project undertaken by staff from the Institute of Agricultural Policy in Bonn and sponsored by DG Research. This project had as a starting point the same MFSS99 model which is also the origin of CAPSIM, such that a later integration of the two modelling activities appeared easy to accomplish. At the same time the IDARA network could indirectly mobilise expertise from the West and East European partners which would not have been available to this project otherwise.

Judged from an ex post perspective we still consider this to be a very sound plan but certain difficulties have been underrated. Whereas the technical starting point in terms of modelling was identical in the two projects, the preconditions for implementation were quite different:

- In the EU15 detailed market balances, activity level information and revised EAA data have been available in standardised form from Eurostat. The work on the database could be confined to render these data fully consistent internally and consistent with the model equations and to complete a certain number of missing or incomplete series.
- In the Candidate Countries EAA data were in the process of compilation and therefore monetary information was fragmentary and varied significantly between countries. Physical information was partly available on the Eurostat website but with so many gaps that it appeared more efficient to compile the IDARA model database from scratch, relying entirely on statistical information from national statistics or compiled in the partner institutes in the IDARA project.

A good part of the efforts in the IDARA project had to be devoted therefore to this database work and to the clarification of model requirements with CC partner institutes. Given this situation it is not very surprising that the IDARA model I-SIM introduced only minor modifications from the original MFSS99 framework.

Modelling work on the EU15 level could envisage instead to overcome a number of methodological limitations and these methodological orientation was supported by the advice from the CAPSIM reference group. Additional improvements were the result from parallel applications on behalf of DG Agri for MTR and sugar CMO analyses. This experience was flexibly picked up in the course of the project. In methodological terms CAPSIM went ahead therefore (see the main report) and left I-SIM behind. Bearing in mind the different starting conditions in terms of data availability and project organisation, this was considered by all sides the most efficient way to approach the ultimate aim of an agricultural sector model adequate both in methodology as well as in geographical coverage.

Based on the groundwork by both CAPSIM and IDARA teams and due to the significant progress on data quality achieved at Eurostat, the starting conditions for a fully integrated and symmetrical approach to CC modelling are vastly improved now. In the framework of the current effort all that appeared feasible was a coordinated use of CAPSIM and the three I-SIM satellite models supplemented with a pragmatic extrapolation to other Candidate Countries. The details of this application will be explained in the following.

10.2 Overview on I-SIM models for Poland, Hungary and the Czech Republic

As has been mentioned in the previous section the I-SIM models have preserved to a very large extent the original MFSS99 structure (Witzke, Verhoog, Zintl 1999). This implies, for example that I-SIM does not yet fully reflect the revised EAA definitions, that it still uses double log behavioural functions and so forth. These characteristics need not be repeated here (see the documentation[45] included on the associated CD-ROM).

However given that MFSS99 is an EU15 model and the I-SIM models are for single countries we may explain that these models are operated technically as if there was an EU with a single Member State which is the respective Candidate Country. Relying on this "trick" it was possible to use the MFSS99 framework and to represent market clearing in the satellite models on the "EU level" which simply becomes the "market level" in the framework of the I-SIM country models. All policy variables specified for EU Member States, for example the premiums, may be combined with policy variables on the market level, for example tariffs, to reflect the national course of policy in these Candidate Countries.

The main interest of modelling efforts in the IDARA project was, quite understandably, the impact of EU accession on these countries. This implies that the reference situation of this project was a "no accession" scenario, which has become quite hypothetical in the meantime, now that the fact of accession and the details on the transition period have been defined precisely on the Copenhagen summit. On the contrary the policy scenario of IDARA, namely accession to the EU, will be a natural reference situation for future policy simulations, as will be shown in section 10.4.

The main addition of the IDARA efforts to the MFSS99 shell was the specification of exogenous inputs which includes policy variables, trends and elasticities. In all cases the starting values or the initial procedure was borrowed from MFSS99 but staff from the partner institutes in Poland, Hungary and the Czech Republic was participating in the task to check and revise these initial settings where appropriate.

10.3 Database for the Candidate Country application of CAPSIM

Regarding the three countries covered by the IDARA project the database has been developed in the course of the project, integrating national sources from the partner institutes with information from international organisations such as FAO or OECD. This database is documented on a supplementary I-SIM CD-ROM.

