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The Common Agricultrual Policy SIMulation (CAPSIM) Model: Structure and Applications

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Acknowledgments

The present technical report published by the European Commission's Joint Research Centre, Institute for Prospective Technological Studies (JRC-IPTS) is based on a study carried out by Heinz Peter Witzke and Andrea Zintl from the European Centre for Agricultural, Regional and Environmental Policy Research (EuroCARE, Bonn, Germany) for the Directorate General Eurostat (DG ESTAT) of the European Commission. We would like to thank the authors and DG ESTAT for giving the right to edit and publish this technical report. The technical report was edited by Axel Tonini, Robert M'barek (JRC-IPTS) and Heinz Peter Witzke (EuroCARE).

Executive Summary

Agricultural sector models are used to analyse the impacts of policy changes and often based on partial equilibrium models. Although the contribution of agriculture to the economy in terms of value and employment is declining, there is a growing need for modelling tools able to analyse the recent developments of the Common Agricultural Policy (CAP) and the European Union (EU) enlargement. This process forces the current modelling tools to be continually updated in terms of products, countries and policies.

The aim of the present technical report is to describe the model structure of the Common Agricultural Policy SIMulation (CAPSIM) model in its version from 2005 which is based on the outcome of a study carried out by European Centre for Agricultural, Regional and Environmental Policy Research (EuroCARE) for the Directorate General Eurostat (DG ESTAT)[1]. Several applications are also provided. The report is particularly addressed to potential CAPSIM users who would like to understand the basic working of the model. The CAPSIM14[2] code written in the General Algebraic Modelling System (GAMS) software is made available through the JRC-IPTS website under publications (http://www.jrc.es/publications/index.cfm). Depending on the target group addressed a different level of knowledge of the GAMS software will be required for the understanding of the model code provided.

CAPSIM was developed in the early 1980s by EuroCARE and the University of Bonn on behalf of DG ESTAT. In 2006, the CAPSIM model was transferred from DG ESTAT to the European Commission's Joint Research Centre, Institute for Prospective Technological Studies (JRC-IPTS) in order to extend the model to new Candidate Countries to the European Union accession and to further develop the modelling tools for CAP analysis. At the JRC-IPTS in Seville there are already several in-house models which are utilized for analysing the impact of agricultural policies at EU level as well as international agri-food trade.

The objective of the CAPSIM model is to provide robust and quick impact analyses for the CAP. Scenario analyses consider a disaggregated coverage of items (30 marketable agricultural products, 5 non-marketable agricultural products and 17 processed products) and individual EU Member States and Candidate Countries. The overall methodology is based on a calibrated, comparative static, partial equilibrium model. Several improvements of the CAPSIM 2005 over the 2003 version were: updates in the database, improvements in the policy and trade description (i.e. gross trade representation), introduction of a labour projection tool, user-friendliness of the software code and more intuitive output export (i.e. XML Tables and Maps).

The first part of the technical report focuses on explaining the model specification, particularly: supply and demand side, processing, labour, different policy regimes as applied in the CAP, trade regimes and welfare calculations. The report also explains the peculiar characteristic of CAPSIM: the reference run methodology which anticipates the policy simulation mode. During the reference run unknown time

[1] Contract no. ESTAT 200463502001.
[2] CAPSIM14 is the program code in its version from 2005 released for the study carried out by EuroCARE for DG ESTAT.

dependent parameters are calibrated exploiting exogenous forecasts and ex-post observations. The policy simulation mode builds upon the previous reference run mode simulating the impact of different policy options and exogenous inputs. Several applications focusing on decoupling and alternative implementations are also included. The data used in CAPSIM are largely derived from market balances, economic accounts and EU producer prices as provided by the DG ESTAT. The completeness and consistency of the data is addressed through the COCO (COmpleteness and COnsistency) routine in co-operation with the Common Agricultural Policy Regionalised Impact (CAPRI) modelling team.

The second part of the technical report describes the CAPSIM software in order to provide a guided tour through the technical aspects of the model for potential users. More precisely the report focuses on explaining to the interested reader how the simulations are performed and what steps are necessary to introduce new input data and obtain a modified set of results for policy analysis.

Table of contents

1. INTRODUCTION

Agricultural sector models are used to analyse the impacts of policy changes. The general structure of agricultural sector models comprises technical, accounting and/or behavioural equations which rely on observed data and projections for exogenous factors. Agricultural sector modelling is often based on partial equilibrium models which only focus on specific agricultural sectors without explicitly treating the interrelationships with other sectors. Although the contribution of agriculture to the economy in terms of GDP and employment is declining, there is a growing need for modelling tools able to analyse the recent developments of the Common Agricultural Policy (CAP) and the European Union (EU) enlargement. This process forces the current modelling tools to be continually updated in terms of products, countries and policies. Sector models can be classified according to their orientation in terms of markets and regions covered.

In the early 1980s, the Directorate General Eurostat (DG ESTAT) supported the development of a complete, consistent, up-to-date database for modelling efforts world-wide ('SPEL/EU Base System'). This was soon followed by the 'SPEL/EU Medium-term Forecasting and Simulation System' (MFSS), which has since been used on various occasions for the EU Commission (see Henrichsmeyer 1994 for this history). Nonetheless, the eventual complexity of the MFSS together with its FORTRAN written code rendered it finally quite intransparent, prompting DG ESTAT in the beginning of 1999 to launch the development of a new, transparent, flexible and user-friendly policy information system for the CAP. The first phase in this development, leading ultimately to the Common Agricultural Policy SIMulation model or CAPSIM (Witzke, Verhoog, and Zintl 2001) significantly increased technical transparency in moving the system from FORTRAN to the General Algebraic Modelling System (GAMS). The second phase addressed a number of weaknesses in CAPSIM and took the first steps to cover the candidate countries (Witzke and Zintl 2005). The main aim of the third and most recent phase was to ensure the full incorporation of the new Member States (new MSs), relying on an improved database. Database improvements were made partly in the course of the normal work carried out in DG ESTAT and the national statistical offices and partly through a call for tender targeting specific data needs for agricultural sector modelling. In 2006 the CAPSIM model was transferred from DG ESTAT to the European Commission's Joint Research Centre, Institute for Prospective Technological Studies (JRC-IPTS) in Seville where several in-house models are already used for analysing the impact of agricultural policies at EU level as well as international agri-food trade.

Key characteristics of CAPSIM can be summarised as follows. It is a *partial equilibrium* model relying on exogenous inputs of macroeconomic variables. It is *comparative static*, but may be used for any sequence of projection years provided that exogenous variables have been forecast for these years and parameters are adjusted according to the length of the run. In terms of empirical specification, it relies on *calibration* techniques and a *rigorous microeconomic framework* for behavioural functions rather than on a full econometric estimation. Several *hard technological relationships* have been incorporated to support the microeconomic framework. Examples are for the balances of male and female calves, land, feed energy and protein, milk fat and protein. For these constraints, it is useful that CAPSIM covers the complete agricultural sector (as described in DG ESTAT's Economic Accounts on Agriculture (EAA) and market balances). It is a *deterministic* model trying to capture the mean result from a set of exogenous variables, so starts from a three-year average base year to eliminate as far as possible the influence of yield fluctuations and short-run price fluctuations. *Market clearing* differs depending on the products. For important products (cereals, meats, and milk products), it explicitly distinguishes gross imports and exports, while for others it only gives the net trade and for a number of items the net trade may also be fixed. Within the EU, a pooled (non-spatial) market is assumed and bilateral trade flows are not modelled.

The *product list* includes 30 marketable agricultural products (soft wheat, durum, rye and meslin, barley, oats, grain maize, other cereals, paddy rice, pulses, potatoes, sugar beet, rape, sunflower seed, soya beans, other oilseeds, olives, industrial crops, vegetables, fruits, wine, other final crop products, cow and buffalo milk, beef, pork, sheep and goat milk, sheep and goat meat, eggs, poultry meat, other animal products, other outputs), 5 non-marketable agricultural products (fodder maize, other fodder, grass, male calves, female calves), 17 processed products (rice in milled rice equivalents, molasses, potato starch, sugar, oils from rape, sunflower, soya, other oilseeds and olives, corresponding cakes, butter, skimmed milk powder, cheese, other milk products), 2 aggregate inputs (general cost items, plant-related inputs) and an aggregate price index for non-agricultural goods or factors to complete the supply and demand sides, as both use nominal prices.

Major *policy instruments* include various premiums for activities with associated ceilings, set-aside, intervention prices, quotas, and border measures (tariffs, flexible levies/export refunds, World Trade Organisation (WTO) limits). The main *simulation outputs* of CAPSIM are market balances, agricultural production and income, changes in processing industry income, consumer welfare and European Agricultural Guarantee and Guidance Fund impacts, which give a conventional measure of welfare change.

This report provides technical background information on the CAPSIM version 2005 evidencing the new major improvements as compared to the 2003 version. The report is addressed to the interested reader who would like to get acquainted with the CAPSIM modelling environment and start to understand the basic working of the model. The document is structured as follows. Chapter 2 reviews the revised structure of the model and describes the ex-post database and the methodology followed in the reference run mode as well as default estimates for structural change. Reference run and selected simulations applications are reported. Chapter 3 provides a tutorial for potential users. The first part (Section 3.1-3.4) focuses on the structure of the model implemented using the GAMS software[3]. The second part (Section 3.5-3.8) focuses in how to perform policy simulation relying on default data and introducing expert

[3] The CAPSIM14 program code in its version from 2005 is released with this publication in order to allow the interested reader to replicate the applications provided in the text.

information. Chapter 3 ends with a section which visualises how model outputs are organised and presented in CAPSIM in order to help potential users.

2. THE COMMON AGRICULTURAL POLICY SIMULATION MODEL (CAPSIM)

2.1. MODEL STRUCTURE AND EMPRICAL SPECIFICATION

2.1.1. Supply side

The supply side of CAPSIM is composed of yields of activities and level of production. In CAPSIM yields are considered exogenous and they are specified according to trends and expert forecasts. Exogenous yields partly contradict empirical evidence on some responsiveness of yields to prices (Jensen 1996; Guyomard, Baudry and Carpentier, 1996) but it appeared that the major part of supply response comes from a variation in activity levels rather than from a variation of yields, such that the assumption may be justified. The same simplification has been made recently in CAPMAT (CWFS/CPB 2003: 149), AGLINK (with few exceptions, see Uebayashi 2004:4) and FAO World Food Model (WFM) (for cereals, see FAO 2003: 173). The specification for production is given by:

$$PRD_{m,i,t} = \Sigma_j \left(YLD_{m,i,j,t} * LVL_{m,j,t}\right) \tag{1}$$

where

$PRD_{m,i,t}$ = production of product i in MS m and year t

$LVL_{m,j,t}$ = level (usually ha or hd) of production (crop or animal) activity j, in MS m and year t

$YLD_{m,i,j,t}$ = (exogenous) yield of activity j in terms of output i in MS m, year t

If yields are specified exogenously, the (gross) revenues of activities $GREV_{m,j,t}$ are exogenous from the farmer's perspective and may enter the supply side specification in the same way prices usually do.

$$GREV_{m,j,t} = \Sigma_i \left(YLD_{m,i,j,t} * PP_{m,i,t}\right) + PRM_{m,j,t} \tag{2}$$

where

$GREV_{m,j,t}$ = (gross) revenue of activity j in MS m and year t

$PP_{m,i,t}$ = producer price of product i in MS m and year t

$PRM_{m,j,t}$ = total premiums (per ha or hd) for activity j in MS m, year t

Total premiums $PRM_{m,j,t}$ are now composed of various parts as required in a detailed description of the CAP premiums (see equation 31). A particular characteristic of CAPSIM is the inclusion of several technological constraints with the help of an endogenous (shadow) price associated with each constraint. These constraints comprise a land balance and nutrient balances for feed energy and protein (see equations 10 to 12 in Witzke and Zintl 2005):

$$AREA_{m,t} = \Sigma_j \lambda_{m,j} LVL_{m,j,t} \tag{3}$$

$$\Sigma_j \eta_{m,j,t} * LVL_{m,j,t} = \Sigma_f \eta_{m,f,t} * INP_{m,f,t} \tag{4}$$

$$\Sigma_j \rho_{m,j,t} * LVL_{m,j,t} = \Sigma_f \rho_{m,f,t} * INP_{m,f,t} \tag{5}$$

where

$AREA_{m,t}$ = total (arable) area in MS m, year t

$LVL_{m,j,t}$ = level of activity j in MS m, year t

$INP_{m,f,t}$ = demand for feed input f in MS m, year t

$\lambda_{m,j}$ = land requirements of activity j (= 1 for crops) in MS m, year t

$\eta_{m,s,t}$ = energy requirement (s =j) or content (s = f) in MS m, year t

$\rho_{m,s,t}$ = protein requirement (s =j) or content (s = f) in MS m, year t

Equation 3 requires that the total crop areas add up to an exogenous estimate for total area, including fallow land as one of the 'crop' activities. Equations 4 and 5 call for the energy and protein content of total feed to match the total requirements for animal activities. Note that this does 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 modelled. An explicit modelling of the feed allocation is beyond the scope of CAPSIM. Nonetheless, examining the aggregate balances of energy and protein is useful for checking the consistency of simulation results for animal production and feed demand, which is ignored in traditional approaches relying on behavioural functions, in contrast with programming approaches (e.g. McKinzie, Paarlberg and Huerta 1986).

To apply these constraints, we use the (endogenous) net revenues $NREV_{m,j,t}$ rather than the gross revenues above in the supply side behavioural functions:

$$NREV_{m,j,t} = GREV_{m,j,t} - \lambda_{m,j} * PLND_{m,t} - \eta_{m,j,t} * PENE_{m,t} - \rho_{m,j,t} * PPRT_{m,t} \quad (6)$$

where

$NREV_{m,j,t}$ = net (shadow) revenue of activity j $\in$ PACT in MS m, year t

$PLND_{m,t}$ = shadow rental price of land in MS m, year t

$PENE_{m,t}$ = shadow price of energy in MS m, year t

$PPRT_{m,t}$ = shadow price of protein in MS m, year t

For crop activities, only the land price is relevant. As land becomes increasingly scarce, the land rental price $PLND_{m,t}$ will increase and reduce net revenues and curb area use, because activity levels respond positively to (own) revenues. As in the previous version, fallow land may increase if the land rental price approaches a lower bound:

$$LVL_{m,FALL,t} = LVL^{est}_{m,FALL,t} + 0.3ARAB_{m,t} \cdot sigmoid\left(100*\left(PLNDLO_{m,t} - PLND_{m,t}\right)\right) \quad (7)$$

sigmoid(x) = 1 / (1+ exp(-x)), sigmoid(x)$\rightarrow$1 for x$\rightarrow\infty$, sigmoid(x)$\rightarrow$0 for x$\rightarrow -\infty$

$LVL_{m,FALL,t}$ = Fallow land in MS m, year t

$LVL^{est}_{m,FALL,t}$ = Estimated fallow land in MS m, year t from trends

$ARAB_{m,t}$ = Arable land in MS m, year t (exogenous estimate)

$PLNDLO_{m,t}$ = Lower bound for rental price of land in MS m, year t

The lower bound PLNDLO in turn is equal to the gross revenue for fallow land resulting from premiums (if any) net of the cost to keep fallow land in good agricultural condition (estimated to be €50 in the old and €25 in the new MSs). A similar equation had already been included in the previous CAPSIM version (equation 13 in Witzke and Zintl 2005) but this one uses the built-in sigmoid function of GAMS.

A more important modification is that the earlier representation of land heterogeneity (also explained in Witzke and Zintl 2005, Section 2.1.2) has been abandoned because it led to less transparent and in some cases distorted results for decoupling scenarios.

For animal activities, the land price is irrelevant (in term of direct effects) but net revenues are reduced if energy or protein prices rise, which occurs if an energy or protein shortage arises. Animal activities tend to decline in this case, maintaining the equilibrium.

For inputs we define (endogenous) net prices as follows:

$$NP_{m,i,t} = PP_{m,i,t} - \eta_{m,i} * PENE_{m,t} - \rho_{m,i} * PPRT_{m,t} \tag{8}$$

where

$NP_{m,i,t}$ = net price of item i in MS m, year t

For feed items, an increase, say, in the energy shadow price would reduce their net price and thus stimulate their use to maintain the balance. For non-feed items, the requirements are zero. Note that there is no time index attached to the contents $\eta_{m,i}$ and $\rho_{m,i}$, because these are taken to be constant whereas the requirements are adjusted to reflect yield growth.

The behavioural functions are derived from a Normalised Quadratic profit function in terms of net revenues and net prices:

$$\pi_{m,t}(\mathbf{N}_{m,t}) = \alpha_{m,0,0,t} + \Sigma_j\, \alpha_{m,j,0,t}\, N_{m,j,t} + \Sigma_j\, \Sigma_k\, \alpha_{m,j,k}\, N_{m,j,t}\, N_{m,k,t} \tag{9}$$

where

$$\mathbf{N}_{m,t} = (\mathbf{NREV}_{m,t}, \mathbf{NP}_{m,t})' / PP_{m,REST,t} \tag{10}$$

and

$\pi_{m,t}$ = normalised profit function in MS m

$\mathbf{N}_{m,t}$ = column vector of price variables normalised by the general price index $PP_{m,REST}$ in MS m

$\mathbf{NREV}_m$ = column vector of net revenues $NREV_{m,j}$ for activity j, MS m, year t

$\mathbf{NP}_{m,t}$ = column vector of net prices $NP_{m,i}$ of input i in MS m, year t

$\alpha_{m,i,j}$ = time-invariant parameters of the profit function in MS m

$\alpha_{m,j,0,t}$ = time-dependent parameters of the profit function in MS m

This gives behavioural functions of netputs $Y_{m,j,t}$ linear in $\mathbf{N}_{m,t}$**,**

$$Y_{m,j,t}(\mathbf{N}_{m,t}) = \partial\pi_{m,j,t}/\partial N_{m,j,t} = \alpha_{m,j,0,t} + \Sigma_k\, \alpha_{m,j,k}\, N_{m,k,t} \quad (11)$$

where

$$Y_{m,s,t} = LVL_{m,s,t} \text{ for } s \in \text{activities} \quad (12)$$

$$Y_{m,s,t} = -INP_{m,s,t} \text{ for } s \in \text{input} \quad (13)$$

The parameters of CAPSIM are calibrated to the three-year average 2001/03 as base year. Econometric estimation on the basis of time series did not appear feasible in the available time for the EU MS. To deal with this calibration problem, we minimise the deviations of the model's elasticities with respect to (gross) price variables from plausible starting values, given a set of constraints to impose microeconomic consistency, including the Cholesky decomposition for convexity. Basically, the procedure is unchanged from the CAPSIM 2003 version (Witzke and Zintl 2005, Section 2.1.2). This applies first of all to the hierarchical initialisation of elasticities from a consistent set of assumed Allen elasticities of transformation[4]. Also unchanged is the calculation of 'equilibrium' or 'arc' elasticities and the initialisation of feed-output elasticities based on the assumption of a non-joint, constant-returns feed technology together with an estimated feed allocation from the CAPRI modelling system. As the behavioural functions have not been modified, all expressions for elasticities continue to hold without modification. However, a change has been made to the objective function. As in other cases, it turned out that a Bayesian Highest Posterior density estimator (Mittelhammer, Heckelei and Britz 2005) is computationally considerably more convenient than the former cross-entropy objective, but this does not affect the model equations.

2.1.2. Food demand

The microeconomic framework for food demand is a standard utility maximisation. In order to maintain microeconomic global consistency for simulation purposes an adequate functional form as to be selected. Among the desired functional form properties, flexibility, simplicity and plausibility are also important. The demand specification for the 2005 version of CAPSIM relies on a Linear Expenditure System (LES) which is a simplification with respect to the 2003 version which utilized a flexible Generalised Leontief (GL) form based on published elasticities for most EU15 countries (Witzke and Zintl 2005, Section 2.2). For the most recent studies incorporated therein the underlying data were extended to the middle of the 90ies but this does not hold for the older studies (e.g. Fulponi 1989; Mergos and Donatos 1989; Michalek and Henning 1992; Molina 1994; Edgerton et al. 1996; Michalek and Keyzer 1990). The situation is even more problematic for the NMS. The choice of a LES food demand specification was due to the fact that the full matrices of cross price parameters were not published but the LES may conveniently reproduce the published

[4] Accordingly, MS-specific particularities enter mainly through the profit shares.

expenditure elasticities. The theoretical inconvenience of an inflexible functional form is largely irrelevant if there is no need for full flexibility. If the empirical knowledge on price elasticities is quite limited there is little to be gained from the use of a fully flexible functional form. The specification for food demand is given by:

$$\frac{CNS_{m,i,t}}{INH_{m,t}} = \beta_{m,i}\left(E_{m,t} - \sum_u \delta_{m,u,t} PC_{m,u,t}\right) \Big/ PC_{m,i,t} + \delta_{m,i,t} \qquad (14)$$

where

$CNS_{m,i,t}$ = consumer demand of item i in MS m, year t

$INH_{m,t}$ = inhabitants in MS m, year t

$E_{m,t}$ = per capita expenditure in MS m, year t

$PC_{m,i,t}$ = consumer price of item i in MS m, year t

The parameters $\beta_{m,i}$, $\delta_{m,i,t}$ have been calibrated to reflect standard price elasticities, which are typically -0.2 to -0.4 for pork as an example product of some importance in all EU MS. Seale, Regmi and Bernstein 2004 describe a cross-country analysis giving expenditure and own-price elasticities for food groups covering 114 countries, including the new MSs. Their analysis did not use a flexible functional form and the cross-price elasticities are not reported. Nonetheless, this study may be considered as close to optimal for our purposes in many respects:

- the reported elasticities appear to be reasonable in level and in their variation with income;
- the data base is quite up to date (1996);
- complete coverage of all MS with the same methodology may be achieved.

It was therefore decided to replace the earlier heterogeneous collection of various time series studies with elasticities from this sole study.

2.1.3. Processing and the food industry

At least 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 user prices, which is specified as an exogenous variable in CAPSIM. Assuming that the food industry uses agricultural raw products from other MS in addition to the domestic supply, the consumer prices are linked to EU prices (which are usually defined at producer level):

$$PC_{m,i,t} = PE_{i,t} + CM_{m,i,t} \qquad (15)$$

where

$PC_{m,i,t}$ = consumer price of item i in MS m, year t

$PE_{i,t}$ = EU market price of item i, year t

$CM_{m,i,t}$ = consumer level margin for item i in MS m, year t

The 'consumer level margins' represent the marginal cost of marketing inputs that are assumed to be combined with the raw product in a constant-returns Leontief technology. In spite of its simplicity, equation 15 captures an essential issue in food markets. Given that the additional marketing services behind the consumer margins $CM_{m,i,t}$ are frequently a multiple of the raw product values, demand elasticities with respect to farm prices will usually be much smaller than those conventionally estimated at the consumer level. To put it differently, ignoring the consumer margins would greatly overstate demand responsiveness at the farm level.

Certain elements of the processing sector are explicitly identified in DG ESTAT market balances. In these cases (e.g. oilseeds), processing demand is specified as a behavioural function of the processing margin PM_i (= derived revenues minus raw product costs), the general price index and the state of technology. The functional form is linear, in line with competitive behaviour according to a normalised quadratic profit function:

$$\begin{aligned} PRC_{m,r,t} &= \beta_{m,r,0,t} + \sum\nolimits_i \beta_{m,r,i}\ PM_{m,i,t} / PP_{m,rest,t} \\ &= \beta_{m,r,0,t} + \sum\nolimits_i \beta_{m,r,i} \left(\left[\Sigma_h\ \theta_{m,i,h} PP_{m,h,t} \right] - PP_{m,i,t} \right) / PP_{m,rest,t} \end{aligned} \tag{16}$$

where $PRC_{m,r,t}$ is processing of raw product r (say rape), $\theta_{m,r,h}$ are fixed processing coefficients and $PP_{m,h,t}$ ($PP_{m,r,t}$) are producer prices of processed products (raw products). Slope parameters $\beta_{m,r,i}$ are specified on the basis of assumed elasticities (typically = 0.5)[5]. After processing, the production of derived products $PRD_{m,i,t}$ follows from the processing coefficients $\theta_{m,i,h}$.