To illustrate the possibility to obtain a rough estimate for other Candidate Countries as well the simulation results from the three I-SIM models are extrapolated to other Candidate Countries using conversion factors which have been derived from Agris and FAO information on selected variables for all CCs in years 1998-99.

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45 Bauer, K. (2002): I-SIM Documentation, Working Paper 1/3, Work Package 8, Version 1-2002, Bonn.

Agris was the source for market balances of crop products, areas and values of total output, total input, gross value added at basic prices as well as factor income. FAO data had to be used for market balances of sugar, butter and various meats. The underlying data are fully included in an excel file (all-candies.xls) which is part of the CD-ROM delivered with this report.

10.4 Illustrative simulations on Candidate Countries using CAPSIM

The simulation described in this section demonstrates that it is possible to obtain results on EU15 and Candidate Countries for a number of key variables with the help of CAPSIM and the existing I-SIM satellites. Because the respective models are not yet integrated technically, coordination is brought about by the appropriate choice of certain exogenous variables: The I-SIM satellite models will basically adjust to EU prices determined in CAPSIM with some exceptions explained below.

The simulation will be a 2006 reference run according to the Agenda 2000 framework and according to the Copenhagen summit. Simulating results according to the agricultural MTR compromise in Luxembourg would be more up to date, but also more speculative and demanding, as the implementation in EU MS is not yet clear. The coordinated simulation will proceed in 3 steps:

1. Starting point will be a revised reference run of CAPSIM, with policy variables and other exogenous inputs corresponding to the year 2006.
2. Revised I-SIM accession simulations will be performed for CZ, HU, PL, using the EU prices resulting from CAPSIM (and hence different from the simulation results from the IDARA project, which were based on OECD/FAPRI projections)
3. Extrapolation to other CCs for selected key variables will use the ratio of these variables in Estonia, Latvia, Lithuania, Slovak Republic and Slovenia to those in the three I-SIM countries according to Agris or FAO, as described in the previous section. Malta and Cyprus were excluded due to severe data gaps and because they cannot be expected to behave similar to our satellite models. Bulgaria and Romania are excluded because their accession is only taking place at some later point in time.

In the following we will show selected results on area use, market balances and income effects, starting with the area use. In EU15 wheat and maize areas are increasing relative to other coarse grains because the drop in prices (until 2006) is smaller than for other coarse grains due to lower base period protection. For potatoes and sugar beet the change in area use is largely caused by yield increase with an inelastic demand or a quota regime. Pulses are treated quite favourably in Agenda 2000 such that their area is projected to increase slightly, in contrast to oilseeds which are affected by the unification of area premiums. In the I-SIM candidate countries (CC3) we may expect an increase in cereal and oilseeds areas which are stimulated by the introduction of area premiums and favourable price developments, with some differences in the CC3 group. This will require declining areas for other crops which is visible on potatoes and sugar beet. In the latter case the decline is enforced by the introduction of sugar quotas in the course of accession the EU. Given that areas in other Candidate Countries (CC5) are linked to CC3 areas proportionally, the percentage changes projected for them are equal to the CC3 group, usually. An exception is soya seed which has been derived from gross production (see below) assuming that yields are equal to those in CC3. This solution was enforced by the current lack of data on area use for soya in Agris, but soya is clearly negligible in Candidate Countries.

Table 10.4-1: Area use in an Agenda 2000 / Copenhagen reference run with CAPSIM and I-SIM models for 2006