Two special cases are milk and sugar. Their treatment has not changed since the CAPSIM 2003 report. For the dairy sector, CAPSIM includes explicit balances of milk fat and protein with fixed contents of milk products (similar to Bouamra and Réquillart 2000, see equations 71 to 73 in Witzke and Zintl 2005). The sugar industry is modelled in a reduced form only. This form assumes a certain price linkage of beet prices to the relevant derived revenue from sugar, taking into account the EU levy system (see equations 87 to 93 in Witzke and Zintl 2005). Beet prices and quotas enter an incentive price function which ultimately steers sugar beet production. This incentive function has been simplified to a linear form:

---

5 The CAPSIM version in Witzke and Zintl 2003 assumed that the positive effect of technological progress in the processing industry and the negative effect of increased labour and capital costs approximately cancel each other out, so both the time index on the constant as well as the normalisation by the general price index $PP_{m,rest,t}$ could be omitted. However, the current version will follow equation 16.

$$
\begin{aligned}
NREV_{m,SUGB,t} = \psi_{m,0} + \psi_{m,SUBA} NREV_{m,SUBA,t} + \psi_{m,SUBB} NREV_{m,SUBB,t} \\
+ \psi_{m,SUBC} NREV_{m,SUBC,t} + \psi_{m,QTL} QTL_{m,t}
\end{aligned}
\tag{17}
$$

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

$QTL_{m,t}$ = aggregate area quota in MS m

The current coefficients ψ have been derived from updated simulations with the CAPRI modelling system, but these do not yet reflect the very recent sugar market reform and would need revision for a serious analysis of this reform. However, the reform also simplifies the analysis: the distinction between A and B beets has been retained only to represent the ex-post situations. Furthermore, we could eliminate the endogenous equations for EU sugar levies (equations 89 and 90 in Witzke and Zintl 2005), as these are known to be zero in the future.

2.1.4. Labour use

The DG ESTAT tender, under which this study was carried, required the specification and incorporation in CAPSIM of a labour projection tool. This labour component was introduced in a rather simplistic way given the critical data situation in many new MSs. It was decided to project labour use using a rather robust methodology. This was linked to time and a single additional variable selected on the basis of conventional fit. The additional variable considered was a certain activity level (group), the gross production of a certain group of products or the deflated European Environmental Agency (EEA) production value of a certain group of products. The forecasting equation for labour (total labour and wage labour separately) is therefore:

$$
LAB_{m,i,t} = \xi_{m,i,0} + \xi_{m,i,1}\, t + \xi_{m,i,2}\, X_{m,i,t} \tag{18}
$$

where

$LAB_{m,i,t}$ = labour use of type i (total labour, wage labour) in MS m, year t

$X_{m,i,t}$ = additional explanatory variable apart from time for labour type i in MS m, year t

The coefficients and statistics (R2, *t* statistic values) for all regressions of 24 MS * 2 labour types are collected in a file LAB.XLS, from which the coefficients are exported for use in the model. In aggregate form, they are shown in section 3 of this report.

Note that this pragmatic form for incorporating labour does not feed back to the behavioural functions. Instead, it is considered a useful indicator variable like environmental indicators in other modelling systems.

2.1.5. Domestic policy

A major distinction between the current CAPSIM version and the previous version is the detailed description of the various premium systems offered to old and new MSs in the implementation of the Mid-Term Review (MTR). The full details of the premium component are as follows:

$$
\begin{aligned}
PRM_{m,j,t} = {} & \\
& HIST_{m,j,t} * PRET_{m,j,t} * PRETFEU_{m,j,t} \\
& + HIST_{m,j,t} * PRETNAT_{m,j,t} * PRETFNA_{m,j,t} \\
& + PREM_{m,j,t} * PREMFEU_{m,j,t} \\
& + PREMNAT_{m,j,t} * PREMFNA_{m,j,t} \\
& + PREMDC_{m,j,t} * PREMFDC_{m,j,t}
\end{aligned}
\tag{19}
$$

where

$PRM_{m,j,t}$ = total premiums (per ha or hd) for activity j in MS m, year t

$HIST_{m,j,t}$ = historical yield of main product in activity j in MS m

$PRET_{m,j,t}$ = 'group' premiums from the EU derive from historical yields for activity j in MS m

$PRETFEU_{m,j,t}$ = scaling factor to implement ceilings on 'general' premiums from the EU for activities j in MS m

$PRETNAT_{m,j,t}$ = national 'group' premiums from the EU derive from historical yields for activity j in MS m

$PRETFNA_{m,j,t}$ = scaling factor to implement ceilings on 'general' national premiums for activities j in MS m

$PREM_{m,j,t}$ = specific EU 'supplements' defined directly per activity j in MS m

$PREMFEU_{m,j,t}$ = scaling factor to implement ceilings on EU 'supplements' for activities j in MS m

$PREMNAT_{m,j,t}$ = national 'supplements' defined directly per activity j in MS m

$PREMFNA_{m,j,t}$ = scaling factor to implement national ceilings for activities j in MS m

$PREMDC_{m,j,t}$ = 'decoupled' MTR premium defined directly per activity j in MS m

$PREMFDC_{m,j,t}$ = scaling factor to implement ceilings for activities j in MS m

According to equation 2, gross revenues stem from market revenues and different types of *premiums*. The latter are scaled downwards where national ceilings for outlays or entitlements are exceeded, but farm level ceilings are ignored. While quite simple conceptually, the empirical details regarding CAP premiums are addressed only in section 2.4 of this final report.

Total *set-aside* had been handled in CAPSIM 2003 as an exogenous activity, either estimated outside of CAPSIM or linked to the obligatory set-aside rate with a fixed elasticity. After the separation of voluntary and obligatory set-aside, the former is now specified as an activity with gross revenue entirely made up of premiums whereas the latter may be projected exogenously, given that the MTR in essence requires the set-aside area to be maintained at the level of the recent past.

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 shadow revenue for the behavioural function and, to initialise the model, an estimate of the base-year percentage quota rent. This representation is unchanged from the 2003 version, as is the description of the *sugar regime*. For the EuroCARE sugar study (Henrichsmeyer et al. 2003), two motives for C beet production apart from profit maximisation (securing quota rights and yield variability) were represented in CAPSIM with an 'incentive revenue' function, giving a kind of shadow revenue for sugar beet $NREV_{beet}$ as an explicit function of net revenues from different types of beet ($NREV_{A\text{-}beet}$, $NREV_{B\text{-}beet}$, $NREV_{C\text{-}beet}$) and from the quotas (QT_{AB}). Their parameters were determined to mimic earlier CAPRI simulation results obtained with an explicit treatment of uncertainty considerations.

2.1.6. Market clearing and border policy

CAPSIM was originally conceived as a net trade model. The 2003 model essentially featured the options to clear certain markets with given border prices, with given net trade volumes or with a price-responsive net trade import demand from the Rest of the World. However, a net trade description does not permit the observation of gross exports relevant for WTO restrictions. This limitation has now been addressed with the option to use a gross trade regime, in particular for the major agricultural commodities subject to WTO limits (cereals, meats, milk products).

Total demand $DEM_{m,i,t}$ is the sum of input demand $INP_{m,i,t}$, human consumption $CNS_{m,i,t}$, and processing demand $PRC_{m,i,t}$, determined according to equations 13, 14, and 16 above, plus a few less important demand components. Seed and waste are proportionally linked to production $LNK_{m,i,t}$, industrial demand $IND_{m,i,t}$ is forecast exogenously, and stock changes $STC_{m,i,t}$ are likewise specified exogenously (usually set to zero) during simulations:

$$DEM_{m,i,t} = INP_{m,i,t} + CNS_{m,i,t} + PRC_{m,i,t} + LNK_{m,i,t} + IND_{m,i,t} + STC_{m,i,t} \qquad (20)$$

The balance of production from equation 1 (or from $PRC_{m,r,t}$ times processing coefficients $\theta_{m,r,i}$) and (private) demand from equation 20 is excess supply. After aggregation to EU level, this (usually[6]) equals EU net exports $NET_{i,t}$:

$$NET_{i,t} = \Sigma_m (PRD_{m,i,t} - DEM_{m,i,t}) \qquad (21)$$

[6] If excess supply exceeds WTO limits, the exceeding quantities are either intervention purchases (if there is an intervention regime) or a slack variable ‘violation of WTO limits’. In both cases, non-zero values indicate that the scenario was politically unsustainable.

Market clearance may occur in various regimes. The simplest solutions are regimes with given border prices (applied in the case of oilseeds and the corresponding cakes and oils) or with exogenously given net trade (currently only for non-tradable items such as calves and fodder). In these regimes, net trade is either a free residual variable or is fixed.

The net trade specification does not permit export and import measures to be handled independently and poses serious difficulties for the modelling of WTO limits. To account for the most important of these, gross extra-EU trade data from COMEXT have been incorporated in the CAPSIM database for cereals, rice, sugar, meats, eggs, milk products, cassava, olive oil and wine. For these products, there are explicit rest-of-the-world import demand functions $X_{i,t}(PX_{i,t})$ and rest-of-the-world export supply functions $M_{i,t}(PM_{i,t})$, which typically are constant elasticity functions of the corresponding border prices:

$$NET_{i,t} = X_{i,t}(PX_{i,t}) - M_{i,t}(PM_{i,t}) \tag{22}$$

Tariff rate quotas (TRQs) are currently not modelled in an endogenous way, because a satisfactory description needs to take into account the fact that they apply to bilateral trade flows in many cases. However, an aggregate TRQ may be described by a constant term in the rest-of-the-world export supply function $M_{i,t}(PM_{i,t})$. Tariffs and export subsidies link import and export unit values at the EU border to internal prices:

$$PX_{i,t} = PE_{i,t} - ESUT_{i,t} * XSSH_{i,t} \tag{23}$$

$$PM_{i,t} * (1 + TARA_{i,t}) = PE_{i,t} - TARS_{i,t} - FLEV_{i,t} \tag{24}$$

$PX_{i,t}$ = EU export unit value of item i, year t

$PE_{i,t}$ = EU market price of item i, year t

$ESUT_{i,t}$ = Export subsidy per tonne of item i, year t

$XSSH_{i,t}$ = Share of subsidised exports in all extra-EU exports of item i, year t

$PM_{i,t}$ = EU import unit value of item i, year t

$TARA_{i,t}$ = Ad valorem tariff on item i, year t

$TARS_{i,t}$ = Specific tariff on item i, year t

$FLEV_{i,t}$ = Flexible levy on item i, year t

If no distinction is made between subsidised and unsubsidised exports (usual case), the share $XSSH_{i,t}$ is set to one and $ESUT_{i,t}$ already gives the average subsidy. This is calculated as the ratio of FEOGA export refunds divided by total extra-EU exports $X_{i,t}$ or subsidised exports $XU_{i,t}$.

For a few sectors, the subsidised share of total extra-EU exports is derived from DG AGRI data[7]. While EU market management tries to reduce export subsidies as far as possible, it is very likely that subsidised exports partly replace unsubsidised exports, which therefore substitute for one other. The substitution is imperfect because export subsidies are applied only to selected market segments. The imperfect substitutability is expressed in a behavioural function of the subsidised share $XSSH_{i,t}$ as a function of the percentage export subsidy:

$$XSSH_{i,t} = \phi_{i,t}(ESUT_{i,t} / PE_{i,t}) = \phi_{0,i,t} * (ESUT_{i,t} / PE_{i,t})^{\varepsilon i} \qquad (25)$$

Unsubsidised exports $XU_{i,t}$ then simply equal one minus this share ($XSSH_{i,t}$) times total exports,

$$XU_{i,t} = (1 - XSSH_{i,t}) * X_{i,t} \qquad (26)$$

and subsidised exports are calculated accordingly.

With subsidised exports explicitly identified, it is straightforward to link them to WTO limits on subsidised exports. For the other items with only aggregate gross trade modelling, we have to apply an exogenous scaling factor to the WTO ceilings, which is equal to the ratio of gross exports according to the CAPSIM database to subsidised exports according to the EU’s WTO notifications. Compared to net trade modelling, this is definitely an important step forward but nonetheless does not fully meet the requirements for modelling Doha round agreements. For such analyses the subsidised/unsubsidised distinction should be applied to all relevant products. In terms of trade modelling, the current CAPSIM therefore still has to be considered an intermediate version.

This specification considers export subsidies per tonne and tariffs as the main independent policy instruments with international markets determining the resulting gross trade flows. This simplifies the description of real market management, which is also able to directly steer subsidised export quantities in the licensing procedure. Nonetheless, the EU administration cannot set subsidised export quantities and unit export subsidies independently from one other, so a policy representation in terms of the unit subsidy may be sufficient.

Administered prices with associated *flexible levies* or *export subsidies* are endogenously determined to impose a floor on EU market prices. For consistency with the ex-post data, the 'official' administered prices are converted to the level of EU market prices in the model, using their ratio in the base period. In simulations, this ratio is held constant so that only the relative changes are translated into EU market prices in the model:

[7] They are available for all products from the WTO notifications, but only for marketing years.

$$PADM_{i,t} = PADM_{i,t}^{official} \cdot PE_{i,bas} / PADM_{i,bas}^{official} \qquad (27)$$

where

$PADM_{i,t}$ = administrative price in simulation for item i, year t

$PADM_{i,t}^{official}$ = administrative price according to the legislation for item i, year t (bas = base year)

$PE_{i,bas}$ = EU market price of item i, base year

The distinction between unit values of exports (UVAE) and imports (UVAI) also permits us, and requires us, to introduce two equations to determine the average export subsidy ESUT and the flexible levy FLEV, which were indistinguishable in CAPSIM 2003, at least if there was an administrative price to be maintained.

$$ESUT_{i,t} = PADM_{i,t} * \text{sigmoid}(\tau_{ESUT,i,1} * [\tau_{ESUT,i,0} * PADM_{i,t} - PE_{i,t}] \;/\; \tau_{ESUT,i,0} * PADM_{i,t}) \qquad (28)$$

$$FLEV_{i,t} = PADM_{i,t} * \text{sigmoid}(\tau_{FLEV,i,1} * [\tau_{FLEV,i,0} * PADM_{i,t} - PE_{i,t}] \;/\; \tau_{FLEV,i,0} * PADM_{i,t}) \qquad (29)$$

where

$ESUT_{i,t}$ = export subsidy per tonne for item i, year t

$FLEV_{i,t}$ = flexible levy on item i, year t

$\tau_{VAR,i,1}$ = ‘responsiveness’ parameter (VAR = ESUT, FLEV)

$\tau_{VAR,i,0}$ = ‘trigger’ parameter (VAR = ESUT, FLEV)

The equations become transparent once we look at the term in brackets. The product of the trigger parameter $\tau_{VAR,i,0}$ and the administrative price indicates a ‘satisfactory’ market price from the viewpoint of market management. If $\tau_{ESUT,i,0} = 0.9$, for example, market management would grant export subsidies of 50% of the administrative price to potential exporters if the EU market prices were at 90% of the administrative price[8]. The responsiveness parameter has been set rather high ($\tau_{VAR,i,1} = 100$) so that EU market management would respond strongly to changes in market prices: If the market price were to rise to 91% of the administrative price, this would

[8] This follows from sigmoid(0) = 0.5. This is a sizeable subsidy, but the numbers facilitate the explanation.

result in a subsidy of sigmoid(100*[-0.01]/0.9) = 24.8% of the administrative price. At 95%, the subsidy would decline to less than 0.4% of the administrative price, which is in essence zero. In the empirical implementation, the trigger parameters have been resolved to reproduce the base year data.

Producer price changes in MS are usually assumed to equal those at EU level in relative terms:

$$PP_{m,i,t} = PE_{i,t} * \beta_{PP,m,i,t} \tag{30}$$

where

$PP_{m,i,t}$ = producer price of product i in MS m, year t

$\beta_{PP,m,i,t}$ = base-period producer price of product i in MS m, year t

The proportional differences between MS prices and EU prices reflect differences in the composition and quality of the products involved. For MS15 countries they are taken to be constant over time (derived from the base period) but for the new MSs they are adjusted to represent some convergence to EU prices.

Prices for feed 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, as explained in Witzke and Zintl 2005.

2.1.7. Welfare measures

Apart from the immediate model results for activity levels (areas) and market balances, CAPSIM also yields standard welfare indicators for producers, consumers, the processing industry and the EU budget.

Given that CAPSIM has complete coverage of agriculture, producer welfare may be computed simply on the basis of the EAA concepts, i.e. as revenues from outputs, less feed costs and other intermediate consumption. Taking account of indirect taxes, subsidies and depreciation gives the net value added at factor prices (NVAF) which is the key income variable relevant in agricultural policy. To ensure the completeness of the welfare calculation, we only have to add the implied change in costs for the primary factor aggregate, $INP_{m,REST,t}$, which is the numeraire of the profit function underlying the supply side, because these costs are not deducted from NVAF. This opportunity cost element of agricultural income was disregarded in the previous version.

Consumer welfare is computed in a straightforward way as the equivalent variation based on the consumer demand system included in CAPSIM (compare equation 105 in Witzke and Zintl 2005). For items with exogenous margins according to equation 15, it may be assumed that this margin corresponds to the fixed marginal cost such that the food industry profit is always zero ('normal' profits being remuneration for managerial capacity). This assumption has been made so far for most items without market balances for processed products, for example soft wheat. If the processing margins from raw products to food items change in alternative policy scenarios, contrary to our assumption, the 'consumer' welfare impacts may be considered to represent the sum of the impacts on final consumers and the food industry[9].

For those items covered by behavioural functions (16), for example oilseeds and milk products, endogenous prices may imply different processing industry margins in the reference run and in the policy simulation. The resulting processing industry profit has to be incorporated in the welfare analysis. As the linear behavioural functions integrate back to a normalised quadratic profit function ν(.), it is straightforward to calculate the normalised profit change in the processing industry:

$$\begin{aligned} & v(\mathbf{M}^{s}_{m,t}) - v(\mathbf{M}^{r}_{m,t}) \\ & = \sum\nolimits_u \beta_{m,u,0,t} (M^{s}_{m,u,t} - M^{r}_{m,u,t}) \\ & + \tfrac{1}{2} \sum\nolimits_u \sum\nolimits_v \beta_{m,u,v} (M^{s}_{m,u,t} M^{s}_{m,v,t} - M^{r}_{m,u,t} M^{r}_{m,v,t}) \end{aligned} \tag{31}$$

with normalised processing margins for the simulation s (and r):

$$M^{s}_{m,u,t} = PM^{s}_{m,u,t} / PP^{s}_{m,rest,t}$$

Processing industry welfare was also considered in the previous CAPSIM version, but the use of normalised margins is an improvement in theoretical consistency. The sugar industry profit is calculated somewhat differently as derived sugar beet revenues minus levies minus processing cost (set at €175/t based on the sugar study mentioned earlier) minus payments to farmers.

Simulations with CAPSIM permit us to estimate budgetary impacts corresponding to the policy scenario, but these impacts will be limited to the most relevant first-pillar CAP positions. These are currently premiums, consumption subsidies for milk products, refunds, tariff revenues and sugar beet levies. Other outlays under FEOGA, other components of the EU budget or national budgets are assumed to be constant. For the national welfare calculations, FEOGA outlays are allocated to MS using their shares in national contributions to the total EU budget.

Compared to the 2003 version, the change to a gross trade description has improved the estimates for export subsidies because the base-period unit export subsidies are calculated based on FEOGA data whereas the former specification derived them from differences in respect of some international reference prices. Nonetheless, we have to acknowledge a number of simplifications in these budget estimates. Farm-level ceilings are ignored at the moment. A number of policy instruments with sizeable budget impacts, for example consumption subsidies in the milk sector, are not yet incorporated. The MS shares in the EU budget might change in the course of the ongoing discussion on a new financial framework or as the result of a political

[9] This holds strictly only in the case where endogenous margins do not influence the aggregate behaviour of 'downstream' agents but only the distribution of welfare effects between them (which is true at most approximately).

compromise on a policy. Finally, first-pillar savings may be used for other purposes, for example second-pillar expenditure, which would have second-round welfare impacts. Alternatively, less tax would be required from taxpayers, which has general equilibrium effects as well.

2.2. EX-POST DATABASE

In general, an economic model requires four types of input data

1. Parameters of behavioural functions

2. Ex-post data characterising the initial situation

3. Exogenous inputs characteristic of alternative situations (projections of exogenous variables, policy variables)

Whereas the sources for parameters are considered in section 2.1, this section will discuss issues relating to the ex-post database. Exogenous inputs are dealt with in section 2.3.

The main principles of the organisation of the database remain unchanged from CAPSIM 2003. In version 2005, the base year data have been updated to the three year average 2001-2003. However, the underlying database usually includes 2004 data for most (say 95%) of the required series. The data are organised within a consistent framework at MS level (see section 3.2 in Witzke and Zintl 2005). In geographical terms CAPSIM covers all MS of EU25 as single countries (apart from the aggregation of Belgium and Luxembourg). CAPSIM comprises data on farm and market balances, activity levels (hectares for crops and heads for animals), unit values and the EAA. Technically, they are stored as a set of two-dimensional matrices, one for each year and region, quite similar to DG ESTAT's AGRIS Table. The columns include activity levels and other information. The rows give the items and other information (see Appendix II for a full listing of CAPSIM codes and other abbreviations used in this report).

The ex-post raw data are in general taken from various DG ESTAT domains, mainly ZPA1 (production statistics and market balances) and COSA (economic accounts). These data do not always fully match. There are frequently differences, for example between the EAA quantities, usable production from the market balances and production from production statistics. These inconsistencies are partly due to different definitions but also partly because the data come from different departments of statistical offices at national level. Incompleteness and inconsistency are still handled in (an updated version of) the 'COCO' module shared between CAPSIM and CAPRI (see http://www.agp.uni-bonn.de/agpo/rsrch/capri/capri-documentation.pdf). It required some updates for the appropriate treatment of the new MSs, but basically the procedure is unchanged.

For the new gross trade component of CAPSIM, we introduced gross trade quantities for major agricultural goods given in convenient aggregations on the DG AGRI website. Originally, they stem from COMEXT. Inconsistencies with the COCO database have been removed in the aggregation step (capsim14.dat.gms), minimising the deviations from the DG AGRI trade data while using the net trade balance from the DG ESTAT/COCO database.

The surprisingly low ratios of EAA production values for roughage compared with the corresponding areas in the UK led to the conclusion that in such cases it may be advisable to deviate from EAA data if this improved the internal plausibility and consistency of the model database. As a consequence, net revenues from fodder maize and ‘other fodder’ (temporary grass land, fodder beets, clover, etc.) are required to be at least 20% of the average net revenues from soft wheat and barley and not more than 130%. For permanent grassland, the bounds are 10% and 100%. Where these bounds are breached, both the production value and the feed cost component for these roughage items are modified to comply with the bounds while leaving aggregate gross value added unchanged.

2.3. METHODOLOGY FOR REFERENCE RUN AND STRUCTURAL CHANGE

2.3.1. Reference run methodology

Using a quantitative model for impact analysis usually requires a reference run to be specified first in order to serve as a yardstick for the subsequent impact analysis. The outlook is usually approached cautiously in the form of conditional forecasts, as a consistent set of predictions that critically depend on a set of key assumptions such as the exchange rate. Nonetheless, because the key assumptions are usually chosen on the basis of their probability, the distinction from an unconditional forecast may be mainly semantic. Performing a reasonable reference run is a forecasting or 'outlook' task carried out in various organisations such as the FAO, OECD, FAPRI or DG AGRI. Usually it relies on some form of econometrics, from simple trends to advanced time series techniques. Typically, the forecasts do not rely on a single overall coherent 'model' but on a set of interlinked models tailored to analyse specific agricultural subsectors ('cereals', 'oilseeds', etc.). Finally, a characteristic feature of serious outlook work is that information from many market observers and participants is integrated in an informal way. This may involve market or regional experts within large public agencies (FAO, DG AGRI) or discussion meetings to solicit expertise from outside (FAPRI, AGLINK process). This informal integration of information may pick up ongoing 'structural' changes within agriculture (farm size distribution, part-time farming, technological progress, etc.) and the food sector (consumer tastes, marketing margins) which are difficult to capture in small case studies but impossible to determine for a differentiated set of products and many regions over a limited period of time.

For policy simulations, a good fit with past observed data is a less crucial quality criterion than for outlook work. It is more important for the model to be able to work out endogenously the consequences of modified, potentially new policy instruments, in a transparent form. Transparency is more important than in outlook work because a reasonable model structure may provide the only secure basis on which to build a policy simulation. If the policy measures represent a significant change from the status quo, the experience of market observers is less valuable because nothing comparable may have been observed in the past. Econometric estimations may be a shaky basis as well, if the structure changes as a consequence of the policy change

(Lucas 1976). This may apply to trend shifts if they are capturing structural changes that may be responding to large policy changes. However, the same may also apply to other parameters considered invariant over scenarios such as price elasticities. The ideal answer to these problems would be a 'super model', able to capture endogenously all structural changes and interrelationships between variables with empirically estimated parameters: an agent-based, highly differentiated, econometrically estimated general equilibrium model. Given that this is an unrealistic goal, many modelling teams focussing on policy simulations (CAPSIM, CAPMAT, CAPRI, ERS/Penn, ESIM, GTAP, WATSIM) have preferred a coherent structure with a more or less rigid microeconomic framework over completeness in terms of endogenous relationships. This requires some critical judgment to evaluate the results based on constant parameters (e.g. regarding labour outflow) or to introduce exogenous parameter shifts (e.g. regarding border prices).