	wheat	barley	maize	other cereals	potatoes	sugar beet	pulses	rape	sunflower	soya & other oilseeds
BAS98										
EU15	17217	11362	4206	4908	1357	2077	1872	2687	2019	847
CZ	869	612	37	164	72	87	0	246	14	10
HU	1055	364	1066	243	59	81	60	107	463	29
PL	2631	1138	85	4990	1295	400	0	488	0	0
CC3	4555	2113	1188	5397	1426	568	60	841	477	39
CC5	981	1061	166	554	256	97	22	180	77	3
EU23	22753	14536	5560	10859	3038	2742	1953	3709	2573	888
REF06										
EU15	17399	10886	4246	4727	1287	1964	1920	2570	1879	779
CZ	968	694	40	188	74	77	0	266	16	12
HU	1093	373	1094	273	56	65	60	104	488	27
PL	2615	1191	84	5255	1197	298	0	466	0	0
CC3	4676	2257	1218	5716	1327	439	60	837	504	39
CC5	1007	1133	170	587	238	75	21	179	82	3
EU23	23082	14277	5634	11029	2851	2478	2001	3586	2464	821
REF-BAS										
EU15	1.1%	-4.2%	0.9%	-3.7%	-5.1%	-5.4%	2.6%	-4.4%	-6.9%	-8.1%
CZ	11.4%	13.4%	9.0%	14.3%	2.5%	-11.9%		8.3%	13.7%	25.1%
HU	3.6%	2.5%	2.6%	12.5%	-5.0%	-20.3%	-0.4%	-2.6%	5.4%	-6.6%
PL	-0.6%	4.7%	-1.5%	5.3%	-7.6%	-25.5%		-4.6%		
CC3	2.7%	6.8%	2.5%	5.9%	-7.0%	-22.7%	-0.4%	-0.6%	5.7%	1.3%
CC5	2.7%	6.8%	2.5%	5.9%	-7.0%	-22.7%	-0.4%	-0.6%	5.7%	13.1%
EU23	1.4%	-1.8%	1.3%	1.6%	-6.2%	-9.6%	2.5%	-3.3%	-4.2%	-7.6%

Coming to the market balances we will start with a look at results for barley because this is a rather typical case.

Table 10.4-2: Market balance for barley in an Agenda 2000 / Copenhagen reference run with CAPSIM and I-SIM models for 2006

	Gross Production	Feed	Food	Processing	Other Domestic Demand	Total Domestic Demand	Net trade
BAS98							
EU15	52372	32017	111	0	10430	42557	9816
CZ	2287	1540	528	0	299	2367	-80
HU	1246	786	240	0	104	1130	115
PL	3606	3089	200	0	748	4037	-431
CC3	7139	5415	968	0	1151	7534	-395
CC5	2081	1838	216	0	158	2212	-131
EU23	61592	39269	1294	0	11739	52302	9290
REF06							
EU15	51601	34396	114	0	10544	45054	6548
CZ	2665	1539	535	0	320	2393	272
HU	1338	637	258	0	110	1005	333
PL	4024	2799	217	0	834	3851	173
CC3	8027	4975	1011	0	1264	7249	778
CC5	2340	1688	225	0	174	2087	253
EU23	61969	41058	1350	0	11982	54390	7579
REF-BAS							
EU15	-1.5%	7.4%	3.3%		1.1%	5.9%	-33.3%
CZ	16.6%	-0.1%	1.4%		6.8%	1.1%	-440.8%
HU	7.4%	-19.0%	7.6%		6.1%	-11.1%	188.4%
PL	11.6%	-9.4%	8.7%		11.6%	-4.6%	-140.2%
CC3	12.5%	-8.1%	4.4%		9.8%	-3.8%	-296.9%
CC5	12.5%	-8.1%	4.4%		9.8%	-5.6%	-293.4%
EU23	0.6%	4.6%	4.4%		2.1%	4.0%	-18.4%

Corresponding to the decline in EU15 area mentioned above there is also a decline in gross production, which is lower in percentage terms due to yield increases. In the Candidate Countries production is clearly increasing. The penultimate line reveals again an implication of our proportional scaling of CC3 modelling results to the CC5 group: the growth rates are assumed equal. Increasing prices will dampen feed demand in the Candidate Countries. This effect is not visible on food demand because low elasticities and the consumer margins reduce the responsiveness to prices and income growth will stimulate food demand. Other domestic demand combines demand for seed, losses, industrial use and stock changes with seed use dominating here and motivating the increase in this demand component. If total domestic demand is calculated as the sum of its components, equality of percentage changes is not imposed. Similarly net trade may evolve differently in CC3 and CC5 countries because it is calculated as a residual for CC5 from gross production less total domestic demand. The last line shows the effect on an EU23 aggregate which is dominated by EU15 but nonetheless reflects the specific developments in Candidate Countries. In this case the drop in net exports from EU 15 is partly compensated by increasing net exports from Candidate Countries.

To give an example of a processed product it will be interesting to look at sugar.

Table 10.4-3: Market balance for sugar in an Agenda 2000 / Copenhagen reference run with CAPSIM and I-SIM models for 2006

	Gross Production	Feed	Food	Processing	Other Domestic Demand	Total Domestic Demand	Net trade
BAS98							
EU15	17181	17	12399	0	630	13046	4135
CZ	501	0	417	0	0	417	84
HU	458	7	454	0	104	565	-107
PL	2167	16	1642	0	61	1719	448
CC3	3126	23	2513	0	165	2701	425
CC5	448	0	449	0	135	584	-136
EU23	20755	39	15362	0	930	16331	4424
REF06							
EU15	17606	18	12313	0	374	12705	4901
CZ	455	0	353	0	0	353	103
HU	400	5	433	0	109	547	-147
PL	1678	12	1553	0	61	1626	53
CC3	2534	17	2338	0	170	2525	8
CC5	363	0	418	0	128	546	-183
EU23	20503	35	15070	0	672	15776	4727
REF-BAS							
EU15	2.5%	6.3%	-0.7%		-40.7%	-2.6%	18.5%
CZ	-9.1%		-15.5%			-15.5%	22.6%
HU	-12.6%	-23.2%	-4.6%		4.8%	-3.1%	37.8%
PL	-22.5%	-25.2%	-5.4%		0.0%	-5.4%	-88.3%
CC3	-18.9%	-24.5%	-6.9%		3.0%	-6.5%	-98.0%
CC5	-18.9%		-6.9%		-5.0%	-6.5%	34.5%
EU23	-1.2%	-11.5%	-1.9%		-27.8%	-3.4%	6.8%

In the EU15 we may expect a slight increase in (C-) sugar production because yields and revenues are developing favourably. In the Candidate Countries the introduction of the quota regime will lead to a marked decline of sugar production which dominates the small increase in EU 15. Food demand is declining as well in Candidate Countries because prices are rising strongly. In this case total demand of CC5 has been linked proportionally to the CC3 development to permit a residual calculation of "other domestic demand" and a different behaviour in CC5 (-5% compared to +3% in CC3). Linking this demand component proportionally to CC3 yielded implausible results because the conversion factor from CC3 to CC5 was very high, based on tiny quantities in the FAO market balances. In cases such as this one, the questionable quantity was calculated as a residual. These ad hoc solutions had to be chosen, if the standard procedure (total demand = sum of components, net trade = gross production– total demand) was affected by unfortunate data constellations[46] such as high conversion factors, high base period stock changes, zero quantities in CC3 or CC5 countries according to FAO data.

Quite similar to the case of sugar, the milk market results are strongly determined by the political decisions on the small quota increase in EU 15 and by the agreed quotas for Candidate Countries. The latter are permitting some increase in production in the Czech Republic whereas Hungary and Poland are required to cut down production to some extent.

[46] This kind of specific extrapolation rules were necessary for wheat, sugar beet, sugar, oilseeds, raw milk and butter. They are indicated with comments in the respective Excel file "appendix4.xls"

Table 10.4-4: Market balance for raw milk in an Agenda 2000 / Copenhagen reference run with CAPSIM and I-SIM models for 2006

	Gross Production	Feed	Food	Processing	Other Domestic Demand	Total Domestic Demand	Net trade
BAS98							
EU15	121941	4255	901	114210	2575	121941	0
CZ	2566	0	228	2338	0	2566	0
HU	2007	63	67	561	134	825	1182
PL	11615	-12	3206	8273	34	11500	114
CC3	16188	51	3501	11172	168	14892	1296
CC5	4830	24	1560	1981	46	3609	1221
EU23	142959	4330	5962	127363	2788	140442	2517
REF06							
EU15	124772	4744	952	116437	2639	124772	0
CZ	2738	0	202	2536	0	2738	0
HU	1947	45	45	585	90	765	1182
PL	9380	-12	1828	7427	23	9266	114
CC3	14065	33	2075	10549	112	12769	1296
CC5	4197	15	1179	1870	31	3095	1102
EU23	143034	4793	4205	128856	2782	140636	2398
REF-BAS							
EU15	2.3%	11.5%	5.6%	1.9%	2.5%	2.3%	
CZ	6.7%		-11.5%	8.5%	-1.3%	6.7%	
HU	-3.0%	-28.1%	-33.0%	4.4%	-33.1%	-7.2%	0.0%
PL	-19.2%	0.0%	-43.0%	-10.2%	-32.2%	-19.4%	0.0%
CC3	-13.1%	-34.5%	-40.7%	-5.6%	-33.0%	-14.3%	0.0%
CC5	-13.1%	-34.5%	-24.4%	-5.6%	-33.0%	-14.3%	-9.7%
EU23	0.1%	10.7%	-29.5%	1.2%	-0.2%	0.1%	-4.7%

Food demand of raw milk (on farm) is evidently of higher importance in Candidate Countries than in EU 15 but it may be expected that structural change will reduce this consumption.