Of course, the distinction between modelling systems for outlook work and for policy simulations is not a strict one. Intensive discussion of simulation results with selected market experts and subsequent revisions of model parameters may render a reference run reasonable even without a complete econometric estimation or numerous inputs from hundreds of people.

Although CAPSIM focuses on policy simulations, it has been prepared for the reference run so as to incorporate various pieces of information from different sources in a systematic way. To serve these two purposes, the system is used in two 'modes'. The *reference run mode* is used to calibrate the unknown time-dependent parameters (shifters) in model equations, building on exogenous forecasts and ex-post observations for the related variables, for example the activity levels. For this calibration of time-dependent parameters, the functional forms of the behavioural functions are chosen so that neither symmetry, homogeneity nor curvature are affected by these translations of shifters, provided the other parameters linked to price responsiveness are held constant. CAPSIM's *policy simulation mode* builds on these calibrated values for parameters to simulate the impacts of alternative policies and exogenous inputs for the given parameters. For those exogenous inputs, which are not open to modification, the standard rule is that they are taken over from the reference run, for example yields, final consumption expenditure, and the inflation rate. When policy inputs and other inputs are chosen with their reference run values in the policy simulation mode, the outcome reproduces exactly the reference run results.

The reference run mode resembles the AGLINK approach, where what are termed 'add factors' shift the model results to match forecasts from OECD members for assumed prices (Uebayashi 2003, Conforti and Londero 2001). The same occurs in the calibration of FAO-@2030 to a new baseline (Britz 2003: 46). Apart from these examples of systematic calibration of reference run results to an existing set of forecasts, it is quite clear that every large-scale modelling system includes thousands of parameters and that some of them will be reconsidered in the event of surprising results. The revision may be based on a re-estimation or 'expert judgment' (Westhoff and Young 2001: 257), which is just another example of parameter adjustments being used to obtain a plausible baseline.

In connection with a recent project on behalf of the EEA, these parameter adjustments for the reference run have been placed on a systematic footing:

- CAPSIM internally merges a set of expert forecasts even if they contradict each other and if they are technically infeasible;
- in addition, another ex-post observation beyond the model's base year is used to specify the time path of time-dependent parameters.

In essence, the expert forecasts are treated as if they were ex-post observations and the development of shifters is chosen to maximise the 'fit' of model outcomes compared to observed or forecast information. To merge the information from different sources, we organise them as a set of 'supports' with associated probabilities reflecting the confidence in them and then calculate the probability-weighted mean:

$$FC_{m,i,t} = \sum_s Sup^s_{m,i,t} \cdot Pr^s_{m,i,t} \tag{32}$$

where

$FC_{m,i,t}$	=	Aggregated expert forecast for variable i, in MS m, and year t
$Sup^s_{m,i,t}$	=	Support (= expert prediction) from source s, for variable i, in MS m, and year t
$Pr^s_{m,i,t}$	=	probability associated with source s, for variable i, in MS m, and year t

An ex-post observation is treated as a single expert forecast with a probability near 1. Two outer, purely technical supports with a low probability characterise the conceivable range for each year and each variable in question. In reference run mode, CAPSIM can translate the matrix of shifters $\Theta_{m,k,t}$ over time, subject to some constraints, to minimise the distance of simulation results $X_{m,i,t}$ from the a priori expectations $FC_{m,i,t}$. Certain variables such as yields may be chosen directly, i.e. without using a related shifter in a behavioural function, but other equations will usually cause some deviation of CAPSIM yields from the expert forecasts:

$$\min_{X,\Theta} \left\{ obj(X, FC) : f(X, \Theta) = 0 \right\} \tag{33}$$

where obj(.) is a fit criterion and f(.) = 0 is a very short representation of the other model equations in CAPSIM. The details of this procedure are presented in the reference manual, but we may note a few advantages and disadvantages here:

- Technical consistency is imposed on the simulation results $X_{m,i,t}$ through the model equations f(.) regardless of the a priori expectations $FC_{m,i,t}$.
- The probabilities and additional weights in the objective function both permit and require explicit statements as to how important certain variables are and how confident we are in the predictions of various sources.

- The compromise between different expert predictions is achieved through a set of equations rather than through an intransparent Delphi process involving discussions among individuals.

- An equation-based compromise will remain mechanical because human individuals may change their minds in the light of convincing arguments whereas supports are unaffected by any discrepancy with other forecasts.

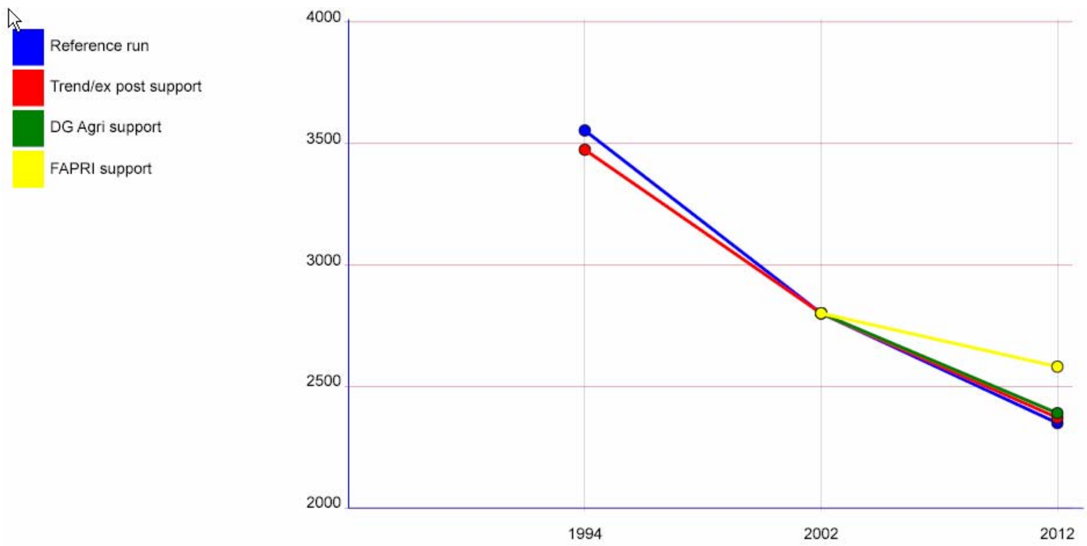
- Even though solution time and transparency is certainly better than in a Delphi process, both the solution time and the model complexity turn out to be daunting.

The current reference run solves for 1994 and 2012. The MS-specific premiums are implemented as known for 2005. As a consequence, new equations and variables had to be introduced to handle the Single Farm Premium and remaining coupled premiums at the same time as well as the national top-ups in the new MSs together with their ceilings.

As mentioned above, this reference run methodology has been applied successfully in a study for the EEA (Witzke and Britz 2005), but it has also been used in this phase of model development for the interim-report reference run and also for the final reference run. Because this is described in more detail in section 3 below, we refrain here from further comment on the substantive results.

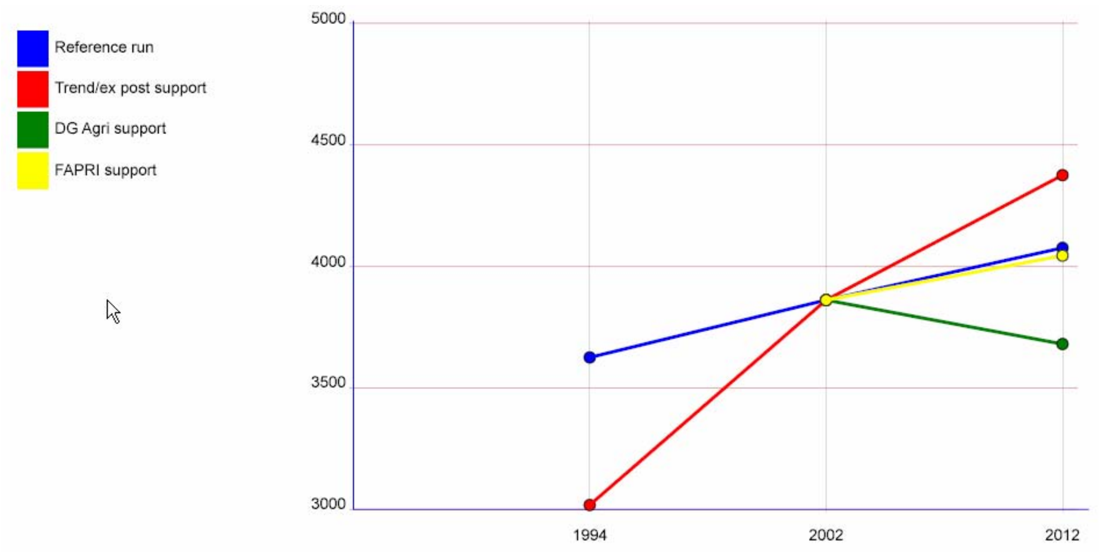
Instead, we give below a few snapshots from the Extensible Mark-up Language (XML) Table, automatically produced during the reference run, showing how the final results relate to expert sources.

Figure 1: Aggregated 'supports' and simulation results for barley area in EU10 [1000 ha]



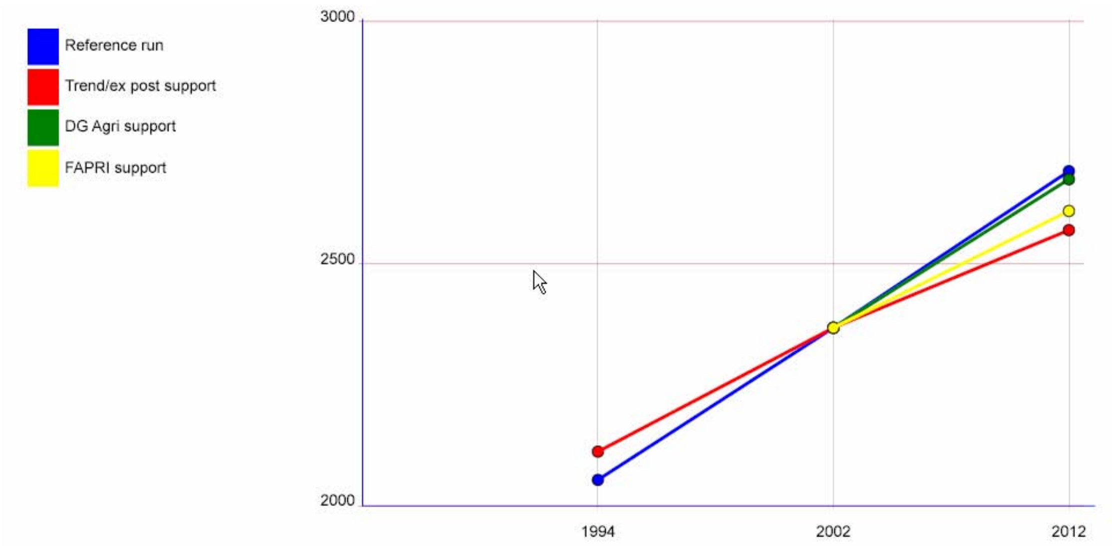
All sources and our reference run results agree that barley is likely to decrease moderately compared to the base year 2002 in the new MSs. This unanimity does not apply to all cases.

Figure 2: Aggregated 'supports' and simulation results for durum wheat area in EU15 [1000 ha]



In this example, the reference run follows FAPRI in indicating a moderately increasing durum wheat area, whereas the trends still anticipate a pronounced increase and the July 2005 DG AGRI forecasts show a moderate fall.

Figure 3: Aggregated 'supports' and simulation results for rape area (food uses) in EU15 [1000 ha]



In this example, the reference run is evidently outside the range spanned by the other ‘expert’ sources. This is possible if some constraints are otherwise violated or if the penalty on second differences for shifters would otherwise further degrade the objective value. Further analysis of these results has to be carried out at MS level, but this is more conveniently performed on the basis of the electronic XML Tables.

We have undertaken an analysis of the deviations of simulation results from the supports using parameter ‘CHKS’ in the program listing. This shows that, apart from the second difference terms, the simulation results usually do not deviate by more than 10% from the mean of the supports for important variables, whereas for unimportant items and smaller MS greater deviations may occur.

To summarise, the *reference run mode* of CAPSIM calibrates unknown time-dependent parameters (shifters) in model equations, building on exogenous forecasts and ex-post observations for the related variables, for example activity levels. The *policy simulation mode* of CAPSIM builds on these calibrated values for parameters to simulate the impacts of alternative policies and exogenous inputs for the given parameters. In the following, we need to add some details on this methodology, in particular:

- the origin of the default trends,
- the sources for external forecasts,
- the consolidation methodology.

2.3.2. Default trend estimates

In the previous version of CAPSIM (see Witzke and Zintl 2005, section 3.3), the trends were estimated with a fairly simple methodology. This was natural if their role was essentially limited to giving exogenous inputs for yields, some exogenous areas and a few other exogenous variables. Parameter shifts were only considered for a few variables, a small set of consumption quantities and activity levels where it was considered useful to incorporate DG AGRI projections.

The 2005 CAPSIM version differs from this in that parameter shifts are considered possible for *all* constant terms of behavioural functions on the agricultural-sector supply and demand side. They are specified to trace a weighted average of expert sources and default trends (see section 2.3.4). If no expert sources are available, the default trends are the key determinants of the parameter shifts incorporated into CAPSIM, so require increased attention.

The trend estimation methodology has been improved following a 2004 study for the EEA (see Witzke and Britz 2005), which has been incorporated in the CAPRI baseline generation. In consequence, CAPSIM can conveniently build on these CAPRI trends, estimated using the same database (section 2.2.). Even though trend estimates will always be mechanical and ignorant of policy changes, a number of ‘intelligent’ safeguards are built into these trends to render them reasonable.

The first of these is a trend function ($a+b\ t^c$, $0 \leq c \leq 1.2$) restricting the maximum change over time. The second is a three-step procedure where the forecast of a series with a bad fit is pulled towards the most recent base year data. The first step consists of finding independent trends for all series in the database. In a standard forecasting effort, the trend term would be ignored if the t-value of the associated trend parameter did not exceed conventional significance levels. We applied this rule in a continuous form rather than with a threshold significance level (noting the relationship of R^2 to the t value in simple regressions) when defining a ‘target’ value for step 2 as a weighted average of the base-year value and defining a projection value weighted by

R^2 from the first step. Weighting the step 1 forecasts with R^2 tends to produce conservative estimates close to the base year value if the fit was bad.

Step 2 introduces a third group of safeguards. This is a quite exhaustive set of technological constraints and identities tying together the series. If we ran independent trends for, say, the barley area, yield and production, the forecasts would almost certainly violate the identity linking the three series. One solution would be to drop one of the three from the estimation, for example the yield, and to compute it later from the forecasts of the two other series. By doing so, however, we would ignore the information incorporated in yield observations, which is avoided in our simultaneous approach. Consequently, we have imposed several balances (for feed energy and crude protein, milk fat and protein in dairies, markets including land and non-tradable young animals) and identities (production = activity levels*yields, values = quantity*price, consumption = per capita consumption*population, aggregates = sum of components). Furthermore, for several variables assumed to change only slowly, maximum yearly growth rates have been defined, e.g. for total agricultural area (max. ± 0.5% per year), cereal consumption per head (max. ± 0.4%), and so forth. The step 2 forecasts are those values that minimise normalised squared deviations from the 'targets' while meeting all the above technical constraints.

The most recent version of this trend estimator tries to incorporate some information on policy developments as well (see http://www.agp.uni-bonn.de/agpo/rsrch/capri/capri-documentation.pdf, section 4).

2.3.3. Expert sources

The most important source of expert information is the regular 'Prospects' publication by DG AGRI. Because DG AGRI does not cover all relevant variables (e.g. cakes and oils related to oilseeds) we have also included FAPRI projections, which are the main source for price developments on international markets.

2.3.4. Consolidation

The reference run consolidates the information incorporated in

- possibly contradictory expert forecasts and default trends,
- ex-post data, including the base year (2001/03) and an earlier observation (1993/95).

In essence, the expert forecasts are treated as if they were ex-post observations, and the development of shifters is chosen to maximise the 'fit' of model outcomes compared to observed or forecast information. A well-known interpretation of an 'optimal' compromise between distinct pieces of a priori information is provided by a cross-entropy approach (Golan, Judge and Miller 1996). However, the cross-entropy approach turns out to be impractical in this large scale modelling effort, because it introduces for each variable of interest auxiliary variables (probabilities) and equations (probability sum, posterior mean of supports). In this study, we used an attractive and computationally less demanding alternative, the 'Highest Posterior Density' (HPD) estimator (Heckelei, Mittelhammer, Britz 2005).

This results in a quite convenient quadratic objective function if we assume a normal prior distribution. Finally, it also turns out useful to introduce additional weights in the objective function characterising the importance of the variable in question, because some variables are deemed more important, e.g. the soft wheat area in France, than others, e.g. the sheep and goat herd in Finland. 'Importance' is measured both as the (quantity) share in EU totals and as the share in the (monetary) national totals, which are combined with equal weights.

The final objective function chosen looks as follows:

$$\begin{aligned} obj = & \sum\nolimits_{r,i,j,t} obwgt^{j}_{r,i} \cdot \left(\frac{X^{j}_{r,i,t} - \overline{X}^{j}_{r,i,t}}{\sigma^{j}_{r,i,t}} \right)^2 \\ & + \sum\nolimits_{r,j} obwgt^{j}_{r,sh2} \cdot \left[\frac{\left(\alpha^{j}_{r,i,tn} - \alpha^{j}_{r,i,tb}\right) / (tn - tb) - \left(\alpha^{j}_{r,i,tb} - \alpha^{j}_{r,i,t1}\right) / (tb - t1)}{X^{j}_{r,i,tb}} \right]^2 \\ & + \sum\nolimits_{r,j} obwgt^{j}_{r,sh1} \cdot \left[\frac{\left(\alpha^{j}_{r,i,tn} - \alpha^{j}_{r,i,t1}\right) / (tn - t1)}{X^{j}_{r,i,tb}} \right]^2 \end{aligned} \tag{34}$$

where

$X^{j}_{r,i,t}$	=	variable in row i, column j, region r and year t (t = t1 = first year 1994, t = tb = base year 2002, t = tn = last year 2012)
$\overline{X}^{j}_{r,i,t}$	=	mean support (from DG AGRI, FAPRI, trend/ex-post) for variable in row i, column j, region r and year t
$\sigma^{j}_{r,i,t}$	=	prior standard deviation for variable in row i, column j, region r and year t
$obwgt^{j}_{r,i}$	=	objective function weight for deviation from mean support in row i, column j, region r and year t
$obwgt^{j}_{r,i,sh2}$	=	objective function weight for change in yearly shift of behavioural parameter for row i, column j, region r (second difference penalty)
$obwgt^{j}_{r,i,sh1}$	=	objective function weight for total yearly shifts of behavioural parameter for row i, column j, region r (first difference penalty)

The second (HP filter-like) term pulls changes in behavioural parameters towards a straight line, expressing the a priori expectation that if parameters shift at all, they should shift in a quite regular way.

The third term penalises any parameter shift, expressing the a priori expectation that, while shifts are not excluded, parameters will normally remain stable. Some experiments have shown that a relative weight of 10% for the first difference penalty compared to the second difference penalty turns out to give plausible results.

The above objective function is an update of Witzke, Britz 2005, where the third term was completely missing and the second term was incorporated in additional constraints.

For external information, we used the following items:

1. Activity levels (mainly for crops),
2. Yields (mainly for crops),
3. Production (for animals and processed items),
4. Demand (total, human consumption, feed, processing),
5. Trade (net trade, imports, exports),
6. Prices (EU prices, world market prices).

Other variables largely depend on these key variables. Producer prices at MS level, for example, are in most cases derived from the EU prices through a fixed proportionality factor (see 30). Income may be calculated once prices and quantities are known. In this way, the closed-sector model framework helps to conveniently complete the quantitative predictions in line with the predictions for key variables.

It should be noted that the shifts in behavioural functions will capture structural changes in agriculture. If a larger percentage of milk is delivered to dairies and marketed through the food system, this may change the quantity and composition of milk products at given prices. This may be expressed with shifting behavioural functions and would be reflected in the reference run projections.

2.4. APPLICATIONS AND FURTHER DEVELOPMENTS

2.4.1. Reference run

This section provides an overview of the results for the reference run. Thanks to a long-run projection effort with CAPSIM for the EEA, the reference run methodology has been put on a systematic footing. The key finding that a reference run using the status quo development is a different challenge from one using a particular starting point had already been acknowledged in the 2003 CAPSIM version, but could only be implemented in patchwork form at that time. The current version merges ex-post data and external forecasts into a reference run providing an optimal compromise between these different kinds of information.

Scenario characterisation

The current reference run solves for 1994 and 2012, relying on world market projections from FAPRI.

Table 1: Base-period international prices and reference-run price changes

	EU, 2002	World, 2002	World, 2012
SWHE	108	107	101
RYEM	90	75	64
BARL	111	111	83
OATS	91	85	72
MAIZ	116	105	98
OCER	93	93	78
RAPE	220	220	171
SUNF	246	246	196
SOYA	210	210	167
BEEF	2660	1363	1112
PORK	1365	1049	814
POUM	1250	760	670
SMIP	2111	1733	2054
BUTT	3540	1752	2292
CHES	4880	3698	4075

Compared to the 2002 international prices, there is some decline except for milk products according to the FAPRI projections (see Table 1). In some cases, these projections translate fairly directly into changes in EU prices, namely those without gross trade modelling (e.g. oilseeds). With gross trade modelling, the export supply and import demand functions (see 22) are shifted from the rest of the world because EU border prices ($PX_{i,t}$, $PM_{i,t}$) enter here relative to the fixed 'average' world prices in the above table.

The MS-specific premiums are implemented as known at the end of 2005 from the DG AGRI website. As a consequence, new equations and variables have had to be introduced to handle the Single Farm Premium and remaining coupled premiums at the same time as well as the national top-ups in the new MSs together with their ceilings.

The sugar market reform was decided when the reference run specification was already essentially finished. Rather than ignoring this reform entirely, an attempt has been made to incorporate it with the old parameters from the earlier EuroCARE sugar study, but the current sugar results do not appear very convincing[10] and are therefore not discussed below.

In addition to the Luxembourg reforms, the 'Mediterranean' reforms introducing some decoupling for olives, tobacco, cotton and hops have been incorporated as well (within the limits of the CAPSIM product aggregation).

The key results for production, quantities and related activity levels are reproduced in Table 2.

[10] Sugar production declines by only 16% in the EU25 rather than by some 40% as might be expected.

Table 2: Reference run results for production and activity levels in EU25

	Production [1000t]				Activity levels [1000 ha or hd]			
	2002	2008	2010	2012	2002	2008	2010	2012
Cereals	256609	274710	280785	286701	52272	52730	52950	53144
Oilseeds	16236	18026	18566	19060	5792	5872	5887	5886
Pulses	5045	4412	4285	4159	1940	1826	1808	1790
Potatoes	65217	59320	57172	55562	2440	1941	1783	1651
Sugar beet	127871	119154	111040	104953	2351	1996	1819	1683
Vegetables	63791	65273	65678	65936	2421	2330	2299	2265
Fruits	36848	36437	36183	35875	3388	3193	3128	3064
Fodder	1846677	1831676	1826840	1821108	74806	73150	72603	72044
Cow milk	145363	143758	143883	143883	2074	1908	1843	1771
Pork	21352	22149	22351	22522	233535	242774	245395	247785
Poultry	10769	11403	11573	11726	6004	6181	6245	6311
Beef	8296	8033	8007	7978	17142	16507	16388	16245

Note: The activity level given for beef comprises slaughtered heads from bulls and heifers.

At the aggregate level, the changes are quite moderate. Cereal areas are taking over part of the released areas, while another part is being lost to non-agricultural uses. As the decline of sugar beet areas was not yet reflected in the July projections of DG AGRI, this, along with the heterogeneous results at MS level, has contributed to a stronger growth in cereal areas compared to the DG AGRI projections.

The outlook for meat markets is the continuation of demand-driven trends for pork and poultry. For beef, we see both the impacts of long-run trends as well as some decoupling effects brought about by the SFP. The size of the beef sector is also constrained by the availability of calves, determined in turn by the declining herd of dairy cows, fixed milk quotas and rising yields.

Table 3 gives an overview of important market developments under reference run conditions. Significant changes are a marked increase in net exports of cereals and a clear decrease in net exports for beef and poultry. It may be seen from the previous table that the key driving force for additional cereal exports is not an increase in area (modest) but rather a strong increase in yields. The changed balance for beef is mainly due to a decline in supply whereas for poultry demand is probably outpacing supply.