Rising milk yields will lead to a marked decline of the dairy herd, even in the Czech Republic, which tends to reduce beef production as well. On the other hand beef prices are rising in Candidate Countries and premiums were unknown before accession. Consequently there are counteracting forces on the beef market. According to I-SIM simulations the declining dairy herd size is likely to dominate the total supply response. In the EU 15 we observe a decline of supply because the 20% drop in beef prices is only incompletely compensated by new or increased premiums. Food demand in the EU 15 is increasing because the recovery from the BSE crisis is still incomplete. In Candidate Countries it may be expected that overall there will be some increase in demand stimulated by income growth. In terms of net exports both the supply and the demand side are thus contributing to a marked decline in net exports.

Similar market balances have been compiled for the key commodities of the CAP (wheat, barley, maize, other cereals, potatoes, sugar beet, pulses, rape, sunflower seed, soya seed, beef & veal, pork, poultry, sheep & goat meat, raw milk, butter) but need not be presented in this Appendix. They illustrate that based on pragmatic procedures it is possible to obtain a first assessment on market developments in an enlarged EU with CAPSIM and I-SIM satellite models.

The projection to the CC5 group and hence EU23 has only been undertaken for key commodities and only according to the above components of the market balances. From the three I-SIM satellite models detailed results are available for Poland, Hungary and the Czech

Republic for all commodities with the MFSS99 break down of marked components plus detailed information on monetary variable such as producer prices[47].

Table 10.4-5: Market balance for beef & veal in an Agenda 2000 / Copenhagen reference run with CAPSIM and I-SIM models for 2006

	Gross Production	Feed	Food	Processing	Other Domestic Demand	Total Domestic Demand	Net trade
BAS98							
EU15	7808	0	7306	0	-10	7296	512
CZ	272	0	279	0	-4	275	-3
HU	65	0	41	0	10	52	13
PL	498	0	373	0	0	373	125
CC3	834	0	693	0	5	699	135
CC5	315	0	247	0	0	247	68
EU23	8957	0	8247	0	-5	8242	715
REF06							
EU15	7707	0	7412	0	76	7488	220
CZ	262	0	255	0	-6	249	13
HU	61	0	48	0	9	58	4
PL	475	0	424	0	-4	420	55
CC3	798	0	727	0	0	727	71
CC5	301	0	259	0	0	259	42
EU23	8806	0	8398	0	75	8473	333
REF-BAS							
EU15	-1.3%		1.4%		-857.6%	2.6%	-57.1%
CZ	-3.7%		-8.8%		30.2%	-9.4%	-565.3%
HU	-5.4%		16.9%		-8.3%	11.8%	-71.8%
PL	-4.6%		13.6%		822.4%	12.7%	-56.4%
CC3	-4.4%		4.8%		-103.8%	4.0%	-47.3%
CC5	-4.4%		4.8%			4.8%	-37.6%
EU23	-1.7%		1.8%		-1769.7%	2.8%	-53.4%

Finally we may look at the income development in the accession reference run which is evidently quite favourable for the Candidate Countries because the output value at basic prices is increasing by about 30% due to the introduction of premiums. When moving to gross value added or even net value added the percentage increase becomes even more impressive (+60% to +90%). However, a great part of this increase is only nominal because inflation is expected to be higher in Candidate Countries (6% to 10% per annum) than in EU 15. Only in Poland the income increase is mainly due to the premiums. Even when valued at producer prices (that is without the premiums), gross value added still increases significantly in the CC3 countries (CZ: +127%, HU: +76%, PL: +18%).

47 See the Excel files CZ_14-10-2003, PL-26-09-2003, and HU_25-09-2003 included on the CAPSIM CD ROM in subdirectory capsim\xls\candies.