Table 3: Reference run results for key market developments EU25

		2002	2008	2010	2012
Cereals	production	256609	274709	280785	286701
	demand	240820	247487	249660	251942
	net trade	15789	27222	31125	34759
	exports	26853	39070	42929	44824
	imports	11064	11848	11804	10065
Oilseeds	production	16236	18026	18566	19060
	demand	34651	36883	37464	38066
	net trade	-18415	-18858	-18898	-19006
Beef	production	8296	8033	8007	7978
	demand	7974	7918	7921	7915
	net trade	322	114	86	62
	exports	704	526	468	415
	imports	384	412	381	352
Pork	production	21352	22149	22351	22522
	demand	19637	20450	20672	20873
	net trade	1715	1699	1679	1649
	exports	1727	1723	1703	1674
	imports	22	24	24	25
Poultry	production	10769	11403	11573	11726
	demand	10244	11071	11293	11502
	net trade	525	332	280	224
	exports	986	780	716	650
	imports	461	448	436	426
Butter	production	2158	2052	2067	2080
	demand	2188	2174	2153	2131
	net trade	-31	-123	-87	-51
	exports	82	27	30	34
	imports	113	150	116	85
Skimmed MP	production	1321	1017	1042	1065
	demand	1143	1012	988	964
	net trade	178	5	54	101
	exports	235	73	100	130
	imports	57	69	46	29
Cheese	production	8167	8773	8928	9076
	demand	7752	8195	8318	8433
	net trade	416	578	610	643
	exports	550	680	708	737
	imports	134	102	98	95

Together with price changes, the above market developments are key determinants of income changes, which are displayed in Table 4. It is quite clear that the relative changes in income, however measured, are more favourable in the new MSs compared to the old. Whether the changes per head of the agricultural labour force will indeed materialise depends on future structural change. The simple regression approach presented in section 2.1.4 yields a stronger decline in agricultural labour than the July 2005 DG AGRI projections. Even though labour market developments may deserve greater attention in the future, the above fully linked projections certainly represent progress compared to the omission in the last CAPSIM version.

Table 4: Reference run results for agricultural income determinants in EU25, EU15 and EU10

	2002	2008	2010	2012
EU25				
Output at producer prices	294222	284711	284256	284836
Output related subsidies	28585	42047	43335	43536
Output related taxes	551	551	551	551
Input at basic prices	162798	166650	170346	174436
GVAD at basic prices	159458	159557	156694	153385
Labour force [1000 ALU]	9922	8103	7516	6937
GVAD [€/hd]	16071	19692	20848	22111
GVAD [€/hd] (real)	16071	17306	17606	17968
EU15				
Output at producer prices	266576	257363	256952	257415
Output related subsidies	28134	37010	37058	36917
Output related taxes	551	551	551	551
Input at basic prices	144832	148814	152158	155734
GVAD at basic prices	149326	145008	141300	138047
Labour force [1000 ALU]	6027	4820	4425	4035
GVAD [€/hd]	24774	30085	31932	34210
GVAD [€/hd] (real)	24774	26424	26944	27770
EU10				
Output at producer prices	27646	27348	27304	27421
Output related subsidies	451	5036	6277	6619
Output related taxes	2	4	4	4
Input at basic prices	17966	17836	18188	18702
GVAD at basic prices	10130	14545	15389	15333
Labour force [1000 ALU]	3895	3283	3091	2902
GVAD [€/hd]	2601	4431	4979	5284
GVAD [€/hd] (real)	2601	3918	4238	4335

2.4.2. Decoupling scenarios

Modelling EU payments, in particular the Single Farm Payment (SFP), is highly controversial. A great part of this discussion focuses on theoretical possibilities why the EU premiums might not be completely decoupled, in particular the risk, wealth, expectation and structural change aspects. The task of incorporating these has been addressed in various ways, most frequently by introducing a ‘decoupling factor’ expressing the incentive effects of ‘decoupled’ payments relative to market-price support measures.

This approach is not followed by the CAPSIM and CAPRI modelling teams in Bonn mainly for two reasons:

- While it is acknowledged that risk, wealth, expectation and structural change effects are valid theoretical arguments, their empirical relevance appears to be quite limited, in particular where some border and coupled support measures are still in place.

- Given the lack of empirical knowledge about their magnitude, decoupling factors introduce a considerable degree of arbitrariness into the model specification. Any percentage chosen (<100%) might be challenged by trading partners trying to accuse the CAP of violating WTO rules.

As an alternative to the use of decoupling factors, a number of modelling groups have chosen to represent the EU SFP as a uniform payment coupled to agricultural land (CAPSIM, CAPRI, GTAP, see e.g. Frandsen, Gersfeld and Jensen 2002). At first glance, this may appear to entirely miss the decoupled character of the SFP. At least in the historical version (historically determined payment rights with more eligible hectares than total payment rights), the eligible area might not constrain the total payments, with the result that the payments will not be immediately capitalised in land rental prices. On the other hand, a decline in land prices takes time and over the years some eligible area will be lost to non agricultural uses, so that in the longer run the SFP is likely to operate as if it were a conventional land subsidy. A number of stylised simulations have been carried out to show that a fully coupled implementation of the SFP, i.e. as a flat rate payment to all agricultural land, may nonetheless fully reflect the decoupled nature of the SFP. Decoupling need not be expressed through a contentious decoupling factor (potentially equal to zero). Instead, decoupling will naturally emerge as an implication of payment equalisation if risk, wealth, expectation and structural change effects are considered negligible. This holds if the land subsidy is paid for all land uses and market imperfections are absent.

Accordingly, a set of scenarios has been chosen and discussed intensively in the CAPSIM reference group demonstrating that the equivalence of decoupling and elimination of premiums holds not only in theory but also in numerical simulations with CAPSIM. At the same time, it has been shown that the equivalence breaks down once we introduce certain side conditions of the Luxembourg compromise of June 2003 (good farming requirement, exemption of some crops from eligibility). These simulations are presented in some detail in the following section.

2.4.3. Applying the decoupling scenarios: extensification in the cattle sector

All simulations start from the ex-post period 2000-2002[11] and ignore elements of the Luxembourg compromise other than the introduction of the SFP, such as the changes in the rye and rice regime, the reduction in monthly reports, and the modifications to the dairy market. Furthermore, we also ignore adjustments of EU market prices, for example an increase in beef prices due to a declining EU supply and the imperfect substitution of beef origins on international markets. This permits us to illustrate the specification issues with simulations for just a single MS (France), which facilitates simulation of a number of alternative versions. All these simplifications help to isolate the factors relevant for decoupling effects. We compare the following scenarios:

REF:

Ex-post situation 2000-2002, i.e. with coupled Agenda 2000 premiums incompletely phased in.

NOPREM

[11] The simulations were carried out before the last database update. Nonetheless, they are still highly illuminating for the economic interpretation of the SFP.

All premiums for the base year 2000-2002 are simply abolished with no changes in EU market prices.

DECO:

As in earlier CAPSIM implementations of the MTR, all premiums (animals and crops) are aggregated to a total premium value granted in an equal amount per hectare to all eligible crops. Eligibility corresponds to the later MTR decision, i.e. essentially the total area less permanent crops, fruits and vegetables and potatoes. In France, this results in an amount of about €246 per hectare. Fallow land is also eligible for the SFP but it is assumed that the requirement to keep land benefiting from payments in 'good agricultural condition' would incur costs of €50 per hectare.

DECO0:

Identical to scenario DECO but without any additional requirements regarding the 'good agricultural condition' of fallow land, which is therefore unconditionally eligible for payments.

DECO0A:

Identical to scenario DECO0 but with *all* crops, including perennial crops, fruits and vegetables and potatoes, eligible for the SFP.

DECOCUT:

Identical to scenario DECO but with a 75% cut in the decoupled premium.

In terms of results (see Table 5), we concentrate on selected activity levels (LEVL) and corresponding revenues. Gross revenues (GREV) are the sum of market revenues and premiums, if applicable. Net revenues (NREV) are gross revenues less the shadow values for land (crops), energy and protein requirements (animals). An earlier distinction between land qualities has been abandoned in CAPSIM because the implementation turned out to give distorted results (or would have required complex amendments). The difference between gross and net revenues in the crop sector is therefore simply the (internal) rental price of land (UVAP LEVL).

If premiums are abolished in NOPREM, gross revenues in the crop sector evidently decline. At the same time, demand for fodder also declines because the cattle sector premiums are abolished as well, causing fodder prices to fall[12] and fodder areas to decline more than other crop areas. With the given set of parameters, this decline drives down land rental prices to zero.

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[12] Prices of a number of items (grass, fodder maize, other fodder, calves) are assumed to clear national markets as the small trade volumes between farmers are unlikely to extend to other MS. Prices of these items are not fixed but endogenously adjusted in the scenarios.

Table 5: Results for the equivalence of decoupling and elimination of premiums

		REF	NOPREM	DECO	DECO0	DECO0A	DECOCUT	NOPREM	DECO	DECO0	DECO0A	DECOCUT
SWHE	GREV	1111	752	999	999	985	814	-32.3%	-10.1%	-10.1%	-11.3%	-26.7%
SWHE	NREV	891	752	802	752	752	802	-15.6%	-10.0%	-15.6%	-15.6%	-10.0%
SWHE	LEVL	4755	4543	4623	4531	4543	4633	-4.5%	-2.8%	-4.7%	-4.5%	-2.6%
BULF	GREV	1284	1086	1086	1086	1086	1086	-15.4%	-15.4%	-15.4%	-15.4%	-15.4%
BULF	NREV	813	617	625	618	617	625	-24.1%	-23.1%	-24.0%	-24.1%	-23.1%
BULF	LEVL	2001	1904	1911	1905	1904	1911	-4.8%	-4.5%	-4.8%	-4.8%	-4.5%
MAIF	GREV	973	648	857	892	881	674	-33.4%	-11.9%	-8.3%	-9.4%	-30.7%
MAIF	NREV	753	648	660	645	648	662	-14.0%	-12.3%	-14.3%	-14.0%	-12.1%
MAIF	LEVL	1426	1353	1367	1354	1353	1366	-5.1%	-4.2%	-5.0%	-5.1%	-4.2%
OFOD	GREV	459	234	447	478	467	264	-49.0%	-2.4%	4.3%	1.8%	-42.4%
OFOD	NREV	239	234	251	232	234	253	-2.2%	4.9%	-3.1%	-2.2%	5.6%
OFOD	LEVL	3341	3120	3247	3128	3120	3241	-6.6%	-2.8%	-6.4%	-6.6%	-3.0%
VSET	GREV	341		246	246	233	62	-100.0%	-27.8%	-27.8%	-31.8%	-82.0%
VSET	NREV	122	0	50	0	0	50	-100.0%	-59.1%	-100.0%	-100.0%	-59.1%
VSET	LEVL	322	266	290	266	266	289	-17.5%	-10.0%	-17.3%	-17.5%	-10.1%
FALL	GREV			196	246	233	12					
FALL	LEVL	136	935	601	947	935	592	585.7%	340.4%	594.4%	585.6%	333.9%
UVAP	LEVL	219	0	196	246	233	12	-100.0%	-10.4%	12.4%	6.2%	-94.7%

Note: SWHE = soft wheat, GREV = gross revenue, NREV = net revenue, LEVL = activity level, BULF = bull fattening, MAIF = fodder maize, OFOD = other fodder, VSET = voluntary set-aside, FALL = fallow land (see text), UVAP LEVL = land price.

Negative land prices are precluded because total fallow land would increase significantly by about 740000 ha, which is the sum of the increase in FALL (= initially unpaid fallow land) and the decline in VSET (initially paid voluntary set-aside). These two activities are distinguished in the ex-post database, but under both the premium abolition and decoupled premium scenarios, the distinction becomes moot. The size of the total increase in fallow land is not only dependent on the parameters but also on the initialisation of the national land rental price[13]. For the following analysis, however, it is not necessary to discuss the empirical specification in more detail as the main focus will be on the *differences* between the abolition and decoupling scenarios.

Looking at the results for the decoupling scenario DECO, we see that the assumed cost of €50 to maintain a 'good agricultural condition' would restrict the increase in total fallow land to some 430000 ha (601000+290000-136000-322000) and land prices would settle at €196/ha. This is the lower bound for the land price following from the average decoupled SFP per ha less the assumed maintenance cost (€246 – €50 = €196). For a lower land rental price, it would pay to increase fallow land. In line with the increase in fallow land, other areas have to decline. This decline is stronger where crops benefited particularly from premiums before the MTR reforms (e.g. MAIF, VSET). Even though fodder areas decline less than under scenario NOPREM and fodder prices (not shown) are somewhat lower (about -5%), this does not significantly affect the decline in the cattle sector. Nonetheless, we see here as well that scenario DECO is not equivalent to the abolition scenario NOPREM.

Scenario DECO0 shows that the maintenance cost of €50 for fallow land is the key element preventing the equivalence of decoupling and abolishing premiums. Without the 'good agricultural condition' requirement, leaving land fallow will always earn a gross return equivalent to the full SFP per ha, which therefore sets a corresponding floor on the rental price of land. This option is used slightly more than under the NOPREM scenario. Because the equilibrium rental price of land corresponds to the decoupled payment, net revenues for crops are almost the same as under NOPREM because higher gross revenues and higher land prices essentially cancel each other out. With essentially the same net revenues, activity levels are very close to NOPREM as well. For crops, this usually means declining areas that are partly converted to fallow land.

Finally, scenario DECO0A shows that the remaining small differences from the NOPREM scenario are due to the exclusion of a few crops (perennial crops, fruits & vegetables, potatoes) from the SFP. Inclusion of all crops gives a lower average decoupled payment, lower land prices and less fallow land. In this case, we see that the uniform premium for *all* crops is exactly offset by higher land prices, so that the results coincide with those of NOPREM apart from rounding errors. This was to be expected from theory in the case of an exogenous land supply and perfect adjustment. In reality, such complete capitalisation would only occur after some years when

[13] In these simulations, the land rental prices have been set at 20% of the average gross revenue of soft wheat and barley in each Member State, giving values between €73 (PT) and €243 (NL). These are mostly in line with the sketchy statistical information available (see Table 3.3.9 in Agriculture in the European Union, statistical and economic information 2004)

agricultural land has become increasingly scarce relative to premium rights and rental contracts are renegotiated.

It is interesting to note that land supply for arable crops may be considered variable if fallow land is viewed as a non-agricultural alternative that landowners could choose for their land. The exogenous land supply is far less restrictive with variable fallow land than without. The only other relevant non-agricultural alternative excluded from the SFP would be forestry, assuming that forests will not be considered 'in good agricultural condition'. This cannot be simulated with CAPSIM because forestry is not included, but from the results of scenario DECO (restricting the eligibility of fallow land for the SFP) we may infer that some land would be converted to forestry without the restriction, at least if the SFP were considered reliable over the length of run needed for afforestation. On the other hand, if the CAP were considered insufficiently predictable by landowners, afforestation would not be attractive and the above simulation DECO0A covers the conditions sufficient for fully decoupled payments: eligibility of all crops without the 'good agricultural condition' requirement, which does not affect all land uses in the same way.

The final scenario DECOCUT shows that the SFP may be called 'differentially decoupled' in the following sense: a sizeable change in the SFP (-75%) would have only marginal impacts on crop allocation if we compare columns DECO and DECOCUT. This is because profitability would not change for most crops: gross revenues would decline but land prices would decline by the same amount, leaving net revenues constant. Because this does not hold for non-eligible crops (permanent crops, fruits and vegetables and potatoes), there are some differences, but these are quite small. However, there is a lower limit on reductions in the SFP without allocative effects: If the SFP does not cover the assumed maintenance cost of 'good agricultural condition' for fallow land (=€50/ha), fallow land would increase regardless of this condition because it would not pay to comply with it.

Another issue investigated in a sensitivity analysis is the importance of an appropriate description of the initial situation regarding the incentive effects of the pre-MTR premiums. In the cattle sector, the incentives provided by the premiums are modified by the following conditions:

- A maximum stocking density (1.9 Livestock Units (LU)/ha of fodder area in 2002) to receive the suckler cow and special male premiums
- Lower ceilings for the stocking density in the case of the extensification premium
- Farm-level ceilings for the suckler cow premium
- National ceilings for the special male and slaughter premiums

The first two conditions clearly entail, as politically intended, that part of the premiums effectively go to fodder areas rather than to animals if the stocking density limits the receipt of premiums.

If binding, the farm-level ceilings on the suckler cow herd mean that the premiums generate only quota rents, so that incentives will be derived from market revenues only (calves and beef, see Gohin 2005). As is the case for C-beet, however, it might be argued that these quota rents help to cover the fixed cost of keeping cattle if the ex-post situation was not in long-run equilibrium. In this case, there might be some internal redistribution between the suckler cow activity and related activities.

For national ceilings, an average revenue calculation appears to be relevant: if farmers do not know and cannot influence the extent to which premiums will be cut, it is plausible to assume that their expectations conform to the national average. The relevant premium (apart from the stocking density issue) would be the average amount per animal. This is built into the CAPSIM database, which simply calculates the average beef premium from FEOGA data and cattle activity levels.

However, to avoid exaggerating the support given to cattle activities, we reallocate part (30%) of these premiums to fodder areas (only grassland and other fodder, with nothing to fodder maize) for the simulations presented above.

To investigate the effect of this reallocation, we reverse it in a set of alternative simulations.

REF1:

Ex-post situation 2000-2002 as in scenario REF above but *without* premium reallocation.

NOPREM1

All premiums for the base year 2000-2002 are abolished with no changes in EU market prices. Because the constant terms of behavioural functions are recalibrated in line with the initial situation REF1, this gives results different from NOPREM above even though the policy framework is identical.

DECO1:

Conversion of all premiums into an amount of about €246 per hectare of eligible land as in scenario DECO. Fallow land is also eligible for the SFP but incurs a cost of €50 to keep it ‘good agricultural condition’.

DECO0A1:

Identical to scenario DECO1 but with *all* crops eligible without any constraint as to ‘good agricultural condition’.

The results in terms of selected activity levels (LEVL) and corresponding revenues are collected in Table 6, where we also repeat the results of scenarios REF, NOPREM and DECO from above to permit easy comparison.

Table 6: Results without premium reallocation in the cattle sector

		REF1	NOPREM1	DECO1	DECO0A1	NOPREM1	DECO1	DECO0A1	REF	NOPREM	DECO
SWHE	GREV	1111	752	999	985	-32.3%	-10.1%	-11.3%	1111	752	999
SWHE	NREV	891	752	797	752	-15.6%	-10.6%	-15.6%	891	752	802
SWHE	LEVL	4755	4588	4658	4588	-3.5%	-2.0%	-3.5%	4755	4543	4623
BULF	GREV	1369	1086	1086	1086	-20.7%	-20.7%	-20.7%	1284	1086	1086
BULF	NREV	892	614	621	614	-31.2%	-30.4%	-31.2%	813	617	625
BULF	LEVL	2001	1878	1884	1878	-6.1%	-5.8%	-6.1%	2001	1904	1911
MAIF	GREV	973	578	791	811	-40.6%	-18.7%	-16.6%	973	648	857
MAIF	NREV	753	578	589	578	-23.2%	-21.8%	-23.2%	753	648	660
MAIF	LEVL	1426	1328	1340	1328	-6.9%	-6.0%	-6.9%	1426	1353	1367
OFOD	GREV	225	119	336	352	-47.1%	49.3%	56.4%	459	234	447
OFOD	NREV	6	119	134	119	2029.3%	2296.6%	2029.3%	239	234	251
OFOD	LEVL	3341	3533	3646	3533	5.7%	9.1%	5.7%	3341	3120	3247
VSET	GREV	341		246	233	-100.0%	-27.8%	-31.8%	341		246
VSET	NREV	122	0	44	0	-100.0%	-63.7%	-100.0%	122	0	50
VSET	LEVL	322	270	291	270	-16.1%	-9.5%	-16.1%	322	266	290
FALL	GREV			196	233						196
FALL	LEVL	136	432	136	432	216.6%	0.0%	216.6%	136	935	601
UVAP	LEVL	219	0	202	233	-100.0%	-7.9%	6.2%	219	0	196

Note: SWHE = soft wheat, GREV = gross revenue, NREV = net revenue, LEVL = activity level, BULF = bull fattening, MAIF = fodder maize, OFOD = other fodder, VSET = voluntary set-aside, FALL = fallow land (see text), UVAP LEVL = land price.

First of all, we see the effect of the premium reallocation on activities BULF and OFOD. Without reallocation, the initial revenues for OFOD are very low in France (and several other EU MS). Net revenues rise considerably under the NOPREM1 scenario because the drop in land prices (to zero) fully benefits this activity, which does not lose any premiums compared to REF1. If gross revenues nonetheless decline by almost 50%, this is because fodder prices drop significantly. As a consequence, the area of OFOD *increases* by almost 200000 ha whereas it declines by more than 200000 ha under scenario NOPREM. This increased use of land for other fodder also explains why fallow land does not rise as markedly as in NOPREM. In the cattle sector, we would expect a stronger decline: -6.1% rather than -4.8% above for the selected activity BULF.

The simulated expansion of other fodder area would be even stronger in the decoupling scenario DECOUP1 because other fodder now becomes eligible for the single farm premium. Even though the increase in land rental prices considerably weakens the incentive to expand the other fodder area, we would nonetheless expect a stronger increase (+9.1%) than under the NOPREM1 scenario. The increased demand for land would be sufficient to maintain the land price above the floor derived from the SFP and the maintenance cost for fallow land (€202 > €246 - €50 = €196). As a consequence, total fallow land (including VSET areas) would be expected to decline marginally rather than to increase.

The decline in the cattle sector would be moderated by a greater drop in (other) fodder prices (-60%) but this effect would be quite small. As a consequence, a decline in the cattle sector would be accompanied by an increase in other fodder areas, which some observers of CAPSIM simulations have considered implausible in the past. The comparison of scenarios DECO and DECO1 clearly shows that very low initial revenues in the database were responsible for this result. In all, the premium reallocation appears to clearly improve the plausibility of results.

Finally, we again see in the DECO0A1 columns that the key requirement for fully equivalent results with decoupled and abolished premiums is that all crops are eligible without further side conditions. As may be expected, this does not depend in any way on the interpretation of the initial situation.

Another issue investigated in a sensitivity analysis is the importance of an appropriate description of the initial situation regarding the incentive effects of the pre-MTR premiums. In the cattle sector, the incentives provided by the premiums are modified by the following conditions:

- A maximum stocking density (1.9 LU/ha of fodder area in 2002) to receive the suckler cow and special male premiums
- Lower ceilings for the stocking density in the case of the extensification premium
- Farm-level ceilings for the suckler cow premium
- National ceilings for the special male and slaughter premiums

The first two conditions clearly entail, as politically intended, that part of the premiums effectively go to fodder areas rather than to animals if the stocking density limits the receipt of premiums.

If binding, the farm-level ceilings on the suckler cow herd mean that the premiums generate only quota rents, so that incentives will be derived from market revenues only (calves and beef, see Gohin 2005). As is the case for C-beet, however, it might be argued that these quota rents help to cover the fixed cost of keeping cattle if the ex-post situation was not in long-run equilibrium. In this case, there might be some internal redistribution between the suckler cow activity and related activities.

For national ceilings, an average revenue calculation appears to be relevant: if farmers do not know and cannot influence the extent to which premiums will be cut, it is plausible to assume that their expectations conform to the national average. The relevant premium (apart from the stocking density issue) would be the average amount per animal. This is built into the CAPSIM database, which simply calculates the average beef premium from FEOGA data and cattle activity levels.

However, to avoid exaggerating the support given to cattle activities, we reallocate part (30%) of these premiums to fodder areas (only grassland and other fodder, with nothing to fodder maize) for the simulations presented above.

To investigate the effect of this reallocation, we reverse it in a set of alternative simulations. The conclusion from these experiments is that the eligibility issue indeed has the expected impact on the results.

2.4.4. Alternative implementation of the Luxembourg decoupling options

In the current reference run, all MS implemented decoupling according to their particular national choices. The possible impacts of such national choices were investigated in two alternative scenarios:

- Max_dec = maximum decoupling as in a number of MS (UK, IR, EL, IT)
- As_France = maximum coupling (as in FR and ES)

The key results are set out in Table 7. The top part shows that the scenarios essentially investigate the redistribution of premiums from beef (suckler cows, special male premium, slaughter premium) to the general area premium used to represent the decoupled SFP, as explained in sections 2.4.2 and 2.4.3 above. Whereas subsidies to beef decline with additional decoupling, the total subsidy amount granted to agriculture is maintained.

As it turns out, this also leads to largely constant agricultural incomes in terms of GVAD at basic prices. The key impact is on the suckler cow herd in EU15. Cereal area is hardly affected, mainly for two reasons. The endogenous change in land prices after the redistribution of premiums in favour of the general area payment would tend to cancel out changes in land prices. Furthermore, the French option also included a 25% partial coupling of the arable sector premium. If this is included in the general area premium, only the type of premium changes, but not the total amount.

Even the impacts on other fodder areas are negligible for two similar reasons. First of all, an increase in profitability for other fodder would be moderated by the resulting increase in land prices. Furthermore, fodder prices are endogenous, so that any net increase in profitability from the redistribution of beef premiums to the area payment will be dampened by a declining demand for fodder.

Table 7: Results of alternative implementations of decoupling in EU15 countries

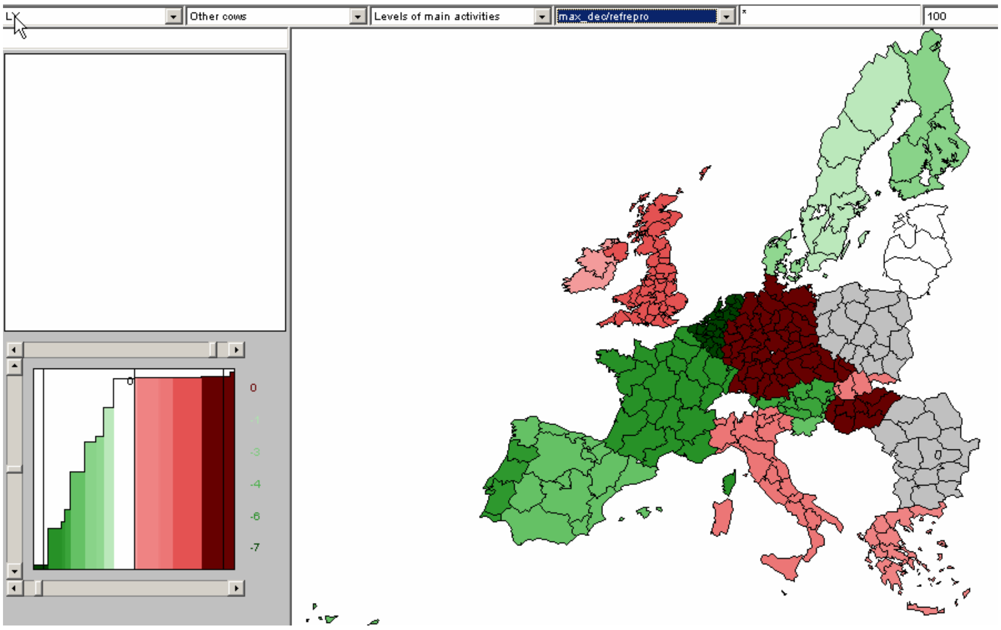
		Reference	max_dec	as_France
EU15	subsidies beef	2988	896	4549
	subsidies output	36917	36535	36664
	GVAD at basic prices	138014	137953	137311
EU25	Sucker cows [1000hd]	12223	11831	12521
	Cereals [1000ha]	53144	53154	53163
	Other fodder [1000ha]	72044	72007	72052
EU15	Sucker cows [1000hd]	11923	11531	12217
	Cereals [1000ha]	37296	37306	37315
	Other fodder [1000ha]	61209	61173	61218
EU10	Sucker cows [1000hd]	301	300	304
	Cereals [1000ha]	15848	15848	15848
	Other fodder [1000ha]	10834	10834	10834

For suckler cows on the other hand, the premium redistribution would have sizable effects in EU15 because the initial profitability of this activity is usually quite low. Any increase or decrease in revenues resulting from the receipt or loss of the suckler cow premium is likely to have a clear impact on the profitability of this activity, even though endogenous prices (calves, fodder, nutrients) would again moderate these impacts to some extent.

In the bottom part, we also see that any impact on the new MSs is probably very low. It would also not come through endogenous EU market prices and market channels, because the EU10 premium implementation is left unchanged in these scenarios. As a consequence, the impacts are almost the same for EU25 as for EU15.

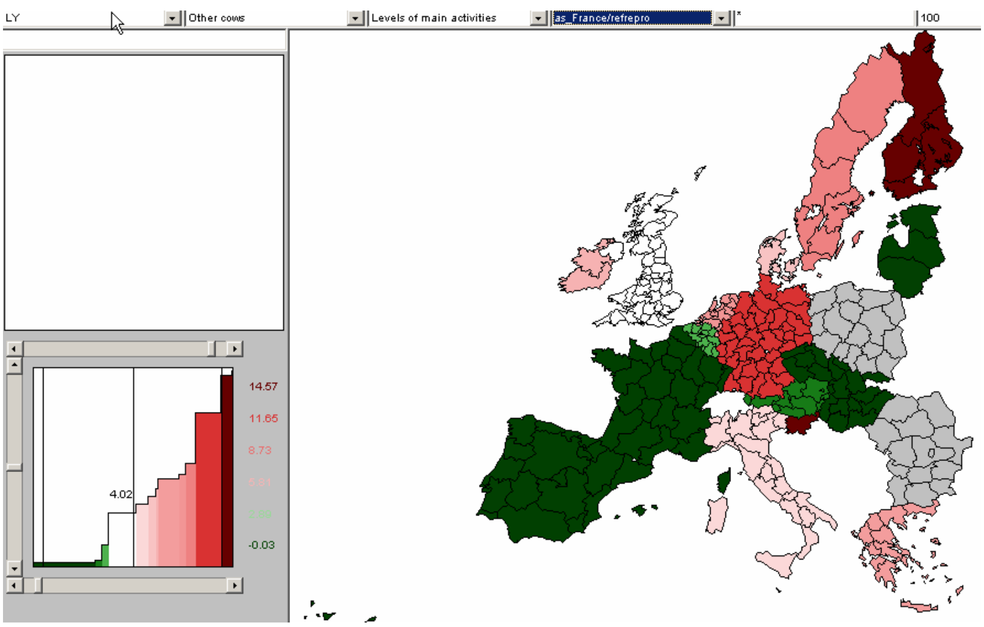
Whereas the aggregate impacts are very small for these variations in the current reference run, this does not hold for individual countries. This is also to be expected given the national heterogeneity in implementation.

Figure 4: Relative changes in the suckler cow herd after maximum decoupling in EU15 countries (dark green ~ -10%, dark red ~ 0%)



It is evident that there are hardly any effects in those countries that already use maximum decoupling in the reference situation (red colours in Figure 4). In contrast, those MS supporting their cattle sectors would see a more or less marked decline. In this respect, it is worth noting that more indirect support for suckler cows such as applied in the Netherlands (only slaughter premiums for adult cattle and calves) may have similar effects to the direct use of the suckler cow premium (FR, ES, PT, BL, AT, SI). Figure 5 shows the converse changes when moving to maximum coupling.

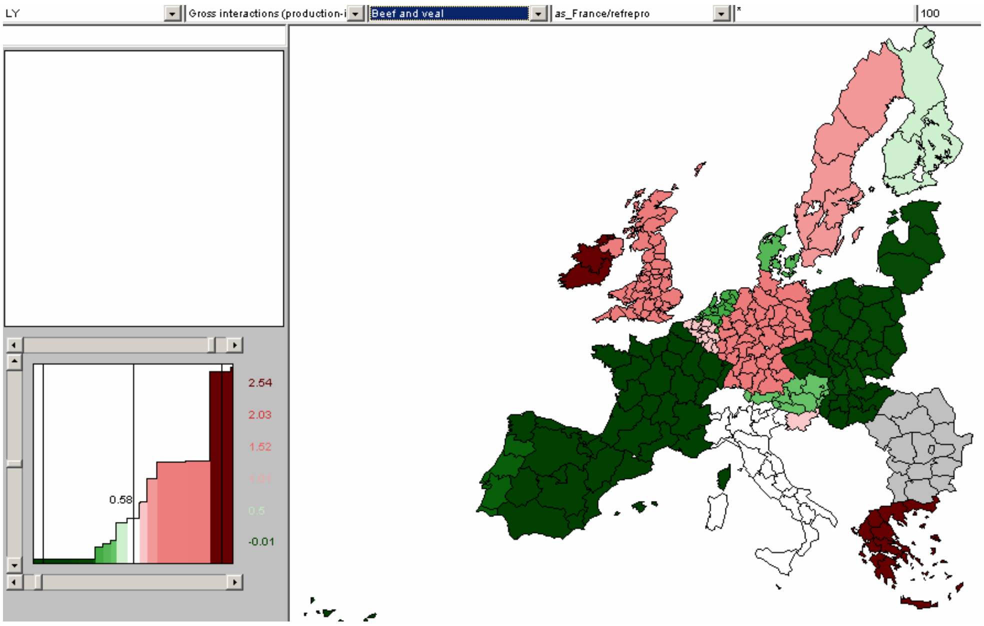
Figure 5: Relative changes in the suckler cow herd after maximum coupling in EU15 countries (dark green ~ 0%, dark red ~ +15%)



It is evident that those countries already granting a lot of coupled support in the reference situation would not be affected because the policy would not change for them. In other cases, the impacts depend both on the initial policy and on the structural characteristics of the cattle sector.

Finally, we can show that the effects for beef production follow the earlier pattern but with some modifications (see Figure 6).

Figure 6: Relative changes in beef production after maximum coupling in EU15 countries (dark green ~ 0%, dark red ~ +2.5%)



First of all, we see that the maximum impacts are much smaller (+2.5%) than in Figure 5, because the large supply of calves from the dairy herd is essentially fixed. Furthermore, we see that the size of the suckler cow herd relative to the dairy cow herd is crucial both for their responsiveness as well as for their impacts on the beef market. This applies in particular for the Netherlands and Finland with shares of less than 10% as against the EU15 average of 60%.

2.4.5. Potential further developments of the CAPSIM model

This part of the final report is essentially an update of Witzke 2004, where the structure of CAPSIM is compared to several other modelling systems. Apart from issues relating to empirical specification, we may assess the structure of CAPSIM as follows, in terms of both its main assets and weak points and as regards potential areas for improvement in the future.

- CAPSIM offers a quite satisfactory degree of disaggregation in terms of products and activities, in particular after the recent disaggregation of cereals into soft wheat, durum, maize, barley, rye, oats, other cereals and paddy rice. Furthermore, it distinguishes obligatory and voluntary set-aside as well as unpaid fallow land. Among the large-scale modelling systems covering EU agriculture as a whole, only CAPRI goes even further than the CAPSIM list of products. Special dairy sector studies (Consortium INRA – University of Wageningen 2002) usually work with an even finer level of disaggregation, which indicates that for milk market applications CAPSIM might benefit from further disaggregation as well.

- Behavioural functions are all derived from globally consistent and flexible functional forms. Parameters are calibrated based on starting values from the literature or from own assumptions. This is certainly a weaker empirical basis than a set of econometrically estimated parameters, but the microeconomic framework will at least safeguard against inadmissible results. Many other modelling systems relying on double log functions can only maintain consistency for the base year.

- Technology in the feed and livestock sector is described in an innovative way to include balances for feed energy and protein. Such balances have so far been considered amenable only to programming models. The inclusion of technological constraints (another example is the land balance) is fully consistent with microtheory. At the same time, it attempts to avoid the use of unobservable data, such as the allocation of feed to animals.

- CAPSIM provides a unique infrastructure to merge forecasts from different sources to produce a reasonable reference run. At least while stand-alone tools for outlook work remain limited, this is a very useful option.

- The land market specification with an endogenous rental price for land is perfectly satisfactory in theory, and permits us to investigate the income redistribution effects among land owners and farmers, at least where we are interested in the long-run effects when market imperfections tend to matter less.

However the analysis of modelling capabilities in comparison with other systems has also identified neglected issues representing options for further improvements in the future.

- On the supply side, a major simplification is that yields are treated as exogenous. This simplification may be defended, but it is recognised that few other modelling systems work with this simplification. Given that a generalisation is straightforward, at least conceptually, it is an option to be considered for the future.

- Imperfect competition is a neglected issue in all major modelling systems. The recent study of the sugar sector (Henrichsmeyer et al. 2003) has again shown that price transmission between the producer and the final consumer is an issue of considerable political relevance. Given that general equilibrium modellers have already addressed this issue, it may be time to introduce this generalisation into a large-scale partial equilibrium model as well.

- With the move to a gross trade description, the policy representation for border measures in CAPSIM has been considerably improved. Potential areas for improvement are TRQs (only acknowledged in exogenous form) and endogenous responses of policy instruments to violations of WTO limits. The most important and most straightforward development would be to apply and test the subsidised/unsubsidised distinction for all relevant markets rather than just the four (pork, poultry meat, eggs, sugar) used for the explorations so far.

- A rather ambitious undertaking would be to transform CAPSIM into a dynamic model in the narrow sense of the word, i.e. including lags, to reflect, for example, adjustment cost or price expectations. A partial adjustment mechanism might be a convenient approach used in several other modelling systems, but it is certainly not entirely convincing theoretically. In view of the difficulties with empirical implementation, a fully dynamic CAPSIM is an option for further development, but certainly not in the immediate future.

- Possibly but not necessarily related to the dynamic model would be explicit coverage of labour and capital. Currently, the required data are not readily available in harmonised form but have to be estimated, especially for capital. A first simplified treatment is envisaged in the near future for labour, but this issue deserves more attention. General equilibrium models usually include labour and capital as explicit factors, but so far only ESIM and Economic Research Service (ERS)/Penn include at least prices for labour and capital. In CAPSIM, both are lumped together and proxied with the general price index.

- An issue only briefly mentioned so far is the deterministic character of CAPSIM. Acknowledging that yields and prices are stochastic in the model would be a challenging but also a rewarding task, given that price fluctuations are likely to increase in the EU and given the current discussion about the wealth and insurance effects of decoupled payments.

Both the list of assets and the promising areas for improvement illustrate that CAPSIM has a rich potential for the future. However, it is quite clear that exploration of the above options has to be selective if the full functionality of the standard version is to be maintained for analyses. These choices would need some guidance from the EU Commission, the main potential user of CAPSIM.

3. CAPSIM SOFTWARE

This section is intended to help users of CAPSIM take the first steps to performing certain simulations on their own. We explain how the different inputs for a CAPSIM simulation should be handled technically. We show how the different input options can be used and give some hints on how they should be used. Currently the ultimate model input is in the form of GAMS code. Consequently, all the inputs are shown here quite close to the form they will have when imported into GAMS. The code includes numerous explanations now both on technical matters as well as on the logic underlying certain statements.

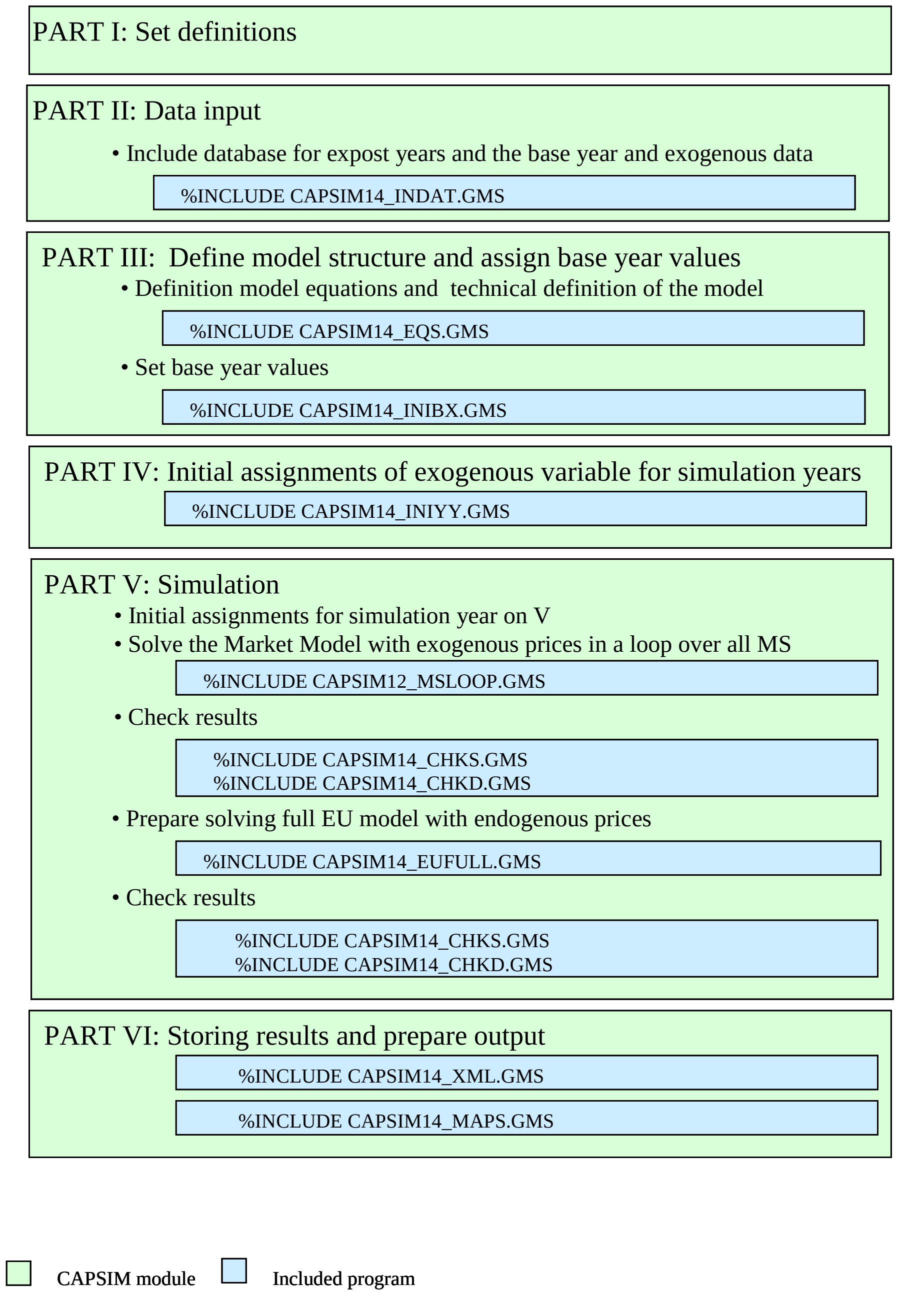
As stated in the introduction, CAPSIM relies technically on the GAMS software (at the time of model development: distribution 20.05). The model solver is CONOPT3. The CAPSIM software is a package of GAMS programs covering input preparation, model simulations, and output processing.

A word of warning: all recent applications of CAPSIM (and other models) to serious policy issues such as the recent implementation of the Luxembourg reforms or the ex-post evaluation of the pigs, poultry and eggs common market organisations (CMOs) have required changes in the model structure, because earlier versions could not satisfactorily answer the questions put. Adjusting the source code of CAPSIM in a meaningful way usually requires the services of a specialist operator or even the model developer.

3.1. CORE MODEL SOFTWARE

The following sections and figures show the CAPSIM program flow including all separate modules and other "include" files, in this way an overview of the content of these modules is provided.. For an overview of the CAPSIM program see Figure 7. Full detail is provided by the statements in the code itself, which also contains detailed comments.

Figure 7: Aggregated flowchart for CAPSIM programs



PART I: Set definitions

Most of the set definitions used in GAMS files are contained in the file CAPSIM_SETS.GMS, for example:

- Sets defining data structure, e.g. standard CAPSIM Table columns and rows, activities, items, input and outputs, and regions.
- Sets defining the default treatment of products and activities, for example which trade regime applies.
- Sets defining the policy variables and the products affected by policy.

PART II: Data input

This part contains input data for the base year and some ex-post years, the data for the selected reference run and further exogenous projections for the simulation year (trends, expert data etc.). Data input is handled by the *CAPSIM14_INDAT.GMS* programme.

- The file *Database_eu00.GMS* includes:
  - 94A3 early ex-post year for reference run
  - BAS Base year of projection
  - 01,02,03 Ex-post years

  These data are derived from the COCO[14] database.
- The file *FORC_TRD2112* contains trend estimations for years 1985-2003,2012,2020 and 2030.
- The file *FORC_POP.PRN* contains population forecasts for the years 1985-2030.
- The file *DAT_REF.gms* is included only for the policy simulation mode and makes earlier simulations results available.
- The file *FORC_DGA_14.prn* contains expert data from DG AGRI 'Prospects'.
- The file *FORC_FAPRI.GMS* contains border prices and quantities from FAPRI.
- The file *FORC_OWN14.PRN* contains some macro variables (consumer expenditure, inflation, exchange rate).
- The files *POLA_IN052005.PRN* and *POLP_IN052005.PRN* contain the CAP policy variables.
- The file *WP1105.prn* contains world market prices in the base period.
- The small files *FEOSH14.prn*, *SUGAR_DAT.GMS* and *FEOGA2005.prn* contain:
  - EU budget shares for EU MS.
  - Sugar data on producer types in 1998A3.

[14]The COCO (Complete & Consistent) database combines times series on areas, herd sizes, production, yields, market balances, price and the EAA at national level for all current EU MS. System estimations under consistency constraints ensure that gaps in the underlying raw data from DG ESTAT are closed and inconsistencies are removed. This data base is maintained by the Institute for Agricultural Policy, Market Research and Economic Sociology, University of Bonn, in close cooperation with EuroCARE GmbH Bonn. For further information see: WOLFGANG BRITZ, TORBJOERN JANSSON AND CHRISTINE WIECK: National Framework of the CAPRI-Data Base: The COCO – Module.

- FEOGA data for budget calibration.

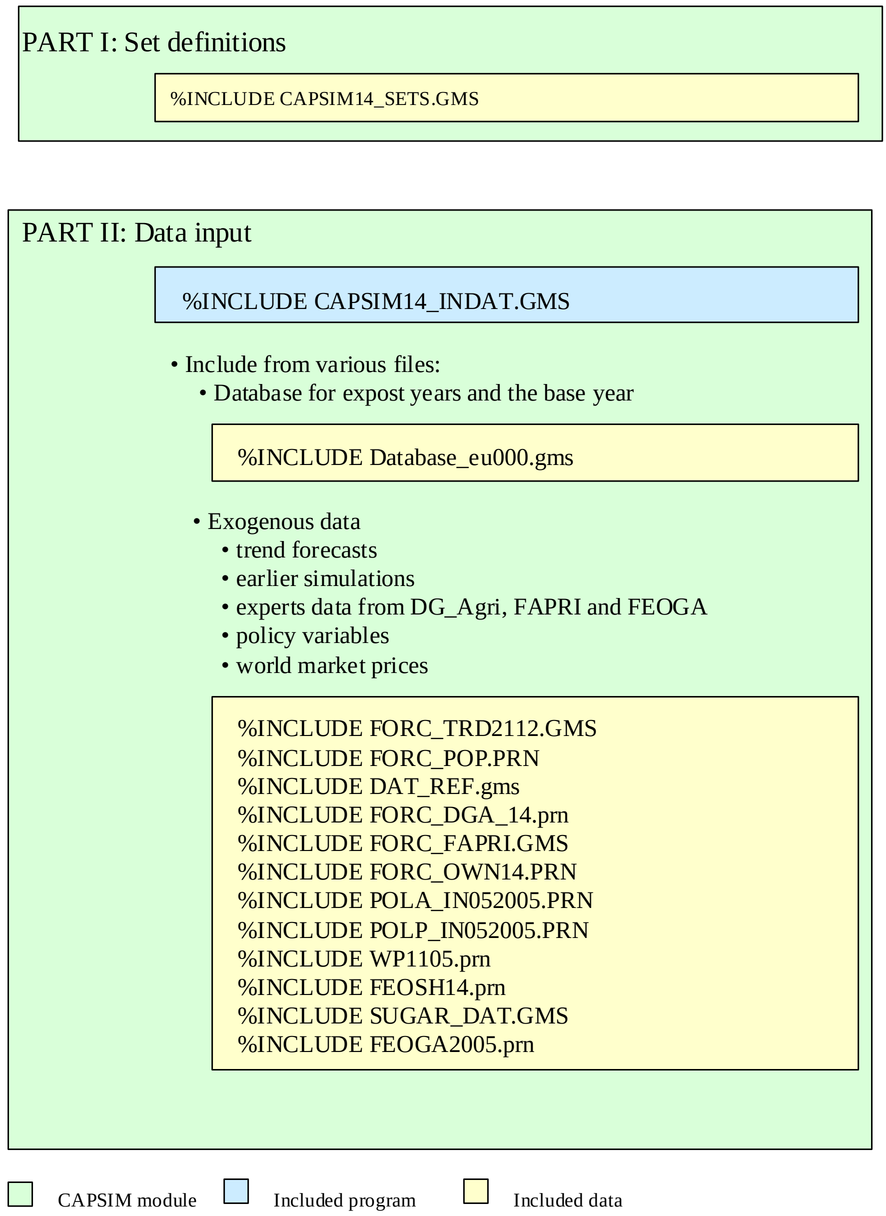
All data are collected, identified by sources, in a single big array DATY with 5 dimensions as follows:

DATY (REG, COLS, ROWS, SOURCE, YEAR), where

REG	MS and EU-25	
COLS	CAPSIM columns, as defined in the CAPSIM14_SETS.GMS, extended by some auxiliary columns	
ROWS	CAPSIM rows, as defined in the CAPSIM14_SETS.GMS, extended by some auxiliary rows	
SOURCE	BAS	Base year data
	SIM	Simulation
	CHIEF	Imposed information
	ADHOC	Own ad hoc support
	DGAGR	DG AGRI-derived support
	FAPRI	FAPRI-derived support
	TRDSP	Trend supports
	MEAN	Mean support
	TRD	Trend data
	OECD	OECD data
	LOSP	Lower conceivable support
	UPSP	Upper conceivable support
	REF	Reference
YEARS	XY	Ex-post three-year average 1994
	BY	Base year
	YY	Set of simulation years

An overview flowchart for Part I and Part II is provided in Figure 8.