Table 10.4-6: Income developments in an Agenda 2000 / Copenhagen reference run with CAPSIM and I-SIM models for 2006

	Total output at basic prices	Total input at basic prices	GVA at basic prices	NVA at factor costs
BAS98				
EU15	275779	130917	144861	116784
CZ	3395	2605	791	580
HU	4485	2861	1625	1031
PL	12509	6133	6376	4649
CC3	20390	11599	8791	6260
CC5	4838	2869	1968	1355
EU23	301006	145385	155621	124399
REF06				
EU15	294922	140221	154701	124517
CZ	4786	2627	2159	1940
HU	7172	3704	3468	2850
PL	14377	5625	8753	6965
CC3	26336	11956	14380	11755
CC5	6248	2958	3291	2544
EU23	327506	155135	172371	138816
REF-BAS				
EU15	6.9%	7.1%	6.8%	6.6%
CZ	41.0%	0.9%	173.1%	234.3%
HU	59.9%	29.5%	113.5%	176.5%
PL	14.9%	-8.3%	37.3%	49.8%
CC3	29.2%	3.1%	63.6%	87.8%
CC5	29.2%	3.1%	67.2%	87.8%
EU23	8.8%	6.7%	10.8%	11.6%

10.5 Current limitations for Candidate Country simulations

The above simulations yielded by and large reasonable results in the Agenda 2000 / Copenhagen reference run but it should be pointed out here that the current modelling capacities are quite limited for a number of reasons.

The first point to be mentioned is that the extrapolation of CC3 results to the remaining Candidate Countries is evidently very ad hoc. The results for the three countries represented explicitly show that there are marked differences between single countries which calls into question any aggregate treatment. On the other hand the absolute figures on relevant variables show that the CC3 group is heavily dominating the group of all Candidate Countries such that the error will be limited. Furthermore we clearly observe that the three Candidate Countries have much more in common with each other than with EU 15.

It was mentioned above that “unfortunate data constellations” frequently required a flexible procedure incorporating some judgement of what are plausible results. These are ad hoc answers to the problems of an incomplete and not fully consistent database which could not be tackled for these simulations. Instead they require more long run efforts to check and impose this internal consistency and completeness of different databases and ultimately to integrate them in a unified framework with common definitions applied to all countries. This is not yet the case as there are some differences between CAPSIM and I-SIM definitions (for example in the income concepts) and between Eurostat and FAO data.

From the methodological point of view it is questionable to use different functional forms and equations for EU 15 (CAPSIM) and for the I-SIM models. This is not to argue that model structures have to be uniform of necessity. On the contrary, there are a number of well known modelling systems which are composed of linked national models each with its own structure (AGLINK, FAPRI-AGMEMOD, IIASA). It is questionable however, if these differences are motivated purely in the history of model development, rather that as a remedy to well-defined peculiarities of the countries covered. Otherwise differences in simulation results between Member States might be caused, to some extent at least, by different model structures operating in different Member States. In the long run it will be preferable therefore to cover the enlarged EU with a fully integrated framework (but this presupposes a fully integrated database as well).

A few methodological limitations have a different character. Given that FEOGA funding for Candidate Countries was irrelevant in the base period, the standard procedure to calibrate the budget estimation (namely to reproduce the observed base year data) is inapplicable. Consequently budget estimations for an enlarged EU are quite demanding and require additional effort and more information than has been incorporated in the simplified budget component of CAPSIM so far. Another limitation is that the current linkage of models neglects feed back from the candidate country models to EU 15 markets. While it is certainly true that the current EU 15 will dominate the enlarged market, the absence of all feed back is surely a simplification which should be removed in the future.

User-friendliness is another point pushing for a full integration. As is explained in section 10.4 these simulations required a three-step procedure to obtain the final results and step 2 in turn requires running as many satellite models as there are Candidate Countries. This is not only time consuming but also dangerous in terms of human errors. Each conversion and copying of certain data carries along with it the probability of errors and even if these are detected, this may cause at least unnecessary time input. A unified model would require considerable investment in checking its functionality but once the model is put in place it would be far more convenient to obtain results for the enlarged EU than with the current procedure.

Finally we should admit that the overall plausibility of the reference run simulation presented above is not a guarantee that the interplay of CAPSIM and I-SIM with extrapolation to the CC5 group will always “work” without technical or other problems in different simulations. While both modelling systems (CAPSIM and I-SIM) have been tested on various occasions the integrated use for coordinated simulations has only been explored in the very last phase of model development. Consequently this is to be considered a promising exploration suggesting potential to build on this experience, rather than proving that the interplay solution presented here is reliable to investigate all kinds of issues. However, given that a number of arguments have been put forward which suggest significant advantages of a fully integrated system, it will not be very efficient to fully develop and test the interplay approach if the latter is unlikely to have a future.