Figure 8: CAPSIM.GMS flowchart (Part I and Part II)



PART III: Define model structure and assign base year values

This part is handled in the two included files *CAPSIM14_EQS.GMS* and *CAPSIM14_INIBX.GMS*.

In the *CAPSIM14_EQS.GMS* module, parameters, variables and equations are declared and model equations are defined.

In the *CAPSIM14_INIBX.GMS* module, 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. All corrections to input data are stored in the data array DATY.

PART IV: Initial assignments of exogenous variables for simulation years

The initial assignments of exogenous variables are in the module *CAPSIM14_INIYY.GMS.*

For the reference run, preliminary adjustments to the exogenous data for sugar and sugar beet have to be made to match the definitions of the base year data.

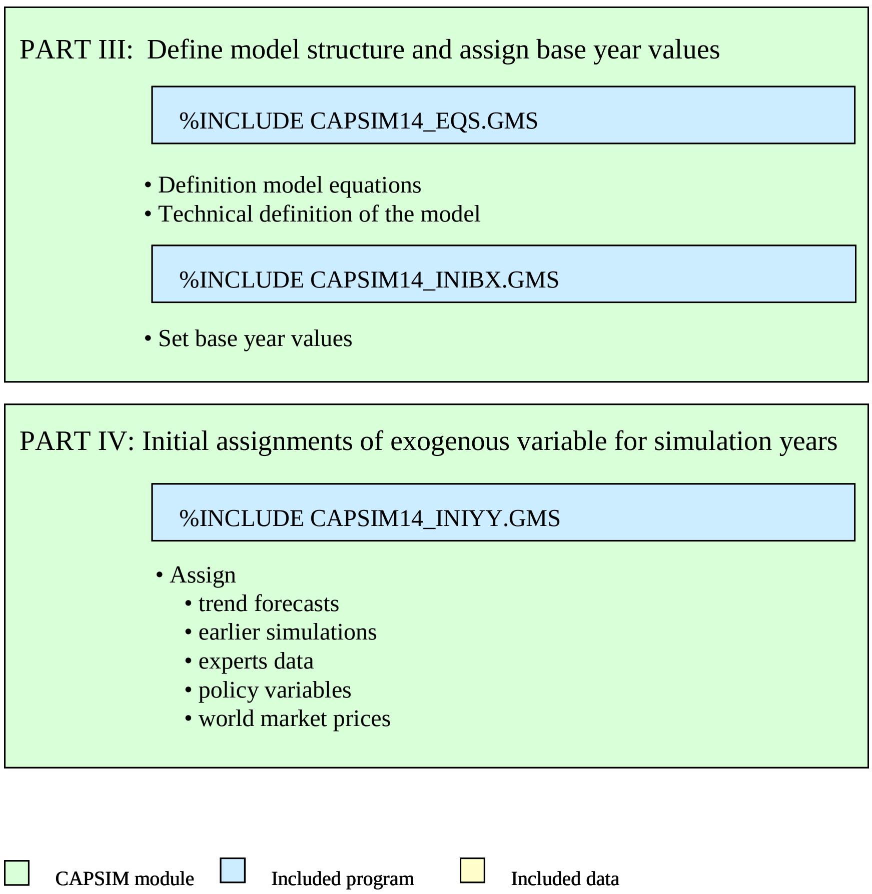
All different expert forecasts are collected in a central array, identified by sources. The source 'CHIEF' is information which is strictly imposed whereas the other sources arte enforced through the definition of support bounds.

Expert forecasts expressed in indices have to be converted into absolute levels.

Relevant data for international trade and policy variables are assigned; some policy variables need conversion to CAPSIM definitions.

Before assigning the trend projection to the simulation year, a number of checks and corrections are made. For Part III and Part IV see Figure 9.

Figure 9: CAPSIM.GMS flowchart (Part III und Part IV)



PART V: Simulation

Before starting the reference run or a simulation run, some model variables (e.g. variable V) have to be assigned for the simulation.

- Bounds:

  Default bounds are set for relevant subsets of variables. For monetary and quantity variables, specific bounds are calculated and set to model variable V.

- For reference run:

  Upper and lower supports may be potentially relevant. Ad hoc supports are set for some activities. Where central supports exist, upper and lower supports are calculated.

  Weights for the objective function are calculated for the importance of quantity in the MS and EU and to set penalties for first and second differences.

- Starting values for some variables

  Depending on whether it is a reference or simulation run, the starting values for constants in consumer demand, input demand and processing behaviour functions are taken from the base year or from the reference run.

- Exogenous variables

  Exogenous variables for the simulation year are set, calculated from trends, policy variables and other sources as described in Part II: Data input.

- For reference run

  For expert forecasts with supports, a priori probabilities are specified.

  Bounds on auxiliary variables are set for shifters for consumption, demand, processing, production of secondary milk and yields.

  Finally the supports and the probabilities are adjusted.

- Scaling factors

  Scaling factors are calculated for variables to ensure that they are equal to 1 in the base year.

Finally the module *CAPSIM14_MSLOOP.GMS* is included, solving the Market Model with exogenous prices for all MS.

The two modules *CAPSIM14_CHKS.GMS and CAPSIM14_CHKD.GMS* display:

- how it is possible to attain good supports

- changes from behavioural functions

Before the full EU Market Model can be started, the supports and weights for NTRD are adjusted and a free-at-border price, where appropriate, is set.

If the module *CAPSIM14_EUFULL.GMS* is included, the Market Model for the full EU runs.

The two modules *CAPSIM14_CHKS.GMS and CAPSIM14_CHKD.GMS* are reapplied for checking results. For Part V see Figure 10.

Figure 10: CAPSIM.GMS flowchart (Part V)

PART V: Simulation

- Initial assignments for simulation year on V
  - Set default ranges for variables
  - Set non default ranges for monetary and quantity variables
  - For reference run:
    Calculating lower and upper supports and weights for objective
  - Set starting values for constants
  - Assignments exogenous variables for the simulation year
  - For reference run:
    Set and adjust supports and probabilities
    Set bounds on auxiliary variables
  - Calculate scaling factors
- Solve the Market Model with exogenous prices in a loop over all MS

  %INCLUDE CAPSIM12_MSLOOP.GMS

- Check how good supports were attained

  %INCLUDE CAPSIM14_CHKS.GMS

- Decompose changes from behavioural functions

  %INCLUDE CAPSIM14_CHKD.GMS

- Prepare solving full EU model with endogenous prices

  %INCLUDE CAPSIM14_EUFULL.GMS

- Check how good supports were attained

  %INCLUDE capsim14_chks.gms

- Decompose changes from behavioural functions

  %INCLUDE capsim14_chkd.gms

CAPSIM module | Included program | Included data

PART VI: Storing results and preparing output

After a successful simulation, the model results are still on model variables such as $LVL_{m,j.\ T}$. To permit the user to compare simulation results and base year values (and perhaps reference run values), they have to be copied to the standard array DATY.

The MS results are aggregated to EU level.

The *CAPSIM14_XML.GMS* module exports all the data in the DATY array to XML format in a set of files that can be viewed in Explorer.

The CAPSIM14_MAPS.GMS module prepares the data to be viewed in maps of Europe and the MS. See Figure 11 for this Part.

Figure 11: CAPSIM.GMS flowchart (Part VI)

PART VI: Storing results and prepare output

- Assign simulation results to year YY in DATA array
    - Calculation prices (UVAP,UVAD,UVAE,UMAC,UMAF,PRIC)
    - Set revenues
    - Calculate levels and yields
    - Calculate GROF / MAPR = gross production
    - Calculate Demand (or use) components
    - Calculate EAA values
    - Consumer welfare calculations
    - Sugar industry calculation
    - Calculate Processing industry income effects
    - Calculate FEOGA impacts
- Aggregation to EU level
- Prepare results for XML output and maps

%INCLUDE CAPSIM14_XML.GMS

%INCLUDE CAPSIM14_MAPS.GMS

CAPSIM module | Included program | Included data

3.2. AUXILIARY SOFTWARE USED TO INITIALISE THE MODEL

The previous section provides a detailed guide to the main CAPSIM program, the data included and the sub-programs run in each simulation, since a technical model administrator at the Commission might find this useful for checking and improving the technical solution chosen in this software.

Setting up the database, estimating default trends and calibrating parameters, by contrast, are tasks carried out much less often. They provide an opportunity to revise the current technical solution to fix certain problems. Other technical solutions have been considered by DG ESTAT to update the database. Default trends may be estimated with various commercial software packages.

Detailed documentation of this auxiliary software may therefore be of little help if those responsible choose other technical solutions. If the same software is used, it is very likely to be handled by experienced staff that should be able to understand the auxiliary software with the help of the comments in it and the general information provided in this manual. This manual therefore restricts itself here to a brief description of the auxiliary programs.

CAPSIMDAT.GMS

This program mainly aggregates COCO data (see Section 2.2) for CAPSIM according to the codes in Appendix II. In addition it handles a number of special cases that take up a lot of code but which are far less important in terms of the figures involved. 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 using 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 for CAPSIM (CAPSIM data). This is straightforward except for the vertical aggregation of animal activities. The coefficients of integrated activities are, in the simplest cases (e.g. pig fattening and sows), the totals (e.g. of pork produced) from the two activities divided by the chosen activity level for the aggregate (pig 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 (this is partly done exploiting entropy formalism).
- Build EU aggregate, three-year average and store CAPSIM data.

ELACALS.GMS

This program calibrates the supply side parameters as presented in section 2.1.2 of Witzke and Zintl 2005. It is divided into 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 to link animal levels and feed from CAPREG and aggregate to CAPSIM definitions.
- Calibration of elasticities as described in section 2.1.2 of Witzke and Zintl 2005.
- Store results in external files.

3.3. INSTRUCTIONS: CHOOSING THE TYPE OF SIMULATION

One of the first and most important user settings determines the type of simulation to be performed, defined by the simulation mode, the scenario and the simulation year.

3.3.1. Simulation mode

This information on the simulation mode 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 standard policy simulations. It requires few settings beyond policy variables because they are taken over from the reference run.

These settings may be made at the top of the CAPSIM[15] main program with a text editor. The crucial section of the code in CAPSIM.GMS looks as follows:

```
-------------------------------------------------------------------------------------
*
* specify the kind of simulation Bas=> SIM = 0 ,Ref=> SIM=1,
*                           => standard policy simulation = 2
* these flags activate appropriate treatments of
*                           * set membership in GROTRD/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
```

[15] The current version number of the CAPSIM model is 14. All program names the user will find on the CD-ROM include this number, e.g. CAPSIM14.GMS. To simplify matters, the version number is omitted in the text.

```
*                          * 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]
*
*
  SCALAR SIM/2/;

-----------------------------------------------------------------------------------
```

The user must check and if necessary update the statement in grey. In the extract above, the mode is set to a standard policy simulation.

Depending on the choice of simulation, the user should check that the desired specification is active (not starred). As will soon become clear, this setting has important consequences.

3.3.2. Scenario

Besides the reference run, which is a precondition for all simulations, users can define their own scenarios or select one of the scenarios already established in the CAPSIM software.

Currently the scenarios 'ref', 'refpro', 'max_dec', and 'as_France' are incorporated in the GAMS code. The names are defined as 'acronyms'. In the following example from the GAMS code, the scenario 'max_dec' (maximal decoupling) has been selected by the user.

```
-----------------------------------------------------------------------------------
*      Acronyms are used to trigger specific statements in the code (if necessary)
*      => Any simulation requiring such special treatment needs to have a name from
the list of acronyms.
 acronym refrepro, ref, max_dec, as_France;
*
*      The global environment variable %SCEN% will characterise the current scenario
*      and incorporates the information which simulation to run
*      Equally important is that the output from the current simulation 'SIM' is
        copied at the end to
*     an element of set SRCALL which permits storing these results under the
acronym name
*       (eg in capsimX_xml.gms+capsimX_maps.gms)
*      For this purpose it is necessary to repeat all acronyms as elements of SRCALL
in CAPSIMx_SETS.gms

$setglobal SCEN max_dec
*
 SCALAR scen / %SCEN% /;
-----------------------------------------------------------------------------------
```

The user must check and if necessary update the statement in grey.

3.3.3. Simulation year

All relevant simulation years are defined by the sets SELYR, YY and FY in the CAPSIM_SETS.GMS file, which is included at the beginning of the CAPSIM.GMS module.

```
-----------------------------------------------------------------------------------
SET SELYR(RELYR)  Selected relevant years
/
   XY      Expost year prior to base year
   BY      Base year
   06      2006
   07      2007
   08      2008
   09      2009
```

```
   10     2010
   11     2011
   LY     2012 is last future simulation year
/;
SET YY(SELYR) Simulation years
/
   XY     Expost year prior to base year
   06     2006
   07     2007
   08     2008
   09     2009
   10     2010
   11     2011
   LY     2012 is last future simulation year
/;
SET FY(SELYR) Future simulation years
/
   06     2006
   07     2007
   08     2008
   09     2009
   10     2010
   11     2011
   LY     2012 is last future simulation year
/;
SET REFYR(SELYR) Reference run mode years
/
   XY     Expost year prior to base year
   BY     Base year
   LY     2012 is last future simulation year
/;
------------------------------------------------------------------------------------
```

The simulation year is selected in the CAPSIM.GMS module by:

```
------------------------------------------------------------------------------------
IF ((SIM EQ 1) ,
         YY(SELYR) $ (NOT REFYR(SELYR)) = NO;
         FY(SELYR) $ (NOT REFYR(SELYR)) = NO;
   );
*
IF ((SIM EQ 2),
         YY(SELYR)  = NO;
         FY(SELYR)  = NO;
         YY(SELYR) $ (SAMEAS(SELYR,"12")) = YES;
         FY(SELYR) $ (SAMEAS(SELYR,"12")) = YES;
     );
*
*     For test of base year reproduction
IF ((SIM EQ 0) ,
         YY(SELYR) $ (SAMEAS(SELYR,"BY")) = YES;
         YY(SELYR) $ (NOT SAMEAS(SELYR,"BY")) = NO;
         FY(SELYR) = NO;
   );
------------------------------------------------------------------------------------
```

The user must check and if necessary update the statements in grey.

In the example above, the user wants to run a simulation (SIM=2). In a first step all simulation years (YY) and future simulation years (FY) are de-activated. The last two statements activate simulation and future simulation year “12” (= year 2012).

3.3.4. Summary

The examples above for simulation mode, scenario and simulation years will start the following simulation:

Run **simulation** '**max_dec**' for the year **2012**.

Table 8 shows the interdependence of the parameters for model runs already defined in the CAPSIM GAMS code:

Table 8: Interdependence of simulation steering as already defined

Simulation mode (SIM)	Scenario (SCEN)	Simulation year	Comment
0	REF	BY	Base year reproduction test
1	REF	1994, 2006-2011, LY	Reference run incl. calibration of parameters
2	REFPRO	2006-2011, LY	Reproduction of reference run using existing parameters
2	max_dec	2006-2011, LY	Simulation of maximal decoupling
2	As_france	2006-2011, LY	Simulation of (minimal) decoupling as in France

3.4. INSTRUCTIONS: DATA INPUT FOR POLICY SIMULATION MODE

As explained in section 2.3, CAPSIM requires different kind of inputs depending on the mode of application. Currently these data are supplied in four files.

'Database_eu000.gms'	base year data
'DAT_REF.gms'	results of a previous reference run
‘WP1105.prn’	world market prices in the base period
‘FEOSH14.prn’	EU budget shares for EU MS
‘SUGAR_DAT.GMS’	Sugar data on producer types n 1998
‘FEOGA2005.prn’	FEOGA data for budget calibration
‘FORC_OWN.GMS’	User chosen expert forecasts for macro variables

3.4.1. Base year data

CAPSIM requires a complete and consistent database for the base year of reference (1994A3[16]), the base year (BY, 2002A3) and the years 2001 and 2003.

These data are derived from the COCO[17] database.

CAPSIM expects an input file of the following form:

----

[16] A3 three year average
[17] See footnote 12.

```
TABLE DATA(*,*,*,*)
*
                        94A3          BAS         0100         0200         0300
BL000.SWHE.SWHE  7.1635628E+3 8.2444090E+3 8.0038608E+3 8.2643516E+3 8.4411650E+3
BL000.SWHE.LEVL  2.1386333E+2 2.0418596E+2 1.8978419E+2 2.1226350E+2 2.1051019E+2
BL000.RYEM.RYEM  4.1478458E+3 6.0353413E+3 5.5417280E+3 6.1723662E+3 6.4402490E+3
BL000.RYEM.LEVL  2.8562210333 1.4573273333 1.4790000000 1.6475000000 1.2454820000
BL000.BARL.BARL  5.9066745E+3 7.0894726E+3 7.1066162E+3 7.3954888E+3 6.7339878E+3
BL000.BARL.LEVL  7.2441129E+1 5.5393453E+1 6.0977509E+1 5.4954781E+1 5.0248070E+1
BL000.OATS.OATS  4.4204429E+3 5.6689874E+3 5.2042280E+3 5.6752671E+3 6.0986509E+3
BL000.OATS.LEVL  1.4412373E+1 9.0240500667 8.8579998000 8.7606506000 9.4534998000
BL000.MAIZ.MAIZ  3.8298814E+3 5.6796386E+3 5.8120479E+3 5.8385698E+3 5.4313589E+3
BL000.MAIZ.LEVL  2.3390026E+1 4.6567015E+1 4.1002998E+1 4.6844399E+1 5.1853649E+1
BL000.OCER.OCER  5.6221726E+3 1.4576519E+4 1.5146610E+4 1.4875150E+4 1.3832960E+4
BL000.OCER.LEVL  1.1735400E+1 1.1038356E+1 9.3950682000 1.1784000E+1 1.1936000E+1
BL000.PULS.PULS  3.5768520E+3 4.0342449E+3 4.1694858E+3 3.7370339E+3 4.1586909E+3
-------------------------------------------------------------------------------
```

Example:

BL000	Region: Belgium/Luxemburg (1st data dimension)
SWHE	Activity: soft wheat (2nd data dimension)
SWHE	Product: soft wheat (3rd data dimension)
94A3,BAS…	Year: base year (4th data dimension)

3.4.2. Results of a previous reference run

Simulations are based on results of the previous reference run, which are stored in the file DAT_REF.GMS.

```
-------------------------------------------------------------------------------
DAT(REG,COLSSS,ROWSS,SRCALL,SELYR) = 0;
DAT("BL000","SWHE","SWHE","BAS","BY") =  8.244409000000E+03;
DAT("BL000","SWHE","SWHE","REF","XY") =  7.163562800000E+03;
DAT("BL000","SWHE","SWHE","REF","BY") =  8.244409000000E+03;
DAT("BL000","SWHE","SWHE","REF","LY") =  9.656525346050E+03;
-------------------------------------------------------------------------------
```

Example:

BL000	Region: Belgium/Luxemburg (1st data dimension)
SWHE	Activity: soft wheat (2nd data dimension)
SWHE	Product: soft wheat (3rd data dimension)
BAS	Source: base data (4th data dimension)
REF	Source: reference run (4th data dimension)
BY	Year: base year (5th data dimension)
XY	Year: ex-post three year average 1994 (5th data dimension)
LY	Year: last projection year (5th data dimension)

The file DAT_REF.GMS will be updated after a new reference run has been accepted.

3.4.3. Ex-post world market prices

World market prices are collected from OECD or from various other sources, stored in source dimension 'ADHOC'. Additional EU-15 producer prices are supplied to calculate a ratio which may be multiplied to give the EU market prices according to the CAPSIM database.

```
--------------------------------------------------------------------------------
        TABLE WP_bas(colsss,rows,SRCALL,BX) Base year border prices and
                         corresponding producer prices in EU15 according to SRCALL
                     OECD.XY     OECD.BY    ADHOC.XY    ADHOC.BY
UVAE.   SWHE         102.153     113.007
UVAE.   DWHE         193.274     212.111
UVAE.   RYEM                                  85.392      84.699
PP.     SWHE         141.829     114.813
PP.     DWHE         193.479     172.061
PP.     RYEM
PP.     BARL         133.950     105.836
--------------------------------------------------------------------------------
```

Example:

UVAE	Item: World market price (1st data dimension)
PP	Item: EU15 producer price (1st data dimension)
SWHE	Product: soft wheat (2ndt data dimension)
OECD	Source: OECD (3rd data dimension)
ADHOC	Source: other various sources (3rd data dimension)
XY	Year: ex-post three-year average 1994 (4th data dimension)
BY	Year: base year (4th data dimension)

3.4.4. EU budget shares

The file FEOSH14.PRN includes shares of national contributions to the EU budget excluding 'traditional own resources'. The data are selected from the EU document: Allocation of 2004 EU expenditure by MS. For the simulation years no change is assumed. Budget shares are used to allocate EU expenditure to MS.

```
--------------------------------------------------------------------------------
TABLE   FEOSH(MS,RELYR)
*
                  XY          BY           LY
BL000        0.03549     0.03543      0.03370
CZ000        0.00000     0.00000      0.00610
--------------------------------------------------------------------------------
```

Example:

BL000	Region: Belgium/Luxemburg (1st data dimension)
CZ000	Region: Czech Republic (1st data dimension)
BY	Year: base year, here (2001+2002+2003)/3 (2nd data dimension)
XY	Year: ex-post three year average 1994 (2nd data dimension)
LY	Year: last projection year (2nd data dimension)

3.4.5. Sugar data on producer types

The file SUGAR_DAT.GMS supplies levels and differentiated yields of sugar beet in the base year. The differentiation by specific producer groups was provided for EuroCARE's sugar project and has not been updated since then.

```
--------------------------------------------------------------------------------
TABLE SDAT(*,*,*)
 YLD AQuot BQuot APrd BPrd CPrd APric BPric CPric Shprd
$ONDELIM
FR000,C_PRD,71.898309215027900,0.986870494582579,0.986870494635468,0.
FR000,A_BIN,0.000000000000000,0.000000000000000,0.000000000000000,0.0
FR000,B_UND,75.775375097642050,0.004233298286079,0.004233298245523,0.
FR000,B_BIN,72.272988305645950,0.008896207131342,0.008896207119010,0.
FR000,REGION,71.910318793101220,0.788040968378084,0.211959031621914,0
```

Example:

FR000	Region: France (1st data dimension)
C_PRD	Producer group: C-sugar beet producer (2nd data dimension)
A_BIN	Producer group: Producers with binding A quota (2nd data dimension)
B_UND	Producer group: Producers incompletely filling their B quota (2nd data dimension)
B_BIN	Producer group: Producers with binding B quota (2nd data dimension)
REGION	Regional aggregates (2nd data dimension)
YLD	Yield (3rd data dimension)
AQuot	A-quota (3rd data dimension)
BQuot	B-quota (3rd data dimension)
APrd	A-product (3rd data dimension)
BPrd	B-product (3rd data dimension)
CPrd	C-product (3rd data dimension)
APric	A-price (3rd data dimension)
BPric	B-price (3rd data dimension)
CPric	C-price (3rd data dimension)
Shprd	Share of producer type in regional production (3rd data dimension)

3.4.6. Data for budget calibration

FEOGA data [EUR million] as provided by DG AGRI and DG ESTAT.

```
----------------------------------------------------------------------------------
*                    PRMS,PRS1,Premiums to small producers
*                    PRMP,PRP1,Premiums to professional producers
*                    PRMV, PRM1Premiums
*                    ITOT,ITO1 Total cost of intervention stocks
*                    ITEC      Technical costs of intervention stocks
*                    IFIN      Financial costs of interventions stocks
*                    IOTH      Other costs of interventions stocks, probably
                               sales/purchases
*                    IDEP      Depriviation of intervention stocks
*                    IPRV      Costs for private storage
*                    CSE, CSE1 Consumption aid
*                    EXPR,EXP1 Export subsidies
*                    RFAI,RFA1 Food aid
*                    RFPR      Processing aid
*                    OTHR,OTH1,Other costs
*                    TREV      Tariff revenues
*                    LEVY      sugar beet production levies
*
*                    NOTE: ALL ENTRIES ARE LAGGED ONE YEAR TO MATCH PHYSICAL DATA
TABLE CAPRI(*,*,*,*)
                            89        90        91        92        93        94
*Premium crops
 EU000.POTA.PRMS        59.108    38.535    36.130    96.149   165.715   182.800
 EU000.MAIZ.PRMS                                              219.073   365.500
 EU000.CERE.PRMS                                             1415.334  1891.500
 EU000.OILS.PRMS                                              113.795    50.400
 EU000.PULS.PRMS                                                4.377     6.300
 EU000.OOIL.PRMS                                                3.824     0.100
 EU000.DWHE.PRS1
 EU000.DWHE.PRS2
 EU000.SILA.PRS2
 EU000.MAIZ.PRMP                                              196.043   374.800
 EU000.CERE.PRMP                                             2893.307  4590.800
 EU000.OILS.PRMP                                             2435.272  2239.100
 EU000.PULS.PRMP                                              620.731   580.000
```

```
 EU000.OOIL.PRMP                                                  121.511    51.800
 EU000.DWHE.PRP1                                                  816.649   944.000
 EU000.DWHE.PRP2
 EU000.DWHE.PRP3
 EU000.SILA.PRMP
 EU000.SETA.PRMV         42.305    76.883   147.629   426.756   1712.851  2412.600
 EU000.OSET.PRMV                                                 1290.147  2162.000
 EU000.OILS.PRM1                                                   12.039    -0.600
 EU000.PARI.PRMV
 EU000.FEOG.OLIV        546.086  1084.435   850.145  1386.149  1072.390   566.500
 EU000.FEOG.TOBA       1232.134  1329.561  1232.990  1165.136  1057.433   993.000
 EU000.FEOG.TEXT        580.280   521.841   771.338   860.559   863.540   876.100
 EU000.FEOG.OIND         10.576     0.887     9.875    24.449     3.672    14.300
----------------------------------------------------------------------------------
```

3.4.7. Expert data from user-chosen sources or assumptions

Currently this file is only used to import some macro variables like consumer expenditure, exchange rate and inflation rate.

```
----------------------------------------------------------------------------------
TABLE OWN_FORC(*,*,*,*,*)
                              BY         XY         LY     1993     1994     1995
BL000.UVAD.REST.CHIEF              0.908399   1.202879
.
.
WO000.UVAE.LEVL.DGAGR   1.01938   0.819722   0.869565 0.85397 0.84068 0.76452
WO000.UVAE.LEVL.FAPRI   1.01938   0.819722   0.697153 0.85397 0.84068 0.76452
----------------------------------------------------------------------------------
```

Explanations for example:

BL000	Region: Belgium (1st data dimension)
WO000	Region: World (1st data dimension)
UVAD.LEVL	Inflation rate (2nd and 3rd data dimension)
UVAE.LEVL	Exchange rate (2nd and 3rd data dimension)
CHIEF	Source: expert highest priority (4th data dimension)
DGAGRI	Source: DG-AGRI(4th data dimension)
FAPRI	Source: FAPRI(4th data dimension)
BY	Year: base year (5th data dimension)
XY	Year: ex-post three-year average 1994 (5th data dimension)
LY	Year: last projection year (5th data dimension)

Note: In general the macro assumptions in this file may be varied (in narrow limits) to undertake a sensitivity analysis by entering different values for ‘source’ CHIEF. For the exchange rate such a sensitivity analysis has been carried out occasionally by switching between DG AGRI and FAPRI assumptions through a flag in the code, hence the input of two exchange rates here (where usually DG AGRI is used only).

3.5. INSTRUCTIONS: POLICY VARIABLES

The origin and meaning of various policy parameters for the current reference run is described in section 2.1. CAPSIM distinguishes between variables for activities (like premium and ceilings) and for products (like quotas), collected in two files.

'POLA_IN122005.PRN' policy variables for activities

'POLP_IN122005.PRN' policy variables for products

Variables for activities are:

PREM	ha or head premium specific for activity
HIST	historical yields for group premium
PRET	premium per tonne for group premium
PREMNAT	specific premium from national budget
PREMDC	decoupled MTR premium
PRETNAT	group premium per tonne from national budget
CEILNAT	monetary ceiling on national premiums
CEIL	ceiling on levels for premium
CUSE	ceiling use on levels for premium
SETR	official set-aside rate

Example:

```
--------------------------------------------------------------------------------
POLA_IN("DE000","SWHE","HIST","XY")=  6.251109148308E+00;
POLA_IN("DE000","SWHE","HIST","BY")=  5.306457984239E+00;
POLA_IN("DE000","SWHE","PRET","XY")=  3.847839912345E+01;
POLA_IN("DE000","SWHE","PRET","BY")=  6.300000000000E+01;
POLA_IN("DE000","DWHE","PREM","BY")=  8.538604689435E+01;
POLA_IN("DE000","DWHE","HIST","XY")=  6.174653966105E+00;
POLA_IN("DE000","DWHE","HIST","BY")=  5.379271646512E+00;
POLA_IN("DE000","DWHE","PRET","XY")=  3.649773954417E+01;
POLA_IN("DE000","DWHE","PRET","BY")=  6.300000000000E+01;
POLA_IN("DE000","DWHE","CEIL","XY")=  1.000000000000E+01;
POLA_IN("DE000","DWHE","CEIL","BY")=  1.000000000000E+01;
--------------------------------------------------------------------------------
```

Explanations for example:

DE000	Region: Germany (1st data dimension)
SWHE	Activity: Soft wheat (2ndt data dimension)
HIST	Historical yield (3rd data dimension)
PRET	Premium per unit (3rd data dimension)
PREM	Premium (3rd data dimension)
CEIL	Ceiling (3rd data dimension)
XY	Year: ex-post three-year average 1994 (4th data dimension)
BY	Year: base year (4th data dimension)

Variables for products are grouped by:

QTS1	quota on sales type 1
QTS2	quota on sales type 2
PADM	administrative price
QADM	administrative price quality factor - PMRK over PADM
TARS	tariff specific
TARV	tariff ad valorem
PAYP	producer subsidy per tonne
PAYC	consumption subsidy per tonne
ESUT	export subsidy per tonne
EXPQ	export quota
EUSE	notified use of export quota
EFAC	export quota scaling factor

IMPQ import quota
PADM: administrative prices

Example:

```
--------------------------------------------------------------------------------
POLP_IN("FR000","COMI","QTS1","XY")=  2.402021666667E+04;
POLP_IN("FR000","COMI","QTS1","BY")=  2.421830000000E+04;
POLP_IN("FR000","COMI","QTS1","06")=  2.432670000000E+04;
POLP_IN("FR000","COMI","QTS1","07")=  2.444790000000E+04;
POLP_IN("FR000","COMI","QTS1","08")=  2.456902500000E+04;
POLP_IN("FR000","COMI","QTS1","09")=  2.459930000000E+04;
--------------------------------------------------------------------------------
```

Explanations for example:

FR000	Region: France (1^{st} data dimension)
COMI	Item: Milk ($2nd^{t}$ data dimension)
QTS1	Quota (3^{rd} data dimension)
XY	Year: ex-post three-year average 1994 (4^{th} data dimension)
BY	Year: base year (4^{th} data dimension)

These policy variables may be entered manually but there is also an auxiliary GAMS program (polcal.gms) for more efficient handling of this task.

3.6. INSTRUCTIONS: EXTERNAL FORECASTS FOR REFERENCE RUN MODE

As stated above, some of the options to supply expert information are not used in an ordinary policy simulation. This section nonetheless gives a complete introduction to the use of expert information, even though inexperienced users may want to confine themselves to policy simulations with only a few settings.

CAPSIM has to read expert information from different sources, which are supplied in five files (see also **Error! Reference source not found.**12).

'FORC_OWN14.PRN'	expert data from user-chosen sources or assumptions
'FORC_DGA_14.PRN'	expert data from DG AGRI
'FORC_FARRI.GMS'	expert data from FAPRI
'WP122005.PRN'	world market prices

3.6.1. Trend data

Trend data are a precondition for the reference run, while in policy simulations most exogenous projections will be taken from the relevant reference run (or from expert information) and the default trend will be ignored. Only CAPSIM users who are very familiar with the model code and the base data situation will want to update the reference run.

In all EuroCARE applications, the file FORC_TRD2112.gms is prepared by the Baseline Generation Model (CAPTRD) of the CAPRI system (see http://www.agp.uni-bonn.de/agpo/rsrch/capri/capri-documentation.pdf, Section 4), but any software able to produce a comparable set of projections would be suitable.

Default trends are needed for the years forming the base year average and for the future projection years.

CAPSIM expects an input file of the following form:

```
---------------------------------------------------------------------------

                              TABLE TRD(*,*,*,*)
1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002
$ONDELIM
BL000.SWHE.SWHE ,  6.277530000000E+03,  6.738237000000E+03,  5.533249000000E+03,…….. 
BL000.SWHE.LEVL ,  1.935865000000E+02,  1.956816000000E+02,  2.015147000000E+02, ……..
BL000.RYEM.RYEM ,  4.337614000000E+03,  4.167619000000E+03,  4.064776000000E+03, ……..
BL000.RYEM.LEVL ,  6.019136000000E+00,  5.224086000000E+00,  4.929177000000E+00, ……..
BL000.BARL.BARL ,  5.536244000000E+03,  5.901416000000E+03,  5.273850000000E+03, ……..
BL000.BARL.LEVL ,  1.349448000000E+02,  1.443808000000E+02,  1.399378000000E+02, ……..
BL000.OATS.OATS ,  4.275966000000E+03,  4.025982000000E+03,  3.934391000000E+03, ……..
BL000.OATS.LEVL ,  3.292896000000E+01,  2.433950000000E+01,  2.442600000000E+01, ……..
```

```
BL000.MAIZ.MAIZ ,  7.333556000000E+03,  7.807813000000E+03,  6.830050000000E+03, …….
BL000.MAIZ.LEVL ,  6.970644000000E+00,  7.216191000000E+00,  5.915500000000E+00, …….
BL000.OCER.OCER ,  4.646710000000E+03,  4.823181000000E+03,  4.597420000000E+03, …….
BL000.OCER.LEVL ,  2.776500000000E+00,  4.962783000000E+00,  7.686855000000E+00, …….
BL000.RAPE.RAPE ,  2.502237000000E+03,  3.033765000000E+03,  3.159000000000E+03, …….
BL000.RAPE.LEVL ,  2.838104000000E+00,  3.263437000000E+00,  4.717085000000E+00, …….

-----------------------------------------------------------------------------------
```

Explanations for example:

BL000	Region: Belgium/Luxemburg (1st data dimension)
SWHE	Activity: soft wheat (2nd data dimension)
SWHE	Product: soft wheat (3rd data dimension)
1985,1986…	Year: base year (4th data dimension)

3.6.2. Population forecasts

Population forecasts are handled like default trends. Currently they are not part of the COCO database. Therefore they are separately included by the file FORC_POP.GMS with the following format:

```
-----------------------------------------------------------------------------------
*
*            source: r:\eea_outlook\dat\EEA-related\primes-key-ass.xls
*                these are auxiliary data from PRIMES interpolated with a HP filter
*
*
table TRD(*,*,*,*)
                          1985    1986    1987    1988    1989    1990    1991    1992
BL000.INHA.LEVL          10224   10227   10241   10278   10318   10350   10393   10439
CZ000.INHA.LEVL          10367   10372   10377   10385   10391   10363   10309   10318
DK000.INHA.LEVL           5113    5120    5127    5130    5132    5140    5154    5171
DE000.INHA.LEVL          61001   61043   61054   61427   62039   63230   79984   80594
EE000.INHA.LEVL           1531    1542    1554    1564    1570    1571    1568    1555
EL000.INHA.LEVL           9967    9997   10017   10037   10090   10161   10247   10322
ES000.INHA.LEVL          38421   38538   38633   38718   38793   38852   38922   39012
FR000.INHA.LEVL          56610   56898   57208   57526   57862   58171   58464   58754
-----------------------------------------------------------------------------------
```

Explanations for example:

BL000	Region: Belgium/Luxemburg (1st data dimension)
INHA	Activity: inhabitants (2nd data dimension)
LEVL	Product: level (3rd data dimension)
1985,1986…	Year: base year (4th data dimension)

3.6.3. Expert data from DG AGRI

In the reference run, we introduce expert forecasts for a number of items, because CAPSIM is not designed to be a forecasting tool. Currently, DG AGRI offers data for production, yields, levels, imports, exports, stock changes and domestic consumption for the simulation years. Where DG AGRI's production specifications do not fit those in CAPSIM, the data are disaggregated. The indices for net trade are calculated by production, exports, imports, and domestic consumption data from DG AGRI.

```
-------------------------------------------------------------------------------
*
*     SET   SRC_Rows
*           CERE        Cereals
*           COAR        Coarse grains
*           WHEA        Wheat
*           RICE        Rice
*           MAIZ        Maize
*           SWHE        Soft wheat
*           DWHE        Durum wheat
*           BARL        Barley
*           RYEM        Rye
*           OAOC        OATS & OCER
*           OILS        Oilseeds
*           RAPE        Rape
*           SUNF        Sunflower seed
*           SOYA        Soya seed
*           PULS        Pulses
*           MAIF        Fodder maize
*           OSET        Obligatory setaside
*           VSET        Voluntary setaside
*           NONF        Nonfood oilseeds
*           BEEF        Beef and veal
*           PORK        Pigmeat
*           SGMT        Sheep and goatmeat
*           POUM        Poultry meat
*           COMI        Milk
*           BTCR        Butter and Ghee
*           MILS        Milk skimmed
*           CHES        Cheese
*     /;
*
*
*     SET   SRC_Cols/
*           PROP        production
*           YIEL        yield
*           LEVL        level
*     *     specific    from DG_Agri
*           PIMP        imports
*           PEXP        exports
*           STOC        stock changes
*           IMPL        import of life animals
*           EXPL        export of life animals
*           PRON        net production equal slaughterings equal gross production
*           STKM        Ending stocks
*     /;

            SET DGA_FILE/
            Dairy2005jul
            MeatEggs2005jul
            Grains2005jul
            Grains15
            /;

TABLE DGADATA_S(*,*,*,*,*)
                                                               2003        2004

EU    .     COMI        . PROP   .Dairy2005jul              143.46      142.33
E15   .     COMI        . PROP   .Dairy2005jul              121.76      120.36
EUN10 .     COMI        . PROP   .Dairy2005jul               21.70       21.98
EU    .     COMI        . YIEL   .Dairy2005jul             5931.00     6017.93
-------------------------------------------------------------------------------
```

In the first part of this file, the products and items of the data array from DG AGRI are defined in the sets SRC_Rows and SRC_Cols. The following set DGA_FILE defines the 4th data dimension as time of publication.

Example:

EU	Region: EU (1st data dimension)
E15	Region: EU of 15 old MS (1st data dimension)
EUN10	Region: 10 new MSs (1st data dimension)
COMI	Product: Milk (2nd data dimension)
PROP	Item: production (3rd data dimension)
Dairy2005jul	Time of publication: July 2005 (4th data dimension)
2003, 2004	Time (5th data dimension)

3.6.4. Expert data from FAPRI

Border prices and quantities for the simulation years are selected from FAPRI (Food and Agriculture Policy Research Institute, University of Missouri, USA). The specific FAPRI codes are matched to CAPSIM coding.

```
-------------------------------------------------------------------------------------
SET FAPRI_PRODUCTS /
  AN         Animals and Animal Products
  AT         All Commodities
  BA         Barley
  BC         Bulk Commodities
  BK         Cereal and Bakery
  BM         Beef Imported
.
/;
SET FAPRI_ITEMS /
  GEQ         Quantity of U S  Agricultural Exports Fiscal Year
  RCH         Cash Receipts
  MDR         Modulation Rate
  UXV         Value of Net Trade
  ACN         Contracted Area
  AHH         Area Harvested
  AHT         Total Area Harvested
.
/;
SET FAPRI_REGIONS /
  U9_         United States (metric units)
  US_         United States (domestic units)
  E5_         European Union - 15
  A7_         Latin America Other
  AG_         Algeria
  AR_         Argentina
.
/;
SET FAPRI_UNITS /
  Thousand_MT_Fiscal_Year
  Billion_USD
  Percent
  Million_USD_Fiscal_Year
.
/;
TABLE FAPRIDAT(FAPRI_PRODUCTS,FAPRI_ITEMS,FAPRI_REGIONS,FAPRI_UNITS,ALLYR19)
*TABLE FAPRIDAT(*,*,*,*,*)
 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
$ONDELIM
AN,GEQ,U9_,Thousand_MT_Fiscal_Year,3693.813,4195.652,5437.492,5686.333,5524.
AN,RCH,US_,Billion_USD,0,88.293906,87.217115,92.948988,96.472345,94.198829,9
.
-------------------------------------------------------------------------------------
```

The products, items, regions and units of the data array from FAPRI are defined in the appropriate sets, followed by the data array.

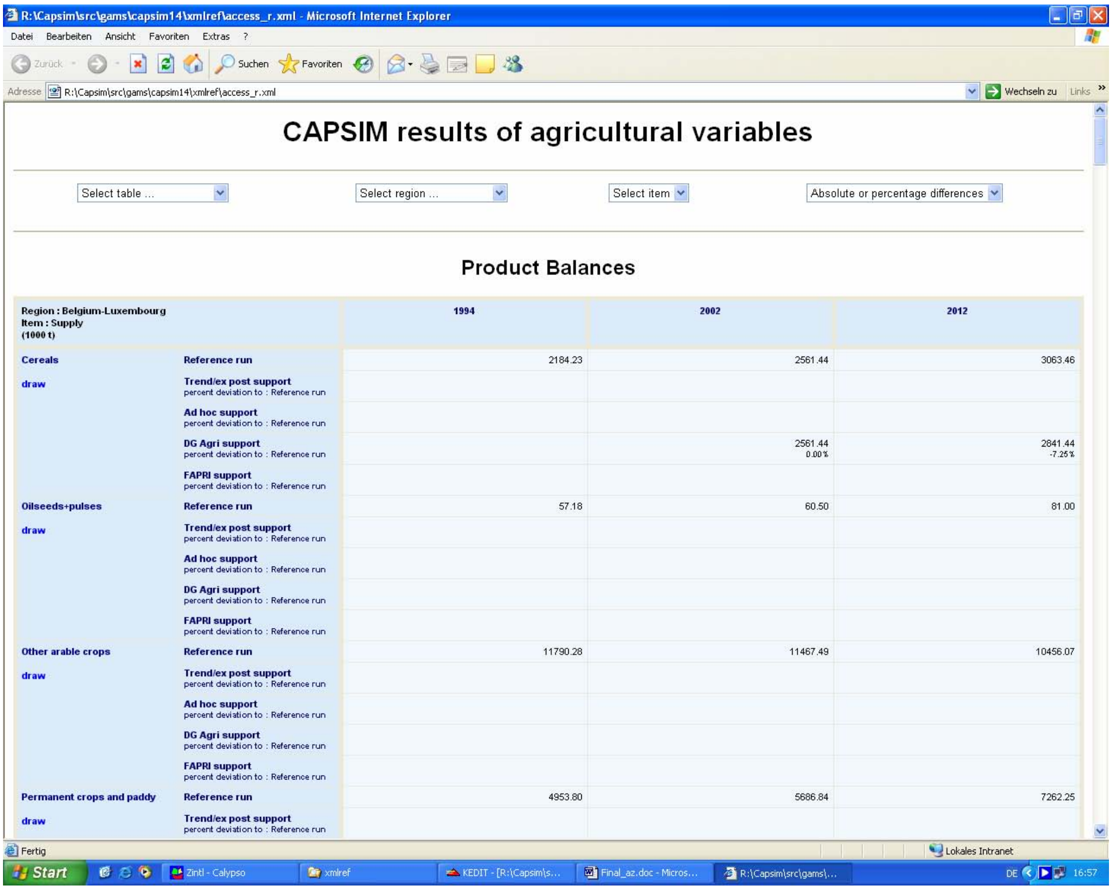
Example:

AN	Product: Animals and animal products (1^{st} data dimension)
GEQ	Item: Quantity of U S Agricultural Exports Fiscal Year (2^{nd} data dimension)
RCH	Item: Cash Receipts (2^{nd} data dimension)
U9	Region: United States (metric units) (3^{rd} data dimension)
US	Region: United States (domestic units) (3^{rd} data dimension)
U9	Inflation rate (2^{nd} and 3^{rd} data dimension)
Thousand_MT_ Fiscal_Year	Unit (4^{th} data dimension)
2003, 2004	Time (5^{th} data dimension)

3.7. INSTRUCTIONS: EXPLOITATION TOOLS

An important aspect of quality control in a process such as that described above, which produces interlink estimates for several thousand time series, is that of exploitation. It is simply impossible to check each and every series individually based on tables. Instead, a combined tabular/graphic exploitation based on XSLT/XML has been developed. The given data and estimates for each MS and the EU are stored separately for each step in XML files, including aggregation results by group of activities and products. An XSLT transformation program combines these data in the different files back into tables. The columns show the results from the different years, while the rows show the results of the reference run and the supports from trend and expert inputs. At the same time it is possible to export all model output or a subset of it in CSV format with the help of the utility 'GAMSVIEW' developed at the Institute of Agricultural Policy, University of Bonn. Maps permit to view the results in the regional dimension which is critical given that we have 24 model regions in the meantime. The maps are derived from the CAPRI mapping tool. In Table 9 the results are shown for product aggregates such as cereals and oil seeds.

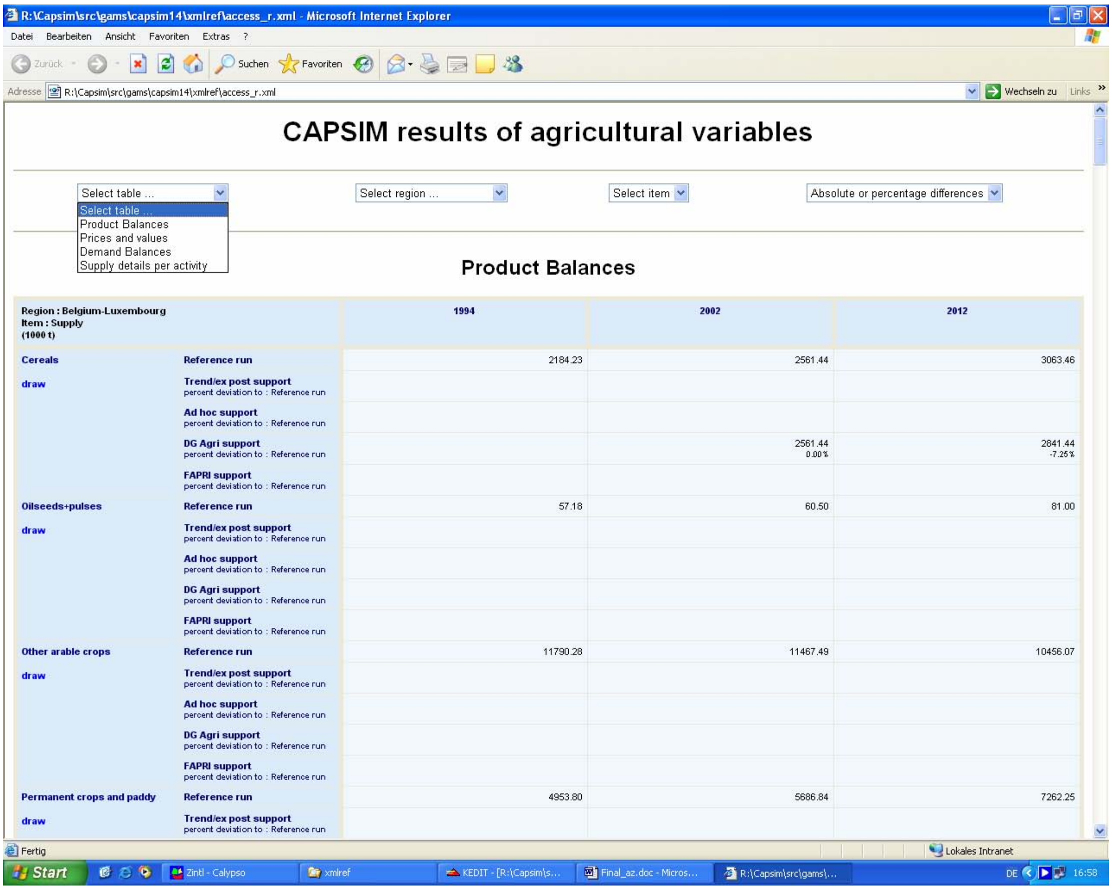
Table 9: Example 1 output from the XSLT/XML tool



Region : Belgium-Luxembourg Item : Supply (1000 t)		1994	2002	2012
Cereals	Reference run	2184.23	2561.44	3063.46
draw	Trend/ex post support percent deviation to : Reference run			
	Ad hoc support percent deviation to : Reference run			
	DG Agri support percent deviation to : Reference run		2561.44 0.00%	2841.44 -7.25%
	FAPRI support percent deviation to : Reference run			
Oilseeds+pulses	Reference run	57.18	60.50	81.00
draw	Trend/ex post support percent deviation to : Reference run			
	Ad hoc support percent deviation to : Reference run			
	DG Agri support percent deviation to : Reference run			
	FAPRI support percent deviation to : Reference run			
Other arable crops	Reference run	11790.28	11467.49	10456.07
draw	Trend/ex post support percent deviation to : Reference run			
	Ad hoc support percent deviation to : Reference run			
	DG Agri support percent deviation to : Reference run			
	FAPRI support percent deviation to : Reference run			
Permanent crops and paddy	Reference run	4953.80	5686.84	7262.25
draw	Trend/ex post support percent deviation to : Reference run			

Clicking on the aggregate name, e.g. 'Cereals', will add the components to the listing. The user can also select different tables, regions, items and data presentations from the pull down menus (see Table 10).

Table 10: Example 2 output from the XSLT/XML tool



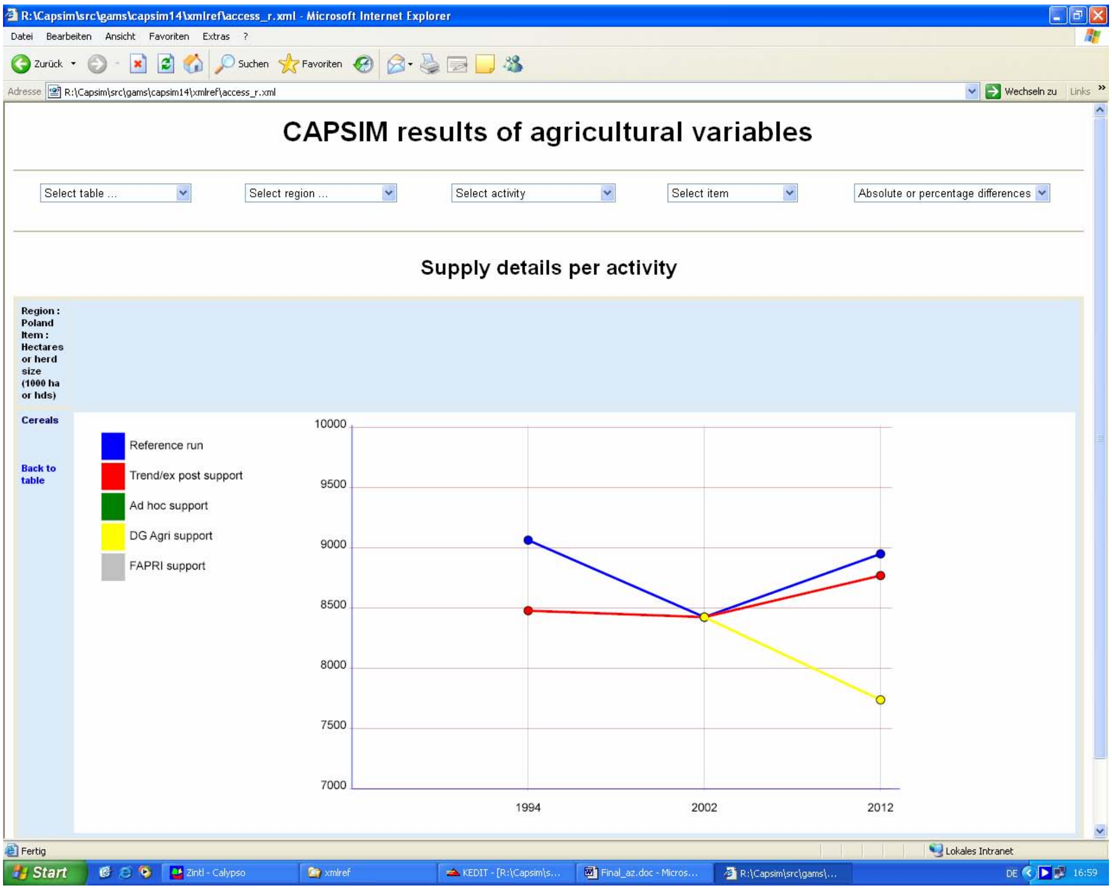
Region : Belgium-Luxembourg Item : Supply (1000 t)		1994	2002	2012
Cereals	Reference run	2184.23	2561.44	3063.46
draw	Trend/ex post support percent deviation to : Reference run			
	Ad hoc support percent deviation to : Reference run			
	DG Agri support percent deviation to : Reference run		2561.44 0.00%	2841.44 -7.25%
	FAPRI support percent deviation to : Reference run			
Oilseeds+pulses	Reference run	57.18	60.50	81.00
draw	Trend/ex post support percent deviation to : Reference run			
	Ad hoc support percent deviation to : Reference run			
	DG Agri support percent deviation to : Reference run			
	FAPRI support percent deviation to : Reference run			
Other arable crops	Reference run	11790.28	11467.49	10456.07
draw	Trend/ex post support percent deviation to : Reference run			
	Ad hoc support percent deviation to : Reference run			
	DG Agri support percent deviation to : Reference run			
	FAPRI support percent deviation to : Reference run			
Permanent crops and paddy	Reference run	4953.80	5686.84	7262.25
draw	Trend/ex post support percent deviation to : Reference run			

The tool was taken largely from the CAPRI project. However, for the problem at hand, a graphic presentation was added as shown in the next graph. The graphic tool is based on SVG (Scalable Vector Graphics)[18].

The user just has to click on 'draw' to activate the graphic presentation.

[18] A tool 'GAMSVIEW' is also available to view the GAMS listing files directly, but this is less user-friendly compared to the XSLT/XML tools and not really needed by the end user.

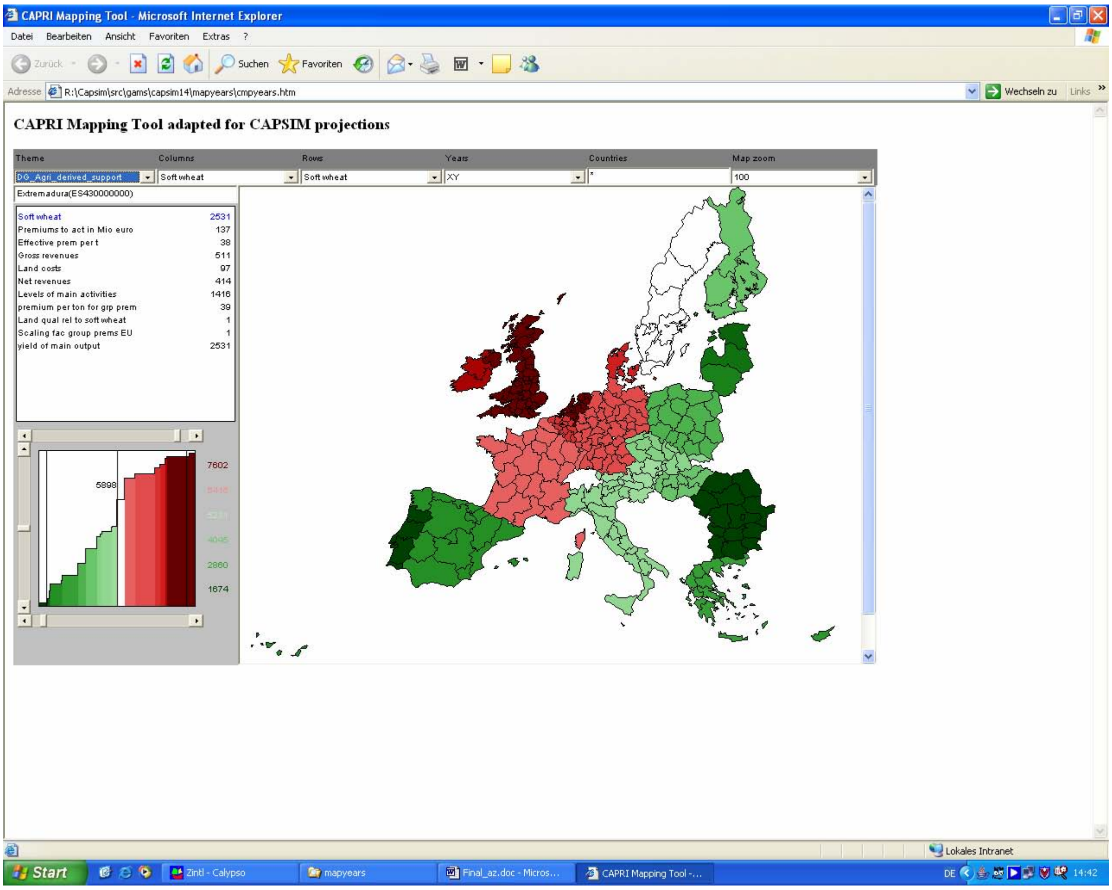
Figure 14: Using the graphical interface of the XSLT/XML tool to view trend projections for cereal levels in Poland



In the 'CAPSIM' folder, users will find the two sub-folders 'xmlref' and 'xmlsim'. To start the exploitation routine, they just need to open 'access_r.xml' (e.g. by simply double-clicking in Explorer on 'access_r.xml') in the sub-folder 'xmlref', or 'access_s.xml' in 'xmlsim'.

In addition, the CAPSIM software also has an exploitation tool to show data in maps. This tool was also taken from the CAPRI system and adapted for use in CAPSIM. For each data source and each year, CSV files are stored containing all data for every region, every activity and every product. The map shows the EU MS with their NUTS II regions (with MS results displayed without differentiation by region). From the pulldown menus, the user can select the 'Theme' (here: data sources), columns, rows, years and countries. The pulldown menu for years allows the user to select single years (e.g. BY, LY, XY) or the percentage deviation from one year to another (e.g. BY/LY). A map zoom is available to enlarge the view. When the mouse is moved over a region, the small window in the upper left hand corner will show the numerical data for that region. The colour scale is shown in the small window in the lower left hand corner.

Figure 15: Using the Map tool on reference run results for soft wheat yields in France



In the 'CAPSIM' folder, users will find a sub-folders 'mapscen'. To start the exploitation routine, they just need to open 'cmpscen.htm' in 'mapscen' to compare simulations.

3.8. CONTENT OF THE SOFTWARE DIRECTORY

This documentation is accompanied with a download option for the core software explained in section 3.1 together with all input files and a selection of associated model output (listings, xml-tables and maps). Supplementary software briefly covered in Section 3.2 (capsimdat.gms for aggregation of database to CAPSIM definitions and elasup.gms for calibration of supply side parameters) is also included but without input and immediate output files to reduce the number of files and storage requirements.

Table 11: Content of the CAPSIM code directory

Name of file	Purpose or content	Input for:
CAPREG9303.GMS	CAPREG data for average historical yields	polcal
capsim14.gms	main capsim program	
capsim14_chkd.gms	check and decompose change over time in refrun	capsim14.gms
capsim14_chks.gms	check how supports are met in refrun	capsim14.gms
capsim14_eqs.gms	model equations	capsim14.gms
capsim14_eufull.gms	start solve of full EU model	capsim14.gms
capsim14_indat.gms	read input data from trends, database, refrun etc...	capsim14.gms
capsim14_inibx.gms	ex-post initialisation + calibration of feed, milk, trade	capsim14.gms
capsim14_iniyy.gms	initialise parameter DATY with supports + fixings	capsim14.gms
capsim14_msloop.gms	start loop over MS to prepare full EU model	capsim14.gms
capsim14_sets.gms	model sets	capsim14.gms
capsim14_xml.gms	write xml files	capsim14.gms
capsim14as_France_ly.lst	listing for simulation capsim14name_of_sim_yr	
capsim14Dat.gms	aggregation from COCO data (non-core software)	
capsim14max_dec_ly.lst	listing for simulation capsim14name_of_simulation	
capsim14refrepro_ly.lst	listing for simulation capsim14name_of_sim_yr	
COMCON9304.GMS	selected COCO data (LEVL, ICOW, SUGA)	polcal
conopt3.op3	conopt option file	capsim14
conopt3.opt	conopt option file	capsim14
DAT.gms	parameter DATY from last run	
DAT_ref.gms	shortened parameter DATY from ref 120106	capsim14_indat
Database_EU000.gms	aggregated CAPSIM database	
DATas_France_ly.gms	parameter DATY from name_of_sim_yr	
DATmax_dec_ly.gms	parameter DATY from name_of_sim_yr	
DATrefrepro_ly.gms	parameter DATY from name_of_sim_yr	
demel05.prn	demand elasticities	capsim14_inibx
Elasup.gms	calibrate supply elasticities (non-core software)	
entrd0.prn	trade elasticities from WATSIM simulation	capsim14_inibx
FEOGA2005.prn	FEOGA time series up to 2005	capsim14_indat, polcal14
feosh14.prn	shares of EU MS in financing EU budget	capsim14_indat
FORC_DGA_14.prn	DG AGRI forecasts of July 2005	capsim14_indat
forc_fapri.gms	FAPRI forecasts of 2005	capsim14_indat
forc_own14.prn	Own forecasts for macro variables and expert input	capsim14_indat
forc_pop.prn	Long run population forecasts from EAA study	capsim14_indat
forc_trd2112.gms	Intelligent' trends from CAPRI	capsim14_indat
kill_model.gms	define dummy model to release memory	capsim14
kill_model1.gms	start dummy model to release memory	capsim14
labpar.prn	parameters from selected labour regressions	capsim14
Lndrent.prn	land rental prices from Ag Sit Report	capsim14_inibx
maps.gms	write csv files for mapping tool	capsim14
mapscen	csv files of scenarios for mapping tool	
MAXENTM.bas	basis with starting values for milk calibration	capsim14_inibx
mlkqrent.prn	milk quota rents	capsim14_inibx
MTRD.bas	basis with starting values for trade calibration	capsim14_inibx
NUTREQ.bas	basis with starting values for feed calibration	capsim14_inibx
PARAMS040106.GMS	supply side parameters	capsim14_inibx

Table 11 (cont.): Content of the CAPSIM code directory

POLA_As_France.PRN	activity related policy variables for sim 'as_france'	capsim14_indat
POLA_IN122005.PRN	activity related policy variables for reference run	capsim14_indat
POLA_max_dec.PRN	activity related policy variables for sim 'max_dec'	capsim14_indat
polcal14.gms	collect and assign policy variables	
polcal14.lst	listing	
POLP_As_France.PRN	product related policy variables for sim 'as_france'	capsim14_indat
POLP_IN122005.PRN	product related policy variables for reference run	capsim14_indat
POLP_max_dec.PRN	product related policy variables for sim 'max_dec'	capsim14_indat
raw_policy_dat	directory with policy variables	capsim14_indat
sugar_dat.gms	Sugar related data on producer types	capsim14_indat
sugb_elas.prn	elasticities of total sugar beet wrt determinants	capsim14_inibx
title.gms	produce informative title for DOS window	capsim14
wp122005.prn	ex-post world market prices	capsim14_indat
wrtvar.inc	write standard ourtput of parameter (DATY)	capsim14
xmlref	xml files of reference run	
xmlsim	xml files of scenarios	

A number of caveats regarding the offered CAPSIM14 code are needed.

First of all the code reflects the situation on 16.01.06 when the final report underlying this documentation was delivered to DG ESTAT. Subsequently model development proceeded for the purpose of an impact analysis for Western Balkan countries and a number of minor bugs have been removed.

It has been decided to offer this historical version to permit a reproduction of the simulations presented in this report if desired. This is not always possible because some simulations have been carried out with slightly different model versions. More precisely the decoupling scenarios of section 2.4.3 have been prepared a few months earlier than the reference run described in section 2.4.1 and the SFP experiments in section 2.4.4 dating from January 2006.

The interested reader should be able to reproduce quite exactly the results of section 2.4.4 which were the last ones obtained. In the case of the reference run of section 2.4.1 the reader will obtain somewhat different results for the following reasons: The reference run is a large scale optimisation problem with some 29000 equations and 34000 variables which usually ends after a few hours where the solver considers the change in the objective insignificant without have reduced all gradients to zero. As a consequence the solution will vary somewhat with slight changes in technical bounds, hardware and GAMS version used. This is also a reason why a reference run needs careful checking to preclude that numerical inaccuracy has led to unreasonable results. A reader repeating the reference run is thus likely to obtain a somewhat different dat.gms and xml tables.

On the contrary the technical problem is much easier in the policy simulation mode: The problem only has about 13500 equations and the same number of variables which is solved in a few minutes. If the same parameters and exogenous inputs are used the solution will be very similar regardless of hardware, GAMS version and so forth as the reader may verify if the results are compared to the original ones. The parameters from 12.01.06 are imported in dat_ref.gms as mentioned in section 3.4.2.

There are a number of usual technical difficulties when starting to install the code:

- The global variable SCRDIR identifying a scratch directory (file capsim14.gms, row 52) will have to be adjusted to an admissible path[19] to get the program running. The program code assumes that a directory d:\temp\ exists for temporary files.

- The global variable CURDIR (file capsim14.gms, row 57) will have to be adjusted to the user's directory structure.

- The graphical display in the xml directory uses a (free) SVG viewer currently downloadable from:
  http://www.adobe.com/svg/viewer/install/mainframed.html.

- The maps require a running version of Java.

Finally a warning for inexperienced users of CAPSIM: A start of CAPSIM (with "gams capsim14.gms") will overwrite any existing output in directories \mapscen, \xmlref, and \xmlsim, depending on the chosen simulation mode (see Section 3.3.1). As the current setting for the scenario is to "max_dec" for year "LY", a start of CAPSIM will overwrite the corresponding files. Consequently the user may want to save the existing (sample) output in another directory if subsequent comparisons of 'own' and 'developer' outputs are intended.

[19] Blanks in directory names may cause troubles. Also make sure that the directory name is closed with a slash ($SETGLOBAL CURDIR dirname\subdirname\). If you have to use blanks in directory names, give the path in quotes ($SETGLOBAL CURDIR "dir name\sub dir name\").

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APPENDIX I: CAPSIM CODES AND ABBREVIATIONS

CAPSIM TABLE: Column codes

Crop (or land using) activities

SWHE	Soft wheat
DWHE	Durum wheat
RYEM	Rye and meslin
BARL	Barley
MAIZ	Maize
OCER	Other cereals
PARI	Paddy rice
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
SOYA	Soya beans
OOIL	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
OSET	Obligatory set-aside
VSET	Voluntary set-aside
NONF	Non-food production on set-aside
FALL	Fallow land

Animal activities

DCOW	Dairy cows
SCOW	Other cows
BULF	Bull fattening
HEIF	Heifers
CAMF	Male calf fattening
CAFF	Female calf 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
DOMC	Domestic consumption
DOMM	Domestic use
STCM	Change in stocks, market
STKM	Final stocks on market
STCI	Change in intervention stocks
STKI	Final intervention stocks
IMPT	Imports, total
IMPE	Imports, extra
EXPT	Exports, total
EXPE	Exports, extra
EXPS	Exports, subsidised
EXPU	Exports, unsubsidised
EXPSSH	Exports, subsidised shared
EXPL	Exports of live animals
IMPL	Imports of live 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 price, 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
TREV	Tariff revenues
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

PRCY	Processing yield per tonne of raw product processed

Selected aggregates

SETA	Set-aside idling
CERE	Cereals
OILS	Oilseeds

Policy variables

QTS1	Quota on sales type 1
QTS2	Quota on sales type 2
PADM	Administrative price
TARS	Tariff, specific
TARV	Tariff, ad valorem
PAYT	Producer payment per tonne
ESUT	Export subsidy per tonne
EXPQ	Export quota
EUSE	Notified use of export quota
EFAC	Export quota scaling factor
IMPQ	Import quota

CAPSIM TABLE: Row codes

Crop products

SWHE	Soft wheat
DWHE	Durum wheat
RYEM	Rye and meslin
BARL	Barley
MAIZ	Maize
OCER	Other cereals
PARI	Paddy rice
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
SOYA	Soya beans
OOIL	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
OTHO	Vegetable fats and oils – other oilseeds
OLIO	Vegetable fats and oils - olives

RAPC	Oilcakes – rape
SUNC	Oilcakes - sunflower
SOYC	Oilcakes – soya
OTHC	Oilcakes – other oilseeds
OLIC	Oilcakes – olives
BUTT	Butter, total
SMIP	Skinned milk powder
CHES	Cheese
OMPR	Other products of milk

Input items

IGEN	General cost items
MANN	Manure nitrate
MANP	Manure phosphate
MANK	Manure potassium
UREF	Urea fertiliser
ONIF	Other nitrate fertiliser
PHOF	Phosphate fertiliser
POTF	Potassium fertiliser
IPLA	Chemical fertiliser
FPRI	Protein-rich feed imported
FENI	Energy-rich feed imported
FOTI	Feed other: imported or industrial
FEED	Animal feeding stuffs, aggregate
ENNE	Net energy lactation
CRPR	Crude protein
ICAM	Input calves male

ICAF Input calves female

Aggregate monetary positions

DEPR Depreciation

INTR Interest received

INTP Interest paid

RENT Rents and other real estate rental charges to be paid

WAGE Compensation of employees

TOOU Total output

TOIN Total intermediate input

SUBO Subsidies

TAXO Taxes linked to production

GVAD Gross value added

NVAF Net value added at factor costs

Components of net revenues of activities

PRMV Premiums to activity

EPEM Effective premium per ha or head

EPET Effective premium per tonne

GREV Gross revenues

LNDC Land costs

PRTC Protein costs

ENEC Energy costs

NREV Net revenues

Other rows

LEVL Levels of activities

SLGH Number of slaughtered heads per activity unit

SLGT Slaughtered tonnes

REST	Rest
LABO	Total labour in AWU
LABN	Salaried labour in AWU
NITF	Nitrate fertiliser
OILS	Oilseeds
CERE	Cereals
MEAT	Meat
OIPU	Oilseeds and pulses
PERE	Perennial products
OARA	Other non-perennial products
FODD	Fodder
PREM	Per ha or head premium specific for activity
HIST	Historical yields for group premium
PRET	Premium per tonne for group premium
PREMNAT	Specific premium from national budget
PREMDC	So-called decoupled MTR premium
PRETNAT	Group premium from nation budget
CEILNAT	Monetary ceiling on national premium
CEIL	Ceiling on levels for premium
CUSE	Ceiling use on levels for premium: in base year
SETR	Official set-aside rate

OTHER ABBREVIATIONS

Region codes

BL000	BELGIUM
DK000	DENMARK
DE000	GERMANY
EL000	GREECE
ES000	SPAIN
FR000	FRANCE
IR000	IRELAND
IT000	ITALY
NL000	NETHERLANDS
AT000	AUSTRIA
PT000	PORTUGAL
FI000	FINLAND
SE000	SWEDEN
UK000	UNITED KINGDOM
CY000	CYPRUS
CZ000	CZECH REPUBLIC
EE000	ESTONIA
HU000	HUNGARY
LT000	LITHUANIA
LV000	LATVIA
MT000	MALTA
PL000	POLAND
SI000	SLOVENIA
SK000	SLOVAK REPUBLIC

EU015	EUROPEAN UNION OF 15 MS
EU010	EUROPEAN UNION OF 10 MS
EU025	EUROPEAN UNION OF 25 MS

Other

CMO	Common Market Organisation
EAA	Economic Accounts on Agriculture
FEOGA	European Agricultural Guarantee and Guidance Fund
EEA	European Environmental Agency
ERS	Economic Research Service (of USDA)
FAO-WFM	FAO World Food Model
GL	Generalised Leontief
LES	Linear Expenditure System
LU	Livestock units
MS	Member State
MSs	Member States
MTR	Mid-Term Review
SFP	Single Farm Payment
SVG	Scalable Vector Graphics
WTO	World Trade Organization
XML	Extensible Mark-up Language

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Abstract

The Common Agricultural Policy SIMulation (CAPSIM) model is one of the European Commission's Joint Research Centre, Institute for Prospective Technological Studies (JRC-IPTS) in-house models used for impact analysis of the Common Agricultural Policy (CAP). It is a calibrated, comparative static, partial equilibrium model which was developed in the early 1980s by the European Centre for Agricultural, Regional and Environmental Policy Research and the University of Bonn on behalf of the Directorate General Eurostat (DG ESTAT) for agricultural policy analysis. In 2006, CAPSIM was transferred from DG ESTAT to JRC-IPTS. The CAPSIM model has a disaggregated coverage of items and individual European Union Member States and Candidate Countries. The present JRC-IPTS Technical Report describes the model structure of CAPSIM in its version from 2005 with several applications. The first part of the report focuses on explaining the model specification, particularly: supply and demand side, processing, labour, different policy regimes as applied in the CAP, trade regimes and welfare calculations. The second part describes the CAPSIM programme code in order to provide a guided tour through the technical aspects of the model for potential users.

The mission of the JRC is to provide customer-driven scientific and technical support for the conception, development, implementation and monitoring of EU policies. As a service of the European Commission, the JRC functions as a reference centre of science and technology for the Union. Close to the policy-making process, it serves the common interest of the Member States, while being independent of special interests, whether private or national.

